Nurses’ early recognition of medical patients in transition states from acute to critical illness or cardiac arrest: The cue composition of clinical judgements.

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ABSTRACT

The purpose of this study is to identify the cue composition of clinicians' judgements for medical patients in transition states from acute to critical illness or cardiac arrest. The theoretical framework is based on Social Judgement Theory (SJT) (Hammond et al., 1988) and the Inference/Correspondence Model of Diagnostic Judgement (Hammond, 1996b). The clinical framework draws on a broad conceptualisation of severity of illness. The research thesis is that experienced medical ward clinicians frequently diagnose deterioration in clinical condition, and predict critical illness or cardiac arrest, using cues that are available before measurable indicators of physiological deterioration are evident.

A systematic review of the research literature for the years 1990 until 2002 identified predictor cues for critical illness or cardiac arrest in general ward patients. Sixty-one papers were selected for inclusion in the review. The results indicated that objective and quantitative cues were reported most frequently. However, qualitative evidence suggests subjective and perceptual cues may be used in the early recognition of deterioration (Cioffi, 2000b; Grossman & Wheeler 1997; Smith, 1988).

An empirical study using qualitative interviewing of thirty-two experienced clinicians was undertaken to investigate the cue composition of nurses' judgements and the time sequence of cues reported in clinical judgements. The findings give tentative support for the research hypothesis that subjective clinician and patient self-report data are frequently the earliest cues to patient deterioration in medical patients. There was also tentative support for the hypothesis that clinicians make diagnostic, evaluative and prognostic judgements of patients' conditions in transition states from acute to critical illness or cardiac arrest. The hypothesis that diagnoses and predictions of patient condition are often reported to be accurate in critical illness, cardiac arrest or acutely ill and "vulnerable to deterioration" outcome states was examined. The hypothesis was tentatively supported in critical illness states, weakly supported in acute and vulnerable to deterioration cases, but was not supported for cardiac arrest cases.

Tentative conclusions arising from the findings are as follows. The severity of the clinical state appears to differentiate patients more than their medical diagnosis. Nurses' judgements can be divided into three stages; initial, early and late with subjective and perceptual cues often the initial cues to medical patients' deterioration. Medical nurses' judgement tasks in the initial stages of clinical deterioration typically induce an intuitive form of cognition which supports the proposition of Cognitive Continuum Theory that the judgement task structure induces a corresponding type of cognition (Hammond, 1996a). A cues typology for medical patients in transition to critical illness or cardiac arrest is presented.

The clinical implications of the study findings and suggestions for further research are highlighted.

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## Contents

**Abstract**

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
</tr>
</tbody>
</table>

**Acknowledgements**

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii</td>
</tr>
</tbody>
</table>

**Chapter 1.**

1. Introduction.
   1.1 Critical illness and cardiac arrest in general ward patients  
   1.2 Study aims  
   1.3 Main research questions  
   1.4 Overview of the thesis

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>

**Chapter 2. Clinical concepts and the conceptual framework.**

2.1 Critical illness and severity of illness
   2.1.1 Recognising critical illness  
   2.2 Severity of illness  
   2.3 Physiological stability  
   2.4 Measuring severity of illness

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>29</td>
</tr>
</tbody>
</table>

**Chapter 3. Literature review- judgement, decision-making components of assessment and nurses' judgement tasks.**

3.1 Approaches to the study of judgement and decision-making
   3.1.1 Introduction  
   3.1.2 Research on diagnostic judgement  
   3.1.3 Social judgement theory and the inference/ correspondence model  
   3.2 The organisation of knowledge

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>32</td>
</tr>
<tr>
<td>34</td>
</tr>
<tr>
<td>37</td>
</tr>
<tr>
<td>41</td>
</tr>
</tbody>
</table>

3.3 Definitions of assessment, judgement, decision, and the judgement process as they relate to the current study
   3.3.1 Clinical reasoning and diagnostic inferences  
   3.3.2 Diagnostic tasks in nursing  
   3.4 Clinical data and cues

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>51</td>
</tr>
<tr>
<td>56</td>
</tr>
<tr>
<td>58</td>
</tr>
<tr>
<td>59</td>
</tr>
<tr>
<td>64</td>
</tr>
</tbody>
</table>

**Chapter 4. Identification of cues for the prediction of critical illness and cardiac arrest in general ward patients: A review and synthesis of evidence.**

4.1 Background information  
4.2 Aims of the review  
4.3 Objectives of the review

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
</tr>
<tr>
<td>65</td>
</tr>
<tr>
<td>66</td>
</tr>
<tr>
<td>66</td>
</tr>
</tbody>
</table>
Chapter 5. Methodology. The philosophical perspective and the research design for the empirical study.  
5.1 Introduction 151  
5.2 Epistemology 151  
5.3 The theoretical perspective 153  
5.4 Quantitative and qualitative approaches to research 158  
5.4.1 Characteristics of qualitative research 159  
5.4.2 Qualitative data 160  
5.5 Methodology 161  
5.6 Research methods 163  
5.6.1 The research relationship 163  
5.6.2 Description of the main research site and the wider research context 165  
5.6.3 Ethical issues 167  
5.6.4 Sampling decisions 168  
5.6.5 Criteria for inclusion of participants 171  
5.6.6 Data collection methods 175  
5.7 Data analysis 176  
5.8 Assessing quality in research 177  
5.8.1 Validity 178  
5.8.2 Reliability 179  
5.8.3 Generalisability or external validity 180  
5.9 Internal validity/ credibility/ authenticity 182  
5.10 Objectivity/ confirmability 187  
5.11 Reliability/ dependability/ auditability 188  
5.12 External validity/ transferability/ fittingness 191  
5.13 Utilisation/ application/ action orientation 193  
5.14 Reflexivity 193  
5.15 Strengths and limitations of the approach chosen 195  
5.16 Conclusion 197  

Chapter 6. Data analysis in the empirical study to identify cues considered important in judgements of patients’ conditions in transition states from acute to critical illness or cardiac arrest.  
6.1 Introduction 198  
6.2 Main components of qualitative data analysis 199  
6.3 Stage 1: Data collection 199  
6.3.1 Data collection using qualitative interviews 199  
6.3.2 The interview guide 202  
6.3.3 Ethics of interviewing 205  
6.3.4 The search for different types of cases 206  
6.4 Stage 2: Data reduction 213  
6.5 Stage 3: Data display 217  
6.6 Stage 4: Conclusion drawing and verification 218  
6.7 Conclusion 225
Chapter 7. Results. Cues considered important in clinicians' judgements of patients' conditions in transition states from acute to critical illness or cardiac arrest. 226

7.1 Introduction 226
7.2 Case Data 226
7.3 Research question one results 229
   7.3.1 Critical illness 230
   7.3.2 Cardiac arrest 232
   7.3.3 Acute illness and vulnerable to deterioration 234
   7.3.4 Acute illness 236
   7.3.5 Chronic illness 238
   7.3.6 Palliative care/terminal illness 238
7.4 Research question two 241
   7.4.1 Critical illness 241
   7.4.2 Cardiac arrest 255
   7.4.3 Acute illness and vulnerable to deterioration 262
7.5 Research question three 270
7.6 Research question four 273
   7.6.1 Critical illness 274
   7.6.2 Cardiac arrest 275
   7.6.3 Acute illness and vulnerable to deterioration 276
   7.6.4 Chronic illness 277
   7.6.5 Palliative care/terminal illness 278
   7.6.6 Acute illness 278
7.7 Research question five 278
7.8 Analysis of clinical judgements according to clinical speciality 286
   7.8.1 General medical ward clinicians 286
   7.8.2 Contrast cases 287
7.9 Accessing research participants at the clinical and university sites 289
7.10 Feedback and member validation 291
7.11 Discussion 293
7.12 Conclusion 301

Chapter 8. General discussion and conclusions. 303
8.1 Introduction 303
8.2 Limitations of the studies 304
8.3 Discussion of findings 307
8.4 Conclusions 309
8.5 Methodological contributions 319
8.6 Clinical and educational implications 321
8.7 Suggestions for further research 323

References 327
Appendices

Chapter 4.
Appendix 1: Quality assessment criteria
Appendix 2: Medline and CINAHL electronic search strategy
Appendix 3: Quality assessment of all primary research and review papers
Appendix 4: Hierarchy of evidence
Appendix 5: Data extraction summary sheets.
Appendix 6: Inter-rater reliability coding checks
Appendix 7: Definition of fields used in the content analysis of cues
Appendix 8: Data entry sheet for predictor cues
Appendix 9: Sample size summary core quantitative papers by clinical states
Appendix 10: Sample size summary core quantitative papers by strength of evidence
Appendix 11: Figures for calculation of applicability of 
central limit theorem
Appendix 12: Cue composition of clinical indexes
Appendix 13: Preliminary coding framework for data analysis in the empirical Study

Chapter 5.
Appendix 14: Letters of support for the study from the Director Nursing Services and a Medical Consultant
Appendix 15: Ethics approval letters
Appendix 16: Researcher’s letter of introduction to potential participants
Appendix 17: MET calling criteria
Appendix 18: Inter-rater reliability checks on interview data

Chapter 6.
Appendix 19: Interview guide
Appendix 20: Summary contact sheet for interviews
Appendix 21: Coding framework and definitions for category membership
Appendix 22: Text extracts from two interviews before coding
Appendix 23: Extracts of interview data with codes attached
Appendix 24: Examples of within-case matrices
Appendix 25: Cross-case matrices

Chapter 7.
Appendix 26: Cross-case matrix- Critical illness/ Medical Cases
Appendix 27: Cross-case matrix- Cardiac arrest/ Medical cases
Appendix 28: Cross-case matrix- Acute illness & vulnerable to deterioration/ Medical

Chapter 8.
Appendix 29: A typology of cues for the prediction of critical illness and cardiac arrest in general medical patients
Appendix 30: Publications/ conference abstract related to research.
List of Tables
Chapter 4. Identification of cues for the prediction of critical illness and cardiac arrest in general ward patients: A review and synthesis of evidence.
Table 1: Summary table of search process 80
Table 2: Data extraction sheet 84
Table 3: Summary of 65 core papers included in review according to clinical states 89
Table 4: The time relationship of cues to events for cardiopulmonary arrest papers 92
Table 5: A simple 2x2 table 95
Table 6: Table 6: Results for Fisher’s exact test computed for cues in cardiopulmonary arrest and non cardiopulmonary arrest papers 96
Table 7: Results for Fisher’s exact test computed for cues in critical illness and non critical illness papers 99
Table 8: Results for Fisher’s exact test computed for cues in early post operative complications and non early post-operative complications papers 102
Table 9: Results for Fisher’s exact test computed for cues in readmission to ICU and non readmission to ICU papers 105
Table 10: Results for Fisher’s exact test computed for cues in-hospital mortality/ outcome and non in-hospital mortality / outcome papers 108
Table 11: Results for Fisher’s exact test computed for cues in strong and non- strong papers 111
Table 12: Results for Fisher’s exact test computed for cues in moderate and non- moderate papers 113
Table 13: Results for Fisher’s exact test computed for cues in weak and non- weak papers 115
Table 14: Clinical indexes reported in core quantitative papers in the systematic review according to their function 116
Table 15: Evaluation of clinical indexes reported in quantitative papers in systematic review 129
Table 16: Clinical indexes reported in quantitative papers in systematic review by clinical states predicted 133
Table 17: Quality appraisal summary table for qualitative papers 137
Table 18: Summary of cues identified in qualitative papers 142

Chapter 5. Methodology. The philosophical perspective and the research design for the empirical study
Table 19: Interview study participants- summary of biographical data 172
Table 20: Comparison of clinicians accessed at clinical and university sites 173
Table 21: The main medical conditions for patient cases 174
Table 22: Total number of cases for clinical outcome states 175
Chapter 7. Results. Cues considered important in clinicians' judgements of patients' conditions in transition states from acute to critical illness or cardiac arrest.

Table 23: Critical illness cases - subjective data as earliest cues 242
Table 24: Critical illness cases - subjective data complementary to objective cues 249
Table 25: Critical illness cases - objective measures as earliest cues 254
Table 26: Cardiac arrest cases - subjective data as earliest cues 256
Table 27: Cardiac arrest cases - subjective data complementary to objective cues 260
Table 28: Cardiac arrest cases - objective measures as earliest cues 262
Table 29: Acute illness and vulnerable to deterioration - subjective data as earliest cue 263
Table 30: Acute illness and vulnerable to deterioration - subjective data complementary to objective cues 266
Table 31: Acute illness and vulnerable to deterioration - objective measures as earliest cues 269
Table 32: Accuracy of clinicians' self-report of patients' current and predicted condition - critical illness cases 274
Table 33: Accuracy of clinicians' self-report of patients' current and predicted condition - cardiac arrest cases 275
Table 34: Accuracy of clinicians' self-report of patients' current and predicted condition - acute and vulnerable to deterioration cases 276
Table 35: Accuracy of clinicians' self-report of patients' current and predicted condition - chronic illness cases 277
Table 36: Accuracy of clinicians' self report of patients' current and predicted condition – acute illness 278

List of Graphs
Chapter 4. Identification of cues for the prediction of critical illness and cardiac arrest in general ward patients: A review and synthesis of evidence.
Graph 1: Core quantitative papers 91
Graph 2: Cardiopulmonary arrest papers 94
Graph 3: Critical illness papers 98
Graph 4: Early post-operative complications papers 101
Graph 5: Readmission to ICU papers 104
Graph 6: In-hospital mortality/ outcome papers 107
Graph 7: Strength of evidence papers- strong 110
Graph 8: Strength of evidence papers- moderate 112
Graph 9: Strength of evidence papers- weak 114
Graph 10: Core quantitative papers- 95% confidence intervals 119
Graph 11: Cardiopulmonary arrest papers- 95% confidence intervals 120
Graph 12: Critical illness papers- 95% confidence intervals 120
Graph 13: In-hospital mortality/ outcome papers- 95% confidence intervals 121
Chapter 7. Results. Cues considered important in clinicians' judgements of patients' conditions in transition states from acute to critical illness or cardiac arrest.

Graph 17: Patient history according to clinical outcome categories
Graph 18: Critical illness cases
Graph 19: Cardiac arrest cases
Graph 20: Acute illness and vulnerable to deterioration cases
Graph 21: Acute illness cases
Graph 22: Chronic illness cases
Graph 23: Palliative care/terminal illness cases
Graph 24: Critical illness and cardiac arrest cases combined

List of Figures
Figure 1: Framework of severity for the prediction of critical illness or cardiac arrest in adult general ward patients
Figure 2: Stable and unstable states
Figure 3: The Lens Model
Figure 4: Model of clinical sub-states preceding critical illness and cardiac arrest
Figure 5: Stages in the search process
Figure 6: The coding framework
Figure 7a & 7b: Clinical judgements and models derived from large numbers of cases
Chapter 1

1. Introduction

Critical care services in England have been the subject of two extensive reviews (Audit Commission, 1999; Department of Health (DH), 2000). One of the most significant outcomes has been an expanded definition of critical care that includes ward patients with developing critical illness as well as patients in intensive care. Previously, critical care patients had been classified according to the level of organ support they required, and by their location in intensive, high dependency or post-operative recovery-care (DH, 1996). Comprehensive critical care, the term given to the new critical care specialty, is focused on the care of the critically ill, and those at risk of critical illness or recovering from it, irrespective of their location (DH, 2000). Evidence of poor recognition of acute deterioration in general ward patients’ conditions or inadequate responses to recognised problems focused attention on the continuum of critical care provision from before admission to the critical care unit, within the unit, and after discharge from critical care.

There is now a sicker in-patient population on general wards than previously. This has been attributed to factors such as reduced lengths of hospital stay, a greater emphasis on the management of patients’ care in the community and more routine surgery taking place in day surgery units (Audit Commission, 1999; Hillman et al., 1999). The demand for intensive care unit (ICU) beds has continued to grow placing increased pressure on this resource (DH, 1996) and more frequently acute ward staff are caring for patients with either developing critical illness, episodes of critical illness or patients recently discharged from ICU (Coad & Haines, 1999). Added to this complex treatments that were previously undertaken in critical care areas increasingly occur on acute general wards (Coad & Haines, 1999). An active approach to the early detection and treatment of potentially life-threatening problems might ease the pressure on ICU beds and improve outcomes for patients by intervening before their condition becomes life-threatening (Bion, 1999).
1.1 Critical illness and cardiac arrest in general ward patients

Deficiencies in the recognition of patients with developing critical illness have been described in some detail. Patients with developing critical illness on general wards sometimes receive sub-optimal care prior to ICU admission and this has contributed to increased morbidity and mortality (McGloin et al., 1999; McQuillan et al., 1998). McGloin and colleagues define sub-optimal care as failure to recognise a problem or inadequate intervention. Delay in the recognition of signs of deterioration and late referrals to ICU have contributed to many admissions that could have been avoided (Garrard & Young, 1998; McQuillan et al., 1998). Higher mortality rates are reported in patients admitted to ICU from general wards compared to operating, recovery or accident and emergency departments; patients admitted to ICU after cardiopulmonary resuscitation account for 30% of all deaths (Goldhill & Sumner, 1998b). High mortality rates on general wards following discharge from ICU have also been recorded (Goldhill & Sumner, 1998b; Wallis et al., 1997). In particular early discharge from ICU is associated with increased mortality (Daly et al., 2001). Many cardiac arrests in general ward patients could be avoided (Hodgetts, 2000). Only 15% of patients who have a cardiac arrest in hospital survive to discharge (Tunstall-Pedoe et al., 1992).

Cardiac arrest in general ward patients often occurs as a result of non cardiac processes, it represents the end stage in major clinical deterioration, and contrasts with patients experiencing cardiac arrest due to acute cardiac conditions (Schein et al., 1990). Evidence for premonitory signs and symptoms of cardiac arrest have been found in both the medical and nursing notes of many cardiac arrest patients and sometimes the urgency of these clinical signs has not been recognised (Franklin & Mathew, 1994; Schein et al., 1990; Smith & Wood, 1998). Deterioration in mental status, acute dyspnoea in patients with pre-existing chronic pulmonary disease, and patients admitted in unstable conditions (i.e. emergency admissions) who subsequently deteriorate, are amongst the most significant signs indicating very high risk for cardiac arrest (Franklin & Mathew, 1994; Sax & Charlson, 1987a). Patients may also go on to cardiac arrest as a result of system failures. The clinical response to
recognised deterioration may be inadequate for some patients with premonitory signs and symptoms of cardiac arrest (Franklin & Mathew, 1994).

Recognition of the potential to improve patient outcomes by intervening earlier in developing critical illness led to the Medical Emergency Team (MET) initiative in the early 1990s in Australia (Lee et al., 1995). The MET system drew on some of the principles of trauma teams, which aimed for early recognition and swift response to problems by a team of experienced clinicians and replaced the usual cardiac arrest team. It could be summoned by medical or nursing staff when they were concerned that a patient was at risk of cardiac arrest or critical illness, and for patients in cardiac and/or respiratory arrest. Pre defined MET calling criteria included abnormalities of the airway, breathing and circulation and were based on clinical judgement and research evidence. This system has since been adopted in the UK and currently a number of indexes are in use for the identification of significant clinical deterioration in hospital patients, and those in need of emergency intervention/resuscitation. Whether the emergency teams are constituted as medical emergency, or patient at risk teams depends on the local arrangements (Hodgetts et al., 2000; Goldhill et al., 1999).

The various early warning indexes currently used to summon emergency assistance all have a similar composition; they contain a list of mainly objectively measured criteria with the more subtle subjective elements being subsumed under the global term of doctor or nurse concern (Daffurn et al., 1994; Hourihan et al., 1995). Evidence of the effectiveness of medical emergency and patient at risk teams in preventing cardiac arrest and improving patient survival was initially tentative (Bristow et al., 2000; Goldhill et al., 1999). Reduced rates of unplanned admissions to ICU/HDU were demonstrated by Bristow et al., (2000) and fewer patients needed cardiopulmonary resuscitation if seen by the patient at risk team before ICU admission compared to those not seen (Goldhill et al., 1999). Some inconclusive findings could have been due to the calling criteria being underused (Buist et al., 1999; Crispin and Daffurn, 1998), or because they did not pick up all seriously ill
patients (Goldhill et al., 1999). Whilst there was limited evidence of the effectiveness of outreach teams and the use of early warning scoring tools initially (McArthur-Rouse, 2001), recent publications have shown encouraging results (Ball et al., 2003; Bellomo et al., 2003; Pittard, 2003; NORF, 2003).

Medical teams responsible for the care of patients on general wards have varying levels of expertise in the resuscitation of the seriously ill, and this could have an impact upon the care of critically ill patients where treatment delays could be life-threatening (Bion, 1999). A recent survey found that many junior doctors lacked basic knowledge about the signs indicating critical illness (Smith & Poplett, 2002). The Royal College of Physicians of London (RCPL, 2002) comments that the trend towards medical specialisation often leaves emergency medical admissions under the care of more junior medical practitioners. Specialist qualifications in acute medicine could establish emergency medicine as a separate speciality with its own designated medical consultants enabling this patient group to receive the required level of medical care (RCPL, 2002).

General ward nurses are in an ideal position to identify and refer patients with developing critical illness; they may also instigate straightforward interventions such as oxygen administration or nasopharyngeal/oropharyngeal suctioning that could help to avert further deterioration. However the current problems with recruitment and retention of nursing staff in the NHS have affected the capacity of the system to retain experienced nurses on the general wards; workforce development is now a priority (DH, 2000; NHS Executive 2000).

Critical care outreach teams were set up in an attempt to address the apparent deficiencies in ward-based critical care. Critical care services in the UK were given an added boost in 2000/2001 by the allocation of £145 million for the formation of outreach teams, more critical care beds and post-operative intensive recovery facilities (NHS Executive, 2000). The partnerships between critical care professionals, other professionals, and patients, based on patient need rather than location, as advocated by the Department of Health (DH, 2000) have undergone rapid
development. Critical care outreach teams are now part of the clinical landscape in general ward care and are playing a key role in the education of ward staff. Formal courses such as *Acute Life-threatening Events Recognition and Treatment* (Smith, 2003), and the Greater Manchester Multi Professional Critical Care Programme (2001) also provide general ward staff with valuable clinical skills in the recognition and treatment of patients at risk of critical illness and cardiac arrest.

The clinical environment of the general ward is complex and constantly changing. A recent survey by Chellel *et al.*, (2002) suggests that low nurse-patient ratios on general wards could be a factor when basic observations are not performed. Increasingly the *task* of physical observations is performed by health care assistants rather than qualified nurses. However physical assessment requires much more than the completion of basic observations; inexperienced personnel could miss important clinical signs.

Clinicians use clinical signs and symptoms as cues in their clinical judgements of patients’ conditions. These cues take the form of observations or laboratory data derived using an independent measure, or objective data, subjective clinician data obtained through the clinician’s observation or palpation, the patient’s self report of symptoms, and the patient’s history (Hammond, 1996b). Signs that can be measured independently and readily quantified generally receive more attention in assessment tools such as the patient at risk scores for predicting critical illness and cardiac arrest. Feinstein (1987) argues that greater attention should be paid to the symptoms and physical signs used to describe human phenomena in clinical practice, there is currently a tendency to rely on data that can be independently measured.

Clinical judgement is frequently reported as a core process in the assessment of critically ill patients. Clinical judgement is required to differentiate between patients requiring different levels of care. This includes patients whose needs can be met through normal ward care (level zero patients), and ward patients who require the extra input of a critical care team because their conditions could deteriorate, or they have recently been moved from higher levels of care (level one patients) (ICS, 2003).
2002a). The Intensive Care Society Guidelines (2002a) state that patients' level of care involves assessing physiological reserve, disordered physiological values, underlying condition/surgery, and the interventions or monitoring needed. Where a patient cannot readily be assigned to a level of care clinical judgement should be used to categorise the patient according to the most relevant level, with the safeguard that the higher level would be selected in uncertain situations. General ward nurses make these clinical judgements when they assess the physical condition of their patients. To identify the patient at risk of deterioration the ICS (2002b) advocate using the criteria of abnormal physical signs, the patient's condition or pre-morbid history (such as major emergency surgery), and the clinician's intuition that a patient's condition is 'not quite right'. The ICS emphasises the importance of intuition in the identification of critical illness acknowledging that any threshold criteria in physiological scoring systems could not be totally accurate, so that some patients with developing critical illness could be missed. Cioffi's (2000b) criteria of poor colour, agitation, or generally being not right are presented as sufficient criteria to place a patient in the at risk of deterioration category (ICS, 2002b).

Clinical judgement and physiological early warning scores are therefore complementary in the identification of the critically ill in general wards. The National Outreach Forum (NORF, 2003) reports that early warning scores or track and trigger tools for referring patients to the critical care outreach service are supporting clinical judgement rather than replacing it. In hospitals responding to the National Critical Care Outreach Survey in England in 2002, 66% reported using other methods to complement track and trigger tools to identify patients at risk of critical illness, and in 49% of these cases the criterion used was nursing or medical staff concern (NORF, 2003).

Ward clinicians need to elicit help in the management and treatment of patients who are deteriorating, and to do so they are required to exercise clinical judgement as well as apply the early warning physiological scores. The process of making clinical judgements about patient conditions may well be more complex and comprise more
cues than the scores imply, as a range of clinical data are available to clinicians. In Bellomo et al., (2003) the MET criterion worried about the patient was the most frequently reported criterion used to alert the MET, providing further evidence that skilled clinical judgement is crucial.

Critical care and experienced general ward staff contribute complementary skills and expertise to general ward patients in need of critical care. The former have skills in the assessment and treatment of actual critical illness, whereas experienced ward clinicians often recognise clinical deterioration and make the initial referral to the critical care outreach or medical staff. However the judgement process leading up to the decision to refer requires further investigation as critical illness is complex. The mainly objective measures cited as early warning criteria may represent late stages in the illness trajectory for some patients. Clinical data in the form of signs and symptoms recorded in clinicians’ subjective assessments may be important in the early recognition of clinical deterioration; they may even be present before significant changes in objectively measured signs have been noted (Cioffi, 2000a; Cioffi, 2000b; Grossman & Wheeler, 1997; Smith, 1988). These additional data are the focus of the current investigation. Early warning scores could have increased predictive validity if the cues that contribute to the judgement of nurse/ doctor concern about patient condition could be identified and defined.

Schein et al., (1990) note that medical ward patients sustain cardiac arrest more frequently than other groups and Franklin and Mathew (1994) identify medical patients recently transferred from ICU as being at higher risk of cardiac arrest than other medical patients. Previous research has not focused on experienced medical ward nurses’ clinical judgements in the recognition of deterioration and prediction of critical illness or cardiac arrest. Cioffi’s study (2000b) investigates clinicians’ accounts of using the MET criterion nurse/ clinician concern but does not analyse these according to clinical speciality or the timing of cues considered important in clinical judgements about the state of the patient. There is a need for greater understanding of experienced nurses’ knowledge relating to the early recognition of
critical illness and prediction of cardiac arrest so that this knowledge may be shared and more widespread acquisition of skills in the early recognition of developing critical illness achieved.

1.2 Study Aims
This thesis aims to examine the research evidence for predictors of critical illness and cardiac arrest in general ward patients, and to investigate the cues experienced clinicians consider important in judgements of patient condition in transition states from acute to critical illness, or cardiac arrest. The cues considered important could then be compared with those identified as predictive in research evidence. A further aim is to develop a clearly articulated framework to present the information underpinning general medical ward clinicians' judgements of patient condition in transition from acute to critical illness or cardiac arrest. This cue identification or descriptive phase of research is an important precursor to later research where the accuracy of clinicians' judgements could be examined using the Judgement Analysis approach (Cooksey, 1996b). A clinical conceptual framework based on severity of illness and critical illness guides the investigation.

1.3 The main research questions
1. What are the predictors of critical illness and cardiac arrest reported in the research literature?
2. What cues do general medical ward clinicians consider important in judgements of patient condition in transition states from acute to critical illness or cardiac arrest?
3. What are the earliest cues in judgements of deterioration and prediction of critical illness or cardiac arrest in general medical patients?
4. Does the study's conceptual framework based on a broad conceptualisation of severity of illness, critical illness, and the cue identification phase of judgement analysis provide a useful framework for general medical ward clinicians' judgements
of patient condition in transition states from acute to critical illness and cardiac 
arrest?

The research comprises two related but separate studies. The first study is a 
systematic review and synthesis of research evidence for predictor cues for critical 
ilness and cardiac arrest in general ward patients. The second study uses qualitative 
interviews to examine clinicians’ reports of the cue composition of their clinical 
j judgements. The research thesis examined is that:

*Experienced medical ward clinicians frequently diagnose deterioration in clinical 
condition and predict further deterioration in condition, critical illness or cardiac 
arrest using cues available before measurable indicators of physiological 
deterioration are evident.*

1.4 Overview of the thesis

**Chapter 2** analyses the clinical concepts and introduces the clinical conceptual 
framework for the research based on severity of illness and critical illness. 
**Chapter 3** reviews approaches to the study of judgement and decision making 
focusing on diagnostic judgement and the cue composition of clinical judgements, the 
aspects addressed in the current research. The organisation of knowledge, domain 
specific knowledge and expertise are examined. The processes of assessment, clinical 
reasoning and diagnostic inference are discussed and a working definition of 
assessment is presented. Diagnostic tasks in nursing are identified, and the term *cue* is 
defined for this research. The relevance of *Cognitive Continuum Theory* (Hammond, 
1996a) for the current investigation is also explored.

**Chapter 4** reports on a systematic review and synthesis of research evidence of 
predictor cues for critical illness or cardiac arrest in general ward patients (study 1). 
The composition and predictive success of existing early warning scores are also 
analysed. A preliminary coding framework arises from the findings of the review and 
is used in the subsequent empirical study.
Chapter 5 discusses the methodology underpinning the systematic review (study 1) and the empirical study (study 2). A qualitative study using semi-structured depth interviews with experienced clinicians was undertaken to elicit cues they consider important in judgements of patient condition and to examine the evidence for the predictive qualities of these cues for critical illness and cardiac arrest.

Chapter 6 describes the methods of data collection and data analysis used in the empirical study.

Chapter 7 presents the results from the empirical study. Various clinical outcome categories and the cues considered important are identified. The judgements reported by clinicians are examined and categorised by type. The severity of illness concept provides an organising framework encompassing the cues considered important in the prediction of the patient's clinical state.

Chapter 8 discusses the findings from the two studies in the light of their limitations and presents tentative conclusions. The data on cues from the two studies are linked and a typology of cues considered important in judgements of patient condition and prediction of critical illness and cardiac arrest, in general medical patients, is proposed.
2. Critical Illness and Severity of Illness

The clinical framework for this research is based on two concepts, critical illness and severity of illness. Therefore definitions of both concepts as they are used in this thesis are presented. The relative usefulness of the critical illness and the severity of illness concepts for the current research are considered. Approaches to the measurement of severity of illness are then analysed.

2.1 Critical Illness

The term critical, in the context of illness, is defined as very seriously ill or injured (Collins Pocket English Dictionary, 1998). Critical illness refers to discrete clinical states where the patient's life is threatened, or is potentially at risk and includes patients with instability, deterioration, or failure in the body systems such as the respiratory, cardiovascular, neurological, metabolic and haematological systems, and abnormal temperature.

Deterioration refers to a condition that is gradually worsening (Mosby's Medical, Nursing & Allied Health Dictionary, 2002). Continued deterioration in the major body systems is likely to result in a catastrophic event such as cardiac or respiratory arrest, unplanned admission to ICU, or death. Cardiac arrest or cardiopulmonary/cardiopulmonary/cardiorespiratory arrest is the most critical of the critical illness states and is defined as absent pulse and loss of blood pressure and spontaneous respiration. Andreasson et al., (1998) identify three main sub-categories of patients with in-hospital cardiac arrest as follows: Firstly, those with end stage terminal illness in whom death would be expected and where resuscitation would achieve little. Secondly, patients who unexpectedly had a cardiac arrest; and thirdly, between these two extremes, patients with life-threatening illness and some possibility of recovery. For the third group, improved understanding and recognition of early signs of clinical deterioration could
significantly affect outcome. The current patient at risk and MET scores are designed to identify critical illness or patients at risk of critical illness or cardiac arrest across all hospital departments using indicators of disordered physiology, or physiological severity, and they represent a change in approach to the management of critical illness.

Until recently the geographical location of patients in intensive care, high dependency or post-operative recovery units tended to define patients as critically ill. Intensive care was considered appropriate for patients "... requiring or likely to require advanced respiratory support, patients requiring support of two or more organ systems", and patients with severe chronic illness impairing their daily activities and acute failure in another system that is reversible (DH, 1996, p.8). High dependency was indicated for patients with a single failing organ system, but excluded those needing advanced respiratory support. It would provide more detailed observation or monitoring than could safely be provided on a general ward, and could act as a receiving area for patients discharged from intensive care who were not sufficiently well for the general wards (DH, 1996, p.8). Post-operative patients requiring monitoring beyond a few hours would also fulfil high dependency criteria (DH, 1996). The main concepts underpinning this classification of critical illness are severity of illness (reflected in organ system failure or physiological severity and need for support) and the patients’ level of dependency on nursing care (DH, 1996).

In the new specialty of *Comprehensive critical care* the emphasis is on patients at risk of critical illness as well as on the care of the critically ill (DH, 2000). Earlier references to intensive and critical care stated that it should be directed towards patients with "potentially recoverable conditions" (Audit Commission, 1999; DH, 1996). In the expanded definition of critical care (DH, 2000) which includes acutely ill patients, this is omitted. The concept of severity of illness still provides the theoretical foundation in critical care but the focus tends to be more on the consequences of severity of illness such as patient dependency and therapeutic requirements or need for organ support. The new levels of care (DH, 2000) represent
a pragmatic approach to the problem of assigning patients to particular areas in the hospital for the provision of medical and nursing care. Patients may be assigned to one of four levels as follows: -

Level 0 - Patients whose needs can be met through normal ward care in an acute hospital.
Level 1 - Patients at risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team.
Level 2 - Patients requiring more detailed observation or intervention including support for a single failing organ system or post-operative care and those 'stepping down' from higher levels of care.
Level 3 - Patients requiring advanced respiratory support alone or basic respiratory support together with support of at least two organ systems. This level includes all complex patients requiring support for multi-organ failure. (DH, 2000, p.10).

Patients' conditions are unlikely to remain static; patients categorised as level one may be clinically unstable and have co-existing conditions giving them the potential to reach level three needs within a very short time period, whereas a level two patient's condition may be clinically stable with recovery in progress. Classification of any patient must be kept under review. Nor may the boundaries between the various levels of care be as clear cut as the (DH, 2000) classification implies; the categories may even overlap. The DH (2000) report implies that the four levels are made up of discrete categories; the clinical reality may be more complex. The recent Guidelines for the introduction of outreach services (ICS, 2002, p.7) presents a linear model of patients' levels of dependency ranging from well at level zero dependency, through to sick patients categorised at level three dependency. Whilst this model depicts the overall population through time, individual patients' profiles may be much more complex or even non-linear. The patient's location is also a factor when considering the overall risk of critical illness or cardiac arrest. A sick patient in a general ward may be at greater risk than a similar patient in critical care because the
ability to recognise further problems and intervene quickly should be greatest in critical care.

2.1.1 Recognising critical illness
Critical illness is difficult to measure because it is the product of two major factors, one being the patient’s physiological reserve, and the other is the extent and nature of the acute disease (Bion & Bennett, 1999). Both need to be considered when making judgements about severity of illness, but neither of these can be accurately measured (Bion, 1999). Physiological reserve refers to biological and physiological severity and in particular genetic factors, cardiac reserve, immune and nutritional status (Bion, 1999). Bion asserts that impaired organ system function can be detected by clinicians but genetic and lifestyle factors that affect physiological reserve, such as infection risk and cardiovascular function, are more difficult to quantify. Measures that are used as substitute indicators for physiological reserve include family history, physical appearance, extent of independence in the activities of living and social factors (Bion, 1999). Some patients cope better with particular problems such as trauma, surgery or infection, whereas others with limited reserve can become severely ill.

Clinicians need to be able to identify patients with reduced physiological reserve or early critical illness, and they need to intervene quickly (Bion, 1999). Certain patients should always be categorised as critically ill and receive medical care from experienced clinicians: Patients with unstable or worsening physiology—hypoxaemia, hypotension, tachypnoea, and metabolic acidosis (Bion, 1999). Patients with known precursors to critical illness need to be detected and given effective treatment such as those with systemic oxygen debt, or impaired myocardial function (Bion, 1999).

Health-illness states range on a continuum from no illness to mild, moderate, severe and moribund illness in the most severe cases (Sax & Charlson, 1987a). The concept of critical illness could be viewed as a sub-category of types of illnesses or conditions occupying one part of the health-illness continuum. The most critically ill patients would be described as severely ill or moribund; however the terminally ill, or patients
at the end of life could also be described as severely ill. The difference lies in the patient’s potential for recovery in the case of critical illness, compared to patients at the end of life, who may have conditions described as non-recoverable. Critical illness is the state being predicted and severity of illness refers to important dimensions relating to this state.

2.2 Severity of Illness
Severity of illness is an abstract concept and various definitions have arisen depending on the perspective and purpose of the person using it. According to Iezzoni (1989) physicians focus on the effect of a disease on an individual’s physiological status and prognosis; psychiatrists are mainly interested in cognitive dysfunction; physiotherapists and occupational therapists are mainly concerned with functional abilities and ability to undertake activities of living; and health care managers focus on the resource implications of severity of illness. Nurses draw on physiological, psychological and functional abilities but the purpose is not described (Iezzoni, 1989). Nurses generally take a holistic view of patients and their situations and focus on the range of functional responses to illness and other life events (Gordon, 1982). From the nursing perspective severity of illness would be used to assess the patient’s condition and requirements for nursing care, to provide assistance in activities of living as required, to provide psychological support and to decide when referral to medical staff should happen. Aronow (1988) presents a similar analysis of definitions of severity adding that the nurse perspective refers to pathophysiology, but concentrates more on the patient’s psychological and activity dependency status. Management or finance definitions tend to associate severity with increased use of health care resources (Aronow, 1988).

Illness severity has been defined as the “... degree and impact of change on health status of an individual as a result of illness or injury” (Kreitzer et al., 1982, p.21). This is a useful definition as it captures the focus of the clinician’s assessment - how the patient’s condition or health status is changing as a result of a health problem.
Crow and Spicer (1995) found that district and general nurses used the concept of severity to classify patients' medical conditions as either curable, long-term chronic, long-term extremely disabling or life threatening. These subdivisions of severity were associated with abstract properties such as “usually recovers, lasts for years, greatly affects lifestyle and could die” which in turn were associated with the particular medical condition and effects on mobility, lifestyle, pain and other factors (Crow & Spicer, 1995, p.418). Lamond (1998) studied the nurses' hand-over report in medical and surgical wards and found evidence that the severity of illness concept was used to distinguish between patients likely to recover compared to those who would not. It seems likely that nurses use dimensions of severity of illness and functional indicators of illness in a way that is complementary to medicine as they focus on functional ability, personal and psychological status as well as physiological aspects. From the nursing perspective severity of illness seems to cover more than biological or physiological dimensions; the study’s conceptual framework described below therefore reflects a broad interpretation of severity of illness.

A comprehensive framework of severity of illness identifies biological, physiological, functional severity, burden of illness and other factors such as personal characteristics and environment as important dimensions (Stein et al., 1987). The purpose of the severity measure and whether it is used to predict, control or measure outcome, should determine the most relevant severity constructs to use in a particular context (Stein et al., 1987). Biological severity refers to the biological presentation of conditions at the most fundamental molecular, genetic and enzymatic levels but these are not yet directly accessible to measurement. Stein and colleagues report that severity of illness is investigated by substituting other clinically available indicators of severity, physiological severity, functional severity and burden of illness, which describe aspects of the disease or condition, how the person is affected, and effects on the social or family unit respectively. Functional severity refers to the effect of a disorder on a person's ability to manage activities of daily living, rather than effects on a specific organ or body system and it can be used to compare severity in different conditions. Severity may also be measured from the burden of illness perspective thus
assessing the impact of disease or condition on the family unit or society (Stein et al., 1987).

The definition of severity of illness used in this thesis is of the comprehensive type after Stein et al., (1987). The dimensions of severity of illness most relevant for clinicians assessing acutely ill patients and identifying those at risk of critical illness or cardiac arrest include physiological severity, functional severity, personal factors such as age, medical history, physiological reserve and psychological status, and burden of illness. Critical illness impacts on the health care system, the individual and his family or social unit and these factors are included in the burden of illness dimension of severity of illness (Figure 1). Within the health care system the patient’s nursing condition, commonly understood as dependency, contributes to nursing workload, and the patient’s medical condition is linked to medical workload. Interestingly within this framework a patient could be highly dependent on nursing as a result of functional severity, personal factors or psychological impairment, yet the medical condition could be improved.

Figure 1. Framework of severity for the prediction of critical illness or cardiac arrest in adult general ward patients (adapted from Stein et al., 1987, p.1506).

Stein et al., (1987) in their original framework of severity of chronic illness explain that the various dimensions refer to the disease, the person, or the social unit. In the above framework biological severity refers to the disease-state leading to critical illness (not measured directly). Physiological and functional severity refer to the manifestations or consequences of the disease state on the person, personal factors
also refers to the person, and medical treatment refers to environmental factors. Physiological reserve is a factor in biological and physiological severity. Burden of illness refers to the social unit but is not the focus in this study.

The main assumption made in the above framework is that increasing severity of illness is related to the development of critical illness and risk of cardiac arrest. Although patients may not yet exhibit measurable signs of critical illness clinicians may be able to recognise increasing severity of illness and patients with limited physiological reserve who require active intervention to prevent critical illness or cardiac arrest. A clinical framework based on a broad conceptualisation of severity of illness may therefore be more useful in the very early prediction of critical illness or cardiac arrest than one based on critical illness that draws mainly on the physiological dimension of severity of illness.

2.3 Physiological stability

The concept of physiological stability is also important in the current study, particularly the patient’s vulnerability to deterioration and the transition from stable to unstable physiological states. Mitchell (1999) states that promoting physiologic stability is a goal of nursing interventions in acute and critical illness, and a crucial area for nursing research. Operational definitions of stability and instability often refer to normal values or ranges for haemodynamic variables or vital signs. For example Buist et al., (1999) define clinical instability using abnormal ranges for respiratory, haemodynamic, conscious state, biochemistry/haematology and temperature. Stabilization in Mosby’s Medical Nursing and Allied Health Dictionary (2002) is defined as “the physiologic and metabolic process of attaining homeostasis”.

Mitchell (1999) reports a systematic search of the literature on biological and physiological stability and nursing from 1966-1997 that revealed contrasting views on how physiological stability is achieved including homeostasis, allostasis, and chaos theory and non linear dynamics. The term homeostasis refers to the
physiological process that preserves the steady states of the organism (Cannon, 1939 as cited in Buchman, 1996). The term states was taken to mean that each physiological parameter had a preferred normal setting and any value outside that showed either a compensatory response or the need for one (Buchman, 1996). Over the years homeostasis has strongly influenced physiological research. The main tenet of homeostasis is that a system of feedback loops return the physiological parameters to particular points or to ranges where changes are small and regular (Mitchell, 1999), in short, the maintenance of a single stable state (Buchman, 1996).

More recently the concept of allostasis suggests that the body when challenged can increase or reduce core functions to achieve a new stable state which contrasts with homeostasis where the emphasis is on maintaining a constant state (McEwen & Stellar, 1993). Research based on complexity from the field of nonlinear dynamics (fractals and chaos theory) suggests that reduced variability may be a sign of poor cardiac or neural health (Mitchell, 1999). Lipsitz and Goldberger (1992) found that ageing (in healthy elderly subjects) was associated with a loss of complexity or reduced variation in neuroendocrine and cardiovascular function, and they hypothesised this might reduce the individual’s ability to adapt to physiological stress. Although there is ongoing debate on the degree to which chaos theory applies to physiological dynamics some applications from non-linear dynamics may find an application in physiological monitoring, particularly in the prediction of electrophysical or haemodynamic instability (Goldberger, 1996).

It is important to find ways of precisely representing patients’ stable and unstable physiological states, and any changes in state over time. Mitchell (1999) refers to work on multiple physiological phase states (Siegel et al., 1979). Siegel and colleagues demonstrate how a few physiological parameters could model patients’ physiological states. Using circle diagrams the direction and amount of deviation from the normal healthy value was plotted and depending on the nature of the pathophysiology the reference circle shape became distorted to a particular polygon shape, whereas the normal or reference state was a circle (Buchman, 1996). Siegel’s
work indicates that there are a number of distinct stable states, which contrasts sharply with the view of homeostasis comprising just one stable state (Buchman, 1996). The model of dynamical systems (Buchman, 1996) suggests that systems are connected together and that they responded to disturbances by acting together, removing the need for separate negative feedback mechanisms for every element (Mitchell, 1999). Research into stability and instability may draw increasingly on non-linear dynamic approaches, and may provide earlier indications of patients at risk of deterioration.

Standard definitions of the term stable do not reflect the above complexities. *Mosby’s Medical Nursing and Allied Health Dictionary* (2002) defines stable as “remaining unchanged”, and the *Collins Pocket English Dictionary* (1996) defines stable as “firmly fixed or established”. However Mitchell (1999) cites Bingham’s (1994) use of the *no net change* definition of stability, borrowed from physics, where two cases may both be stable but one may be closer to a steep physiological slope and thus be more easily tipped into a severe deterioration. These ideas are translated to the current study in Figure 2 where two patients could be in apparently stable states. Patient A could be located in a depression upon a parabolic path, and although there may be variations in the physiological parameters it would take something major to push this person into serious deterioration. In contrast Patient B could be sitting uneasily at the top of a steep physiological slope, physiological parameters may be within normal ranges, but it would take very little disturbance to push this person into serious deterioration.
Stable states viewed from the perspective of how vulnerable the individual would be to small changes may provide a more useful picture than standard definitions of stability based on the usual physiological parameters.

The early recognition of physiological instability is a primary concern for ward and critical care staff. Critical care outreach teams are normally triggered by one of a number of early warning scores and these teams were introduced in 2002 across England as a result of Department of Health initiatives in critical care (DH, 2000). Early warning scores focus on physiological severity and indicators of the acute disease process. They do not attempt to measure patients' physiological reserve, as this is complex. The scores are used to identify patients with evidence of actual physiological deterioration. However it may be possible to identify vulnerable patients even earlier based on a range of cues including patient history, current medical condition, estimates of physiological reserve, and subjectively assessed clinical signs in addition to the physiological indicators in early warning scores.

Preliminary results on the impact of critical care outreach teams on patient outcomes are encouraging. In one UK study critical care outreach teams reduced unplanned admissions to ICU, reduced ICU mortality, and reduced the average length of ICU
stay for surgical patients (Pittard, 2003). Ball et al., (2003) in a further UK study report that critical care outreach follow up of recently discharged ICU patients significantly improved hospital survival rates and reduced ICU readmissions. In Australia, Bellomo et al., (2003) found that the Medical Emergency Team significantly decreased the incidence of cardiac arrest and hospital mortality generally. The apparent success of these initiatives may be due to improvements in the organisation of care and timely interventions once patients are identified as requiring critical care intervention.

General ward nurses remain well-placed to make judgements of individual patients’ physiological stability and physiological reserve as they have such close contact with patients enabling them to pick up subtle changes in patient activity levels in ongoing assessments of patients’ independence in the activities of living when planning care. Ward nurses are also in an ideal position to practice preventive critical care identifying patients at risk of critical illness, recognising developing problems, and preventing critical situations (Gibson, 1997). Early warning scores and the critical care outreach teams are important adjuncts to optimal care of patients developing critical illness or patients at greatest risk of cardiac arrest, but they do not replace the requirement for ward nurses to monitor the condition of patients in their care and intervene appropriately. Whilst the criteria included within the early warning scores may represent the critical cues for developing critical illness, other relevant cues could be important in the earlier prediction of patients vulnerable to critical illness or cardiac arrest. The recognition of these cues may require experienced general ward nurses who are able to exercise their clinical judgement.

There is evidence that a more comprehensive interpretation of severity of illness would capture useful information for the prediction of patient outcomes. The Nursing Severity Index developed and validated by Rosenthal, Halloran, Kiley et al., (1992) was based on a broad conceptualisation of severity of illness (after Stein et al., 1987) rather than a disease or patho-physiological focus. The Nursing Severity index comprised thirty-four nursing diagnoses and predicted mortality in general medical
and surgical patients as accurately as the Medisgroups score. The authors comment that it could be used prospectively to identify patients likely to experience adverse events where particular interventions could improve outcomes (Rosenthal et al., 1992).

2.4 Measuring severity of illness

Quantitative measures of severity of illness have been developed for a range of health care management, clinical, and research purposes, including quality assurance/evaluation of care, prediction of mortality and morbidity, and to record patient condition in clinical research. Indexes to identify evolving critical illness or predict cardiac arrest in clinical practice are in the early stages of development.

2.4.1 Quality Assurance/ Evaluation of Care

Severity of illness needs to be included in any analysis of patient outcome. Iezzoni (1989, p.71) presents a model of factors affecting patient outcome as follows:

\[\text{Clinical and other patient attributes} + \text{Effectiveness of care} + \text{Other factors including random events} = \text{Patient outcome}\]

Severity of illness is included in the clinical and other patient attributes and it can also describe patient outcome such as severity of illness upon discharge (Iezzoni, 1989). In North America the prospective payment system of reimbursing hospitals for care administered was calculated according to patients’ diagnosis related groups (DRGs), but did not take account of severity of illness; hospitals could be underpaid if they had a case-mix of sicker patients absorbing more resources than others (Iezzoni, 1989). Various types of severity of illness measures were developed.

Disease staging was used to add severity information to the DRG hospital payment system (Gonnella et al., 1984). The Computerized Severity Index (Horn & Horn, 1986) uses the International Classification of Diseases, ICD-9-CM codes, disease
specific severity of illness criteria, complications, co-morbidities, and the clinical context during hospital treatment to calculate the illness burden (Iezzoni, 1989). The AS-SCORE (Roveti et al., 1980) defines case mix variables and appropriate lengths of stay for medical audit. APACHE II (Knaus et al., 1984) was originally developed to evaluate the care of the critically ill based on acute physiology variables. POSSUM (Copeland et al., 1991) predicts mortality and morbidity in surgical patients. Medisgrps (Brewster et al., 1985) compares patients on admission and mid-stay and uses the degree of organ failure and physiological indicators of severity of illness to examine quality of care. The Therapeutic Intervention Scoring System (TISS) (Cullen et al., 1974; Cullen et al., 1994) classifies severity by totalling the therapeutic interventions a critically ill patient, or a medical patient outside the ICU needs. The Patient Intensity for Nursing Index (PINI) (Prescott & Phillips, 1988) focuses on the severity of the patient's condition and its effect on nursing workload. The PINI uses existing patient classification systems and adds complex factors such as severity of illness, patient need for nursing care, complexity of nursing care and hours of care (Prescott & Phillips, 1988).

The above approaches to the evaluation of care/ quality assurance draw mainly on biological and physiological dimensions of the severity of illness concept. The TISS is an exception (Cullen et al., 1974) as it uses therapeutic interventions, reflecting possible consequences of biological and physiological severity.

\subsection*{2.4.2 Prediction of Mortality and Morbidity}

The major focus of severity of illness scores considered here is the prediction of mortality and morbidity in ICU patients. Lemeshow and Le Gall (1994) refer to three generations of scoring systems. The first generation system was the Acute Physiology and Chronic Health Evaluation (APACHE) system (Knaus et al., 1981). The second generation consists of three distinct systems, the APACHE II (Knaus et al., 1985), the Simplified Acute Physiology Score (SAPS 1) (Le Gall et al., 1984), and the Mortality Probability Models (MPM 1) (Lemeshow et al., 1988). The third generation systems
include the APACHE III (Knaus et al., 1991), the MPM II (Lemeshow et al., 1993) and the SAPS II (Le Gall et al., 1993). The MPM I and MPM II can be applied immediately on admission to ICU whereas the other indexes require the patient to have been in ICU for at least 24 hours. The variables included in APACHE and APACHE II were devised using a nominal group process based on the judgement of clinical experts, whereas all the others, including APACHE III, were developed using multiple or logistic regression modelling techniques (Lemeshow & Le Gall, 1994).

The original APACHE system (Knaus et al., 1981) was revised and simplified resulting in APACHE II (Knaus et al., 1985). APACHE II was developed to assess severity of illness and risk of mortality in critical care patients by classifying severity of disease and stratifying patients' risk of death based on twelve physiologic measurements (34 in the original APACHE system), previous health status and age. The Acute Physiology Score (APS) was considered more important, than the Chronic Health Evaluation (CHE) (Wagner et al., 1987). The APACHE systems sought to develop more accurate ways of stratifying patients so that valid comparisons of patients' responses to new therapies could be made, to examine use of hospital resources, and to compare different ICUs' performance over time. The basic assumption is that abnormal acute physiologic measures are strongly correlated with risk of death in acute illness. The Apache II score from 0-71 is derived by adding up points from the three sections of acute physiology score, patient age and chronic health status, and is based on the recording of the most deranged value for the physiological factors within the first 24 hours of ICU admission. The severity of disease classification system (APACHE II) was evaluated by comparing predictions with actual patient mortality in a sample of 5815 patients admitted to thirteen ICUs in the U.S. The system was able to classify groups of patients according to severity of illness (it could identify which patient groups do better or worse than others do), but it was less sensitive for guiding decisions about individual patients' treatments. A combination of clinical judgement expertise, the use of objective data as well as response to treatment, and the patient's wishes must all be factors in the provision of care as estimates of the likelihood of a particular outcome cannot be 100% accurate.
Despite Knaus and colleagues' original recommendations that APACHE II should not be used to decide on treatment choices for individual patients, there is some evidence that it is being used to discriminate between patients for admission to ICU (Iezzoni, 1989).

Studies comparing physicians' subjective assessments/prognostic estimates with the APACHE II score found that experienced physicians were either as accurate (McClish & Powell, 1989) or were more accurate, in predicting mortality, than APACHE II predictions (Marks et al., 1991). In the latter study experienced nurses' predictions were also more accurate than APACHE II predictions. However Bion (1995) asserts that scoring systems and clinical judgement are complementary as the former contain more information about groups of patients than the clinician can process, but clinicians have much more knowledge of individual patients than the scores could possibly include. This may also be important for the use of early warning scores to predict critical illness or cardiac arrest.

Knaus, Harrell, Lynn et al., (1995) in the SUPPORT Prognostic Model study, focus on the development and validation of a model for estimating survival in seriously ill hospitalised patients that included a prospective cohort of non-ICU and ICU patients. The model's performance was tested against Apache III and physicians' judgements. The SUPPORT model included the variables of diagnosis, age, number of days in hospital before study entry, presence of cancer, neurologic function, and eleven physiologic measures all recorded at day three and 180 days after study entry. At day three, physicians also gave their predictions. The ability of the model to discriminate between individuals who would live or die was examined using the receiver operating characteristic (ROC) curve. Statistical analysis of the area under the receiver-operating characteristics (ROC) curve for predicting survival at 180 days in the SUPPORT Prognostic Model study was 0.79 in phase I, 0.78 in an independent phase II validation, and 0.78 when the APACHE III replaced the SUPPORT model (Knaus et al., 1995). When the SUPPORT model was combined with the physicians' judgements the predictive accuracy improved to ROC 0.82.
The sensitivity (proportion of true positives) and specificity (proportion of true negatives) are important elements when assessing the discriminatory power of scoring systems (Ridley, 1998). The ROC curve is used to examine mortality predictions across possible classification thresholds using information about sensitivity and specificity. The area under the ROC curve would denote patients who died but also had a greater probability of mortality than those who survived (Ridley, 1998). Therefore the larger the area under the ROC curve, the better the discriminatory power of the score, for example 0.5 indicates no better discrimination than by chance, 0.9 refers to excellent discrimination, and 1.0 perfect discrimination (Ridley, 1998).

The physiology score calculated on day three was the most significant single predictive value in the SUPPORT model and the Glasgow coma scale was the most important risk factor for predicting death (Knaus et al., 1995). However with a focus on patient outcome this model was not developed to measure changes in patient state as they happen.

The Nursing Severity Index developed and validated by Rosenthal, Halloran, Kiley et al., (1992) reflects a concept of health drawing on biological, physiological, functional, social / psychological constructs approached through 34 nursing diagnoses. This equates to the constructs identified within the severity of illness framework described by Stein et al., (1987). Nursing diagnoses were used as measures of severity of illness upon hospital admission and it was hypothesised that the number of nursing diagnoses on admission could predict death and duration of hospital stay. The index was based on information collected in daily care rather than in an expensive retrospective audit. Developed primarily as a quality assurance tool, the authors recognised its potential for identifying high-risk patients and those where particular interventions could improve outcome but further validation would be needed. This study demonstrates that nursing assessments provide valuable
information for the prediction of patient outcomes but generalisability is limited as
nursing diagnoses have been more widely adopted in the US than in the UK.

Nurses’ assessments of functional status provide an uncomplicated and inexpensive
method of predicting in-hospital mortality of patients with cerebrovascular disease or
pneumonia (Davis et al., 1995). This retrospective study consisted of a final sample
of 1561 pneumonia patients and 608 cerebrovascular disease patients. Two
computerized clinical databases were analysed: ClinQuery containing laboratory test
results, chronic co-existing conditions and the Nursing Acuity Assessment that
included nurses’ evaluations of functional status to predict in-hospital mortality. The
nurses’ assessment that a patient needed total assistance for bathing was the best
single predictor of in-hospital mortality in models developed for these two patient
groups. Studies focusing on prediction of in-hospital death have mainly used acute
physiologic indicators but this study, and Rosenthal, Halloran et al., (1992), indicate
that functional status in areas such as bathing and incontinence also provide valuable
information about imminent death.

Severity scores have been used in daily assessments to revise predicted risk of
mortality (Wagner et al., 1994), and to develop discharge criteria based on estimates
of the likelihood of requiring life support within the next 24 hours after discharge
from ICU (Zimmerman et al., 1994). They have also been used to estimate the
probability of patients requiring either high dependency or intensive care
(Zimmerman et al., 1995). The consensus in the literature is that severity of illness
measures are useful in the prediction of outcomes for groups of patients, but their in-
built error rates related to statistical methodology means that currently they are not
sufficiently sensitive for individual prediction (Lefering & Goris, 1998; Ridley,
1998). Other potential sources of error in the APACHE scoring system relate to
differences in the way data are collected, in how clinical states such as acute renal
failure are defined, and problems inherent in some of the clinical measurement
techniques used (Goldhill & Sumner, 1998a).
2.5 Conclusion

The concepts of critical illness and severity of illness were analysed and defined, and a clinical framework for the current study was proposed. The concept of physiological stability was also discussed with reference to patients in transition states from acute to critical illness or cardiac arrest. The development of severity of illness measures was described. The measures were categorised according to their primary purpose, either as quality assurance/evaluation of care, or prediction of mortality and morbidity. The majority of measures contained indicators of physiological severity, but other factors such as disease state(s), age, previous health status were often included. Burden of illness was reflected in the quality assurance papers where the implications of severity of illness on resource use were addressed. Functional severity and psychological status received less attention in these measures with the exception of Davis et al., (1995) and Rosenthal, et al., (1992).

Generally severity of illness scoring systems have not been designed to pick up important clinical changes in patients’ conditions as they occur, but they have demonstrated that severity of illness is an important concept for understanding the progression of illness and outcomes in groups of patients. The clinical indexes/risk prediction scores recently developed for the purpose of identifying individuals at risk of critical illness/cardiac arrest are in the early stages of development and validation and focus mainly on physiological severity.

As clinical judgement is central to the identification of patients with clinical deterioration and prediction of critical illness or cardiac arrest, the next chapter reviews approaches used in judgement and decision making research, the processes of judgement and decision making, and analyses the components of assessment and nurses’ judgement tasks.
Chapter 3

Literature Review: Judgement, decision making, components of assessment and nurses' judgement tasks.

3.1 Approaches to the study of Judgement and Decision making

Clinical judgement is used in the diagnosis and prediction of patients' clinical states in transition from acute to critical illness or cardiac arrest. There are various approaches to the study of judgement and decision making and these will now be reviewed. A case is made for the approach selected in the current research.

3.1.1 Introduction

Research into judgement and decision making can be categorised as normative, prescriptive or descriptive in nature (Baron, 1994; Bell et al., 1988). Normative theories and the models derived from this perspective, describe how rational individuals should decide in ideal circumstances, they emphasise the application of logic and consistency, and draw mainly on statistical methods such as utility and probability theory.

Prescriptive theories and decision making models arising from this perspective, examine how individuals could be assisted to make good decisions, and coached to make better decisions (Bell et al., 1988); they prescribe how thinking could approach the ideal or normative model (Baron, 1994). The focus in prescriptive decision theory is usually on selecting an option rather than on diagnosis or carrying out a decision (Beach, 1997). The decision-maker is assumed to want to maximise expected value and so prescriptive theories fit closely with the utilitarian paradigm prevalent in the social sciences (Beach, 1997).

Behavioural decision theory and models linked to this perspective could be viewed as an extension of prescriptive theory; the focus of research being how unaided decision making matches up to prescriptive theory. Diagnosis and choice are the two distinct areas that are investigated using behavioural decision theory (Beach, 1997). Work on
diagnosis developed from Egon Brunswik’s ideas about perception where cues perceived by the senses are used to infer or diagnose a particular state or situation in the environment. Brunswik used the term *Probabilistic Functionalism* to describe how the organism and environment are related in a probabilistic way (Cooksey, 1996a). Contemporary approaches to psychology were criticised by Brunswik because they failed to take account of both the environment and the organism (Cooksey, 1996a).

Kenneth Hammond and colleagues applied Brunswik’s lens model to the study of human judgement and used this framework to identify individuals’ use of cues and their *judgement policies* or how they weigh cues to arrive at judgements (Beach, 1997). These *policy-capturing* studies did not claim to model what went on within the clinician’s head, rather they treated the clinician’s mind as a *black box* (Dowie & Elstein, 1988). Statistical techniques using simple linear additive equations were found to accurately model the intuitive judgements of clinicians (Dowie & Elstein, 1988). Within the Lens Model the judge is characterised as a statistician working intuitively to infer the unknown state from available *fallible* cues (Beach, 1997). It is assumed that the best performance is achieved when the judge’s decision-making process mimics the approach of a statistician using multiple regression analysis with the same information (Beach, 1997).

The analysis of data to produce judgement policies involves the application of multiple regression techniques. Beach (1997) asserts that multiple regression oversimplifies the structure of how judgements are made. However the main defence for the use of multiple regression analysis is that it accurately predicts the conclusion the clinician would reach given the same cues, rather than being a precise model of how the clinician reached the conclusion (Dowie, 1989).

The *choice* researchers within the behavioural decision theory perspective initially compared decision behaviour with principles of prescriptive decision theory derived from von Neumann and Morgenstern’s work on game theory and expected utility.
theory (Beach, 1997). There is an assumption that in an ideal situation individuals choose the option that maximises *utility* or their chance to achieve goals from a range of available options. According to *utility theory* when there is uncertainty about outcomes this can be taken into account by multiplying the outcome’s utility by its probability (Baron, 1994). Subjective expected utility theory represented an extension of expected utility to incorporate individuals’ personal or subjective estimates of outcomes (Plous, 1993).

Naturalistic or descriptive theories focus on describing *how and why* individuals make particular decisions in the real-world and have been particularly influenced by Information Processing Theory (Beach, 1997; Newell & Simon, 1972). Descriptive theories grew out of a recognition of the limitations of normative models of decision making which focused on how rational decision makers would function in particular circumstances. Herbert Simon’s proposal that individuals *satisfice* or choose an option that satisfies the most important needs, rather than choosing the ideal option, contrasts with expected utility theory (Plous, 1993). Initially Newell and Simon had wanted to model the cognitive processes occurring inside the clinician’s head, but these investigations gave way to more practical applications of information processing and clinical reasoning (Dowie & Elstein, 1988).

### 3.1.2 Research on diagnostic judgement.

Within research on diagnostic judgement Hammond (1996b) argues for the development of a general research paradigm, described as *complementarity theory*, that would include the choice (or *coherence*) and the judgement (or *correspondence*) perspectives. Hammond argues that the two perspectives could have a harmonious relationship because they investigate two different phases of the diagnostic process and each produce information that feeds into the contrasting perspective. Correspondence research is focused on the first phase, the inference phase of the diagnostic process whereas coherence research is located within the second or justification phase (Hammond, 1996b). According to Hammond the characteristics of the two research traditions can be contrasted in terms of their overall goals, the
process used, the type of decision making model reflected, their focus, methods used and types of results. The current research is located within the inference phase of diagnostic judgement, rather than the contrasting phase of justification.

Coherence theories, as in heuristics and biases research, focus on the mind and test decisions according to how rational they are comparing the clinician’s decisions to the results obtained using probability theory and Bayes’ Theorem (Hammond, 1996b).

Alternatively, empirical (clinical) accuracy is the main focus in the correspondence approaches where the clinician’s achievement of the correct diagnosis is the test rather than the rationality of the process leading to diagnosis (Hammond, 1996b). In terms of the judgement process used, coherence approaches use justification and compare the clinician’s judgement with that derived through the rational method of Bayes’ Theorem, rather than checking on empirical accuracy. The process underpinning correspondence approaches is the accuracy of the clinician’s inference of the clinical condition using multiple fallible indicators or signs and symptoms.

Two contrasting models of decision-making inform the two perspectives; the correspondence approaches focus on description of the current situation to analyse the task, physician and accuracy, and coherence approaches use prescription to identify what ought to happen by comparing a rational model with the clinician’s judgement. Correspondence approaches produce a judgement about the intangible event or state, whereas coherence approaches give a probability estimate of the event or state (Hammond 1996b). Brunswik’s Lens Model is used to model the judgement in correspondence research, and Bayes’ Theorem and Decision Analysis are frequently used in coherence research. Correspondence approaches therefore describe judgements and analyse their accuracy, whereas coherence approaches describe where decisions differ from the rational prescriptions of what ought to happen (Hammond, 1996b). Both correspondence and coherence perspectives are important in research into diagnostic judgement with the former being particularly relevant for
investigating the cues used to infer the state of the patient and formulate clinical judgements, the areas addressed in the current research.

3.1.3 Social Judgement Theory (SJT) and the Inference /Correspondence Model of Diagnostic Judgement.

Social Judgement Theory (SJT) took shape during the 1960s and 1970s, building on Egon Brunswik's earlier work on perception (Hammond et al., 1975). SJT describes how Brunswik's probabilistic functionalism (using the Lens Model) and representative design could be applied to studies of human judgement, and clinical judgement in particular (Brehmer, 1988; Cooksey, 1996b). SJT assumes that judgements are the product of the combination of cues from the environment (Cooksey, 1996b). Within the lens model approach judgements are analysed or dissected, after judgements have been made, a posteriori decomposition (Arkes & Hammond, 1986). SJT is particularly appropriate for investigating medical (and nursing) judgements as many clinical decisions are made in conditions of uncertainty and multiple fallible cues have to be considered; the lens model enables clinical judgements to be broken down and analysed quantitatively (Wigton, 1996).

Within the lens model the individual draws on cues (fallible indicators) which are probabilistically related to the real clinical state and to the individual's judgement of the state (Cooksey, 1996b). In the principle of parallel concepts the environmental/clinical task system and the perceptual/cognitive system of the judge could be represented using the same kinds of concepts (Cooksey, 1996b). Brunswik (1952) as cited by Cooksey (1996a&b) uses correlational statistics to describe ecological validity, defined as the correlation between the proximal or superficial cue and the distal/depth state, and functional validity (or cue utilisation validity), in parallel with this, defined as the correlation between the proximal cue and the person's judgement of the state. Achievement or accuracy refers to the correlation between measures of the actual state, and the judgements made using the available information (Cooksey, 1996a). Inferences are made within the uncertain area between the accessible surface cues and the depth conditions. These elements were translated into the clinical
judgement domain by Hammond (1996b); a simplified version of the lens model is shown below in Figure 3. Often cues are not independent indicators of particular clinical states, but are combined with information from other cues. Within medical textbooks the relative ability of particular cues to discriminate between diseases (the weighting of cues) is not fully explored; the focus has mainly been on the frequency of cues or how sensitive they are (Wigton, 1996). The lens model could be used to examine the weighting of cues in particular clinical states, how cues are combined/overlap, and the extent of uncertainty associated with particular cues (Wigton, 1996).

![The Lens Model](image)

**The Lens Model** (after Hammond 1996b)

Figure 3. The Lens Model (after Hammond, 1996b, p.282).

Through the concept of *representative design* Brunswik maintains that just as much effort should go into obtaining representative environmental tasks or cases as is focused on subject sampling (Cooksey, 1996a). This contrasts with experimental designs which aim to separate variables from the environment to undertake factorial designs (Cooksey, 1996a). The approach to statistical analysis is also unconventional. Brunswik advocates an *Idiographic-Statistical Approach* to data analysis as a way of including the environmental or ecological perspective (Cooksey, 1996b). Whilst experimental design is concerned with averaging performance across individuals using a *nomothetic* approach, the *idiographic-statistical approach* is concerned with
studying the characteristics of each individual and their behaviours in particular situations (Cooksey, 1996b). In the latter each individual’s behaviour is analysed and tested separately before data are generalised across cases - the sampling of judgements is the focus rather than the number of judges.

Most SJT studies in medicine have focused on representing judgement policies or how clinicians weight cues when making judgements using single system designs based on the right-hand side of the lens (Wigton, 1996), for example Kirwin et al., (1983); and Kirwan & Currey, (1984). However there is potential for greater use of *lens model* studies or double system designs which include the *ecology* and enable judgemental accuracy to be studied as in Speroff et al., (1989); Tape et al., (1991) and Wigton et al., (1986). The aim in SJT studies is to describe how clinicians use clinical cues when making judgements in contrast to clinical prediction rule modelling, where the intention is to examine the extent to which particular independent variables accurately predict a dependent variable or a particular patient outcome (Speroff et al., 1989). Overall, lens model studies could be very important in medicine and nursing because they offer considerable scope for the analysis of clinicians’ judgements (Wigton, 1996). They have also enabled the identification of cues that clinicians actually attend to in practice and these may differ from cues reported in the literature (Wigton, 1988).

Undertaking SJT research involves a number of stages common to all Lens Model research designs. These include:

- conceptualisation and definition of the judgement problem
- collection of information about the ecology
- identification of relevant cues (to be included in judgement profiles)
- development of a representative sample of cue profiles to examine judgements
- sampling of judges with knowledge of the particular judgement task
- collection of judgements from each judge, and
- analysis which involves policy capturing for each judge followed by comparison with other judges’ performance. In *double-system designs* the judges’
performance can be compared with the best possible prediction model based on the Lens Model Equation (Cooksey, 1996b).

To summarise, Judgement Analysis is particularly suited to the analysis of clinicians' use and weighting of cues to infer the clinical state or predict the future clinical state. Judgement Analysis does not attempt to analyse why clinicians target particular cues, how their knowledge is structured, or the internal processing of information.

3.2 The organisation of knowledge

Clinicians require an organised system of concepts (or a taxonomy) to enable items in a particular domain to be classified more consistently. Classification underpins everything that we do (Harré, 2002). Medical science uses a disease classification system with membership assigned according to the presence/absence of particular signs, symptoms and pathology. Nursing to some extent also works with the disease classification system but more recently nursing science has started to develop taxonomies for nursing diagnosis, interventions, and outcomes, with much work still to be done (NANDA, 1998; McCloskey et al., 1996; Johnson & Maas, 1997). A taxonomy of diagnostic judgements in nursing could draw on concepts such as severity of illness and patient dependency. The features or attributes used to assign patients to the category critica\ll y ill or to predict patients at risk of critical illness or cardiac arrest need to be clearly articulated so that appropriate referrals are made. To reach the goal of more accurate assessments of the patient's condition nurses need to contribute to the development of a clinical taxonomy as identified by Feinstein (1994); this would involve investigating patterns of symptoms, severity of illness, timing of phenomena, functional capacity and other factors in particular groups of patients. Agreement on such a taxonomy could lead to more consistent judgements.

Within this thesis the clinical framework of severity of illness (as described in chapter 2) is used as an organising framework for clinical knowledge, and it is argued that severity is one of the major concepts informing judgements in acute and critical
illness states. Categories and concepts are used to interpret knowledge of the world held in our semantic memory (Matlin, 2002). Semantic memory refers to factual information located in long term memory (Oxford Dictionary of Psychology, 2001). The term concept refers to a mental representation of a category or class (Matlin, 2002; Ross & Spalding, 1994). A category denotes a group of objects that belong together (Matlin, 2002, p.236). For the current research the major concept is severity of illness and the levels of critical illness from level zero through to level three represent the various categories (DH, 2000).

The process of inferring the distal clinical state and predicting critical illness or cardiac arrest may rely on the clinician’s skilled use of perception, recognition and integration of relevant proximal cues drawing on the clinician’s stored knowledge. Thus clinical judgement includes problem-solving activities such as bottom-up processing (information about the stimulus recorded by sensory receptors) and top-down processing drawing on concepts, expectations and memory based on previous experience (Matlin, 2002, p.377). Two major approaches to perception are identified; the direct and the constructivist (indirect) approaches (Eysenck, 2001).

Direct perception considers perception to be a bottom-up approach where the observer is the passive recipient of sensory stimuli and there is minimal information processing (Eysenck, 2001). Alternatively, the constructivist or indirect approach to visual perception views perception as a top-down process where the focus is on internal processes rather than the stimulus (Eysenck & Keane, 1995). The main assumptions of the constructivist approach identified by Eysenck (2001) are that perceptions are actively constructed by the mind, they result from the interplay of the stimulus, hypotheses, expectations and knowledge, and emotional elements, and perceptual errors occur when hypotheses or explanations are inaccurate.

Harre (2002) highlights the role of perception in classification where the application of a system of concepts helps in the interpretation of sensory stimuli. Immanuel Kant’s observation that “...Concepts without percepts are empty: percepts without
concepts are blind” emphasises the interdependency of these two systems (Kant as cited in Harré, 2002, p.36). It is postulated that clinicians use particular concepts to organise their clinical knowledge and that they draw on these concepts to categorise the various clinical states within their domain of practice. Cues become associated with the particular clinical states in the mind via formal learning and through practical experience. The clinician therefore directs the search for cues according to the types of cues that are believed to be clinically relevant; clinical observations are made in the light of the clinician’s particular frame of reference. Within the process of inference and clinical judgement the clinician may be testing hypotheses in the light of observations (proximal cues) so that a judgement about the unknown clinical state can be made. The process of ruling in or ruling out diagnostic hypotheses is where the clinician may be attempting to confirm or refute particular hypotheses.

Ross and Spalding (1994) suggest that work on object concepts and categories are relevant to the internal representation of knowledge in complex tasks such as diagnosis. When a new case is met it might be compared to specific examples or to a generalised abstraction held in memory. The former refers to exemplar-based recognition, and the latter to prototype recognition (Elstein & Schwartz, 2000). Exemplar-based recognition has been explored most thoroughly in branches of medicine where visible cues are particularly important such as dermatology or radiology (Elstein & Schwartz, 2000). The exemplar approach contends that specific examples of a concept are learnt and that the similarity of new cases is compared to these examples (Matlin, 2002; Sternberg & Ben Zeev, 2001).

Bordage and Zacks (1986) found support for prototype categorisation as a method of structuring medical knowledge in which the clinician abstracts the most commonly occurring features that occur in a category so that new cases can be compared with this. The probabilistic or prototype view therefore classifies cases according to the presence of probable rather than necessary features (Ross & Spalding, 1994). Categories are held together because members of the category share family resemblances (Komatsu, 1992). Where the family resemblance is strong items are
considered more typical of the category (Komatsu, 1992). For example a patient with respiratory distress might be recognised because he/she exhibits a number of the characteristic signs and symptoms of respiratory distress that the clinician has stored as his generalised example of the category.

Schema Theory may describe the classification of large knowledge units where particular situations or events may be termed schemata, and scripts refer to particular sequences of events within a period of time (Matlin, 2002). Komatsu (1992) defines a schema as a structure that combines aspects from both the family resemblance view (abstractions from instances are stored), and the instance view (holding information about actual instances) (Komatsu, 1992). The variables or attributes within schema are termed roles or slots and the schema indicates the values that may fill each slot (Komatsu, 1992). General information about situations may be encoded and stored in memory and lead to expectations of what should happen in other similar situations.

It is likely that schemata are used by more experienced clinicians in the prediction of critical illness or cardiac arrest. These clinicians may have a mental picture of the various medical conditions they encounter in their domain of practice and be able to recognise patients with deviations from the expected courses of illnesses. Clinicians should also have scripts for actions to take when patients become critically ill such as, referral to the critical care or medical emergency team, emergency interventions, supportive therapy, monitoring of physiological status, provision of psychological care for the patient and relatives, and possible transfer to ICU.

Clinicians may use a mixture of models in the categorisation of new instances of critical illness or cardiac arrest. A combination of the prototype and exemplar approaches may account for how knowledge and clinical experience both contribute to the clinician's classification of new occurrences of a particular item/concept, and schemata may help in the organisation of larger units of information relating to the management of care. It is possible that particular cues may be early triggers to the
activation of experienced nurses’ schemata in developing critical illness or cardiac arrest.

3.2.1 Domain specific knowledge and expertise
At this stage the topics of domain specific knowledge and the development of expertise are considered because research in these areas has contributed to understanding of the perceptual and cognitive dimensions of clinical judgement. An expert is someone who knows a lot about a particular area; expertise is characterised by the possession of knowledge, and flexibility in its application (Sternberg & Ben Zeev, 2001). Experts also seem to solve problems quickly and more accurately than novices (Larkin et al., 1980).

Medical experts need to be able to define and re-define problems as new information becomes available (Sternberg & Ben Zeev 2001). Experts seem to have strong perceptual and recognition skills in their own domains that enable them to target relevant information (Lesgold et al., 1988). Experts seem to attend to deep structures or underlying principles when solving problems whereas novices tend to focus on surface structures (Chi et al., 1981; Larkin et al., 1980). Accurate diagnoses by experts were linked to their use of forward reasoning and application of causal rules with prior conditions linked to consequences, and these processes were based on the generation of relevant propositions from the information given (Patel & Groen, 1986). Inaccurate diagnoses in the same study were found to be the result of forward and backward reasoning where a hypothesis started a top-down problem-solving process and propositions where attached to the information given, or incorrect rules were identified (Patel & Groen, 1986)

It is thought that context-specific knowledge structures are used in experts’ problem-solving processes (Bordage & Zacks, 1986; Groen & Patel, 1985), and that these structures contribute to domain-specific knowledge (Crow et al., 1995). Aitken (2000) used a concept attainment model to investigate eight expert critical care nurses’ decision-making about pulmonary artery pressure monitoring and found the
majority organised their knowledge around core concepts such as preload, cardiac output and blood pressure. One participant did not use an organising framework and referred to gut feelings rather than specific objective data. Aitken concludes that practice in this case was not at the expert level. Larkin et al., (1980) claim experts' considerable knowledge and the way knowledge is indexed enables them to solve problems. Larkin and colleagues suggest that physics experts' ability to use pattern-indexed schemata explains much of what is often termed intuition (Larkin et al., 1980).

Schmidt et al., (1990) present a theory of medical expertise based on cognitive structures or illness scripts containing prototypical and individual patient exemplars that the experienced clinician can readily access. The cognitive structures are considered the signifiers of expertise rather than advanced reasoning skills or extensive in-depth knowledge. Experience with a wide range of cases is seen to be crucial in the development of expertise. Pattern recognition is viewed as an essential skill in expert clinicians; pattern matching is used to judge how well a new case matches previous examples (Schmidt et al., 1990). It is thought that experienced clinicians use pathophysiology or general descriptions of clinical syndromes only when similarity judgements do not yield results (Schmidt et al., 1990).

Custers et al., (1996) refer to the importance of factors present early in the diagnostic situation. Enabling conditions (medical and non-medical factors that influence the likelihood of a particular disease or condition being present) and some consequences/cues (such as patient self-report, or an obvious clinical sign) seem to be used by experts to activate illness scripts at an early stage. However the weaving of enabling conditions into fully detailed illness scripts seems to occur quite late in medical expertise, whereas at earlier stages clinicians seem to rely on consequences to generate diagnostic hypotheses (Custers et al., 1996). Experienced nurse clinicians may also be sensitive to enabling conditions such as patient history and early consequences or cues, in a similar way to expert doctors. Radwin (1998) reports that expert cardiology nurses' knowledge of antecedents and consequences is
incorporated into patterns that can be applied to new patient situations and used to judge potentially relevant diagnoses.

Benner (1984) examines nursing expertise from a phenomenological perspective and draws on the Dreyfuses' model of skill acquisition rather than the cognitive perspective on expertise. Within the model of skill acquisition, levels of skill are identified from novice through advanced beginner, competent, proficient to expert clinician: the focus is on the clinician's level of skill rather than the internal representation of knowledge. Experience of the particular client group is also included in this model of nursing expertise (Benner, 1984; Benner et al., 1996; Benner et al., 1999). Intuition is regarded as the hallmark of the expert practitioner (Benner et al., 1996). Benner and colleagues include the Dreyfuses' six components of intuitive judgement, *pattern recognition, similarity recognition, common-sense understanding, skilled know-how, sense of salience, and deliberative rationality* in their model of nursing expertise. English (1993) comments that Benner does not attempt to falsify the hypothesis that intuition is the defining characteristic of the expert by looking for evidence that non-experts use intuition. English also argues that the Dreyfuses' model provides no greater understanding of perceptual skill than the cognitive models that Benner rejects.

Having considered the organisation of knowledge, domain specific knowledge and expertise the next section provides definitions and analyses of the key terms used in the current investigation of clinical judgements.
3.3 Definitions of assessment, judgement, decision, and the judgement process as they relate to the current study (including a working definition of assessment)

Assessment.
Assessment is an important activity in health care practice, it provides the foundation for developing plans of care, and is informed by the clinician's cognitive and perceptual skills, and clinical knowledge. The nursing process, a problem-solving approach to care, is recognised as the professional model of clinical decision making in the USA, the UK and elsewhere (McFarland & McFarlane, 1997; NMC, 2000 Statutory Instrument 2000 No.2554- The Nurses, Midwives and Health Visitors (Training) Amendment Rules Approval Order 2000). Assessment is the first phase in the nursing process followed by planning, implementation and evaluation. Sometimes an extra phase, nursing diagnosis, is included after assessment to emphasise problem identification (Rubenfeld & Scheffer, 1995). Nursing assessment is defined as ...an identification by a nurse of the needs, preferences, and abilities of a patient (Mosby's Medical Nursing & Allied Health Dictionary, 2002). Assessment in the Roper, Logan and Tierney Model of Nursing based on the activities of living (Als) is defined as collecting information from the patient, examining the information, specifying any problems the patient may have in the Als and prioritising problems (Roper et al., 2000).

However this problem identification view of assessment may be too restrictive. Mosby's Medical Nursing & Allied Health Dictionary (2002) defines assessment as an appraisal of a condition, the process of making such an evaluation. This suggests that assessment comprises more than problem-identification. Crow et al., (1995) also refer to a medical nursing and allied health dictionary definition of assessment as the critical analysis and evaluation or judgement of the status or quality of a particular condition and situation of the object of appraisal (Miller & Keane, 1987).
Thus assessment based on this definition is directed towards making an evaluation or judgement about the patient’s condition which may be a more complex task than the diagnosis of patient problems and needs as suggested within the nursing process model (Crow et al., 1995).

It appears that assessment may be undertaken with different purposes in mind and may result in different types of decisions. Firstly the purpose may be to make a judgement about the patient’s current condition as a basis for deciding on particular actions (the focus in the current study). Secondly, assessment may be used to identify patient problems requiring a general plan of care such as the assessment conducted around the admission period and at specific points thereafter. Thirdly assessment is involved when decisions are made about the order in which care activities should be undertaken within a particular period of time (Kim, 1983a). It is also possible that patient problems or nursing diagnoses may contribute information to the process of assessing the patient’s clinical state (Crow et al., 1995).

Patient problems and diagnosing the clinical state of the patient are not synonymous terms. The distinctions between these terms are comparable to the observations made about the terms’ medical problem and medical problem-solving by Boshuizen and Claessen (1982). According to Boshuizen and Claessen the medical problem could be described as the activity directed towards identifying and listing the patient’s problems using an approach such as the Problem Oriented Medical Record, where the doctor’s goal is to find a solution to the patient’s problems. In contrast medical problem-solving focuses on the doctor’s diagnosis and medical management of the patient’s disease or illness (Boshuizen & Claessen, 1982). This distinction is important for research into nursing assessment and clinical judgements as the nursing process and nursing diagnosis approaches have tended to emphasise the development of problem lists rather than the diagnosis of the patient’s clinical state. Therefore a patient with acute breathing problems such as dyspnoea related to a chest infection might have nursing diagnoses of ineffective airway clearance, ineffective breathing pattern and/or impaired gas exchange, and a range of other nursing diagnoses.
(according to the NANDA list) or problems related to impaired functional status. However based on the patient’s problems, the rate and severity of deterioration, and the patient’s underlying health status the nurse may diagnose the patient’s clinical state as critical illness or developing critical illness related to respiratory failure or respiratory insufficiency. Based on this diagnosis the patient should be referred to the medical emergency or critical care outreach team. In other cases the patient’s problems may be symptomatic of a quite different clinical state. For example a patient who is malnourished and refuses to eat may have a nursing diagnosis of altered nutrition: less than body requirements (McFarland & McFarlane, 1997) or a problem of inadequate nutritional intake. However the underlying clinical state may be one of a number such as terminal illness in advanced cancer, or an acute psychological disturbance arising from a recent bereavement.

In medicine, assessment usually results in a diagnostic judgement/medical diagnosis that describes the patient’s medical state and is used to decide on the most appropriate medical treatment for the patient’s condition (Crow et al., 1995). Medical phenomena tend to correspond to pathophysiology, the goal of diagnosis being to find the most likely cause of a problem to enable the pathology to be treated, a cure found or the disease ameliorated. Nursing diagnostic tasks focus on the aetiology of symptoms and their relief or alleviation (Kelly, 1966).

Generally diagnosis refers to “a process of recognising, sorting and classifying phenomena into discrete categories to which labels are attached” (Thomas et al., 1991, p.9). Although the process is the same across disciplines the phenomena or objects of diagnoses may be different (Tanner, 1983; Thomas et al., 1991). In addition doctors and nurses may be focusing on similar problems but their approach to solving them may be different. For example DiGiulio and Crow (1997) suggest that doctors and nurses have different strategies for solving problems in the administration of pro re nata (PRN) drugs.
Operational definition of assessment

Assessment in the current research is defined as a process of collecting information and critically analysing the patient’s presenting condition to make a diagnostic judgement of the current clinical state, to evaluate if there has been a change in state, or to predict a future clinical state. Within assessment clinicians may also diagnose patient problems or needs.

The judgement of the patient’s condition is used to determine which operational decision is necessary to achieve optimal patient outcomes. Operational control decisions refer to decisions taken to achieve particular purposes or outcomes (Kim, 1983a). This contrasts with program decisions focused on developing a plan of care for a range of client problems, or agenda decisions relating to how nursing care activities are to be delivered within a particular time period (Kim, 1983a). In the current research the clinical condition to be recognised is critical illness or prediction of the patient at high risk of critical illness or cardiac arrest. The decisions might include referral of the patient to the appropriate specialists such as the medical emergency or critical care outreach teams and instigation of emergency interventions such as airway management or oxygen administration.

As judgement is an important element in assessing the state of the patient the next section considers definitions of this term.

Definitions of judgement.

Thinking is a cognitive activity that is involved in all aspects of daily life and underpins judgements and decisions. Baron (1994) refers to thinking as a way of resolving doubts about how to act, what to believe and what to desire. Baron considers actions (decisions), beliefs (extent to which a belief is held to be true) and goals (chosen according to potential benefits) in the light of a search-inference framework where thinking comprises a search for objects followed by making inferences based on the objects or evidence found. Judgement focuses on the process of making inferences. Judgement is defined as
"the evaluation of one or more possibilities with respect to a specific set of evidence and goals. In decision making, we can judge whether to take an option or not, or we can judge its desirability relative to other options" (Baron, 1994 p.6).

Possibilities refer to possible solutions to the original doubt or question. The evidence is weighed according to how much it strengthens or weakens the possible solution as a way of achieving the goals, a phase which Baron terms inference (Baron, 1994).

From the SJT perspective, the position adopted in the current research, judgement may be viewed as

"...a cognitive process similar to inductive inference, in which a person draws a conclusion, or an inference ...about something which cannot be seen, on the basis of data... which can be seen." (Arkes & Hammond 1986, p.7).

A distinction can be made between the terms judgement and decision.

"It { a decision } involves choosing between alternatives, whereas judgement involves the assessment of alternatives" (Dowie, 1993, p.8).

The Components of Clinical Judgement

Feinstein (1994) refers to the components of clinical judgement as

1. the clinical phenomena that manifest in patients (necessary for the development of classification systems)
2. the clinical data that refer to the clinical phenomena also encompassing data collected during assessment (further specification and quality improvements required)
3. the clinimetric measure used to describe the outcome of assessment (the condition or clinical phenomenon) expressed as either a verbal category or quantitative measure such as a rating or a score, and finally,
4. the clinical reasoning processes underpinning the above activities- the diagnostic reasoning, diagnostic inference process.
Clinical phenomena and their corresponding clinical data/indicators are considered within the severity of illness clinical framework in the current research. This framework is further developed through the systematic review and the empirical study. The components of clinical judgement termed clinimetric measures and the clinical reasoning process are considered in more detail at this stage.

Clinimetric Measurement
Within the science of clinimetrics in medicine, Feinstein (1987) proposes principles and methods for the description or rating of clinical phenomena that emerge from the clinician's direct contact with individual patients. Important symptoms, physical signs and other clinical phenomena can be identified, labelled and measured so that human and clinical phenomena that were often considered too soft could receive greater scientific credibility and inclusion in research about patient care. Verbal descriptions of the patient's state or condition in medicine such as "a patient with acute myocardial infarction, severe chest pain, and moderate congestive heart failure" (Feinstein, 1987) would include a range of clinimetric measures. Firstly a diagnostic label refers to the disease, such as myocardial infarction. Secondly, a measurement of time is conveyed when the myocardial infarction is described as acute; and thirdly, the magnitude or severity of the condition is indicated by terms such as mild, moderate, or severe congestive heart failure (Feinstein, 1987, p.6). Feinstein's approach to diagnostic measures may also have relevance for the development of nursing diagnostic measures or verbal categories.

A nurse's verbal description of a particular patient's clinical state in a general medical ward might be acute deterioration/developing critical illness, with severe dyspnoea and moderate confusion. In this case the clinical state is developing critical illness, a measure of time is made in the description of acute physiological deterioration/critical illness, a measure of severity is evident in the severe dyspnoea, and the magnitude of a condition is given in the verbal measure of moderate confusion.
3.3.1 Clinical Reasoning and Diagnostic Inferences

Clinical diagnosis in medicine is described as

"...classification for a purpose: an effort to recognise the class or group to which a patient’s illness belongs so that, based on our prior experience with that class, the subsequent clinical acts we (medical practitioners) can afford to carry out, and the patient is willing to follow, will maximize that patient’s health." (Sackett, Haynes et al., 1991, p.4).

Feinstein (1994) argues that the current clinical taxonomy in medicine does not include elements such as

"...patterns of symptoms, severity of illness, effects of comorbid conditions, timing of phenomena, rate of progression of illness, functional capacity and other clinical distinctions that demarcate major prognostic and therapeutic differences among groups of patients who otherwise seem deceptively similar because they have the same medical diagnosis, laboratory results and demographic status” (Feinstein, 1994, p.800).

Medical diagnoses seek to explain the cause of the presenting signs and symptoms in patients, and nursing assessments may be more concerned with accurately describing patients’ current conditions (Crow et al., 1995). Nurses’ diagnoses or assessment conclusions tend to be transitory, they may be more likely to change as the patient’s condition alters, compared to medical diagnoses which often remain stable throughout care (Carnevali & Thomas, 1993; Crow et al., 1995). In both disciplines diagnostic judgements form the basis of prognostic judgements where the likely future course of events and outcomes is predicted. Carnevali and Thomas (1993) refer to components of prognosis as firstly, areas where change can occur, secondly, type of change, and finally, the trajectory of change. All of these aspects of prognosis are relevant to the current research.
3.3.2 Diagnostic Tasks in Nursing

The position adopted in this thesis is that nurses are concerned with different types of diagnostic judgements with one of the most important being identified by Hammond (1966) as the task of inferring the state of the patient in an uncertain environment. This type of diagnostic judgement in nursing refers to the nurse’s inference about the most likely cause of the patient’s presenting symptoms (a probabilistic or likelihood judgement). Identification of the cause of symptoms may enable the clinician to either remove, or alleviate the symptoms in the immediate time period assisting the client within a defined period (Hammond, 1966). Although the nurse makes her own inferences about the state of the patient this is complicated because she must also consider the patient’s symptoms and current clinical state in the light of the medical instructions pertaining to the patient, and take appropriate action (Hammond, 1966). The nurse’s inference about the state of the patient is not the same as the complaints that the patient reports (symptoms) or the signs and behaviours observed by clinicians. The presenting state or condition can be used to make treatment decisions or to predict outcomes (prognostic judgements). A definition that accords with the position taken in this thesis views the state of the patient as “- a covert condition- one which is not directly observable” (Kelly, 1964, p.315). Verbal descriptions of patients’ states could be viewed as diagnostic judgements that measure the existence of a state for deciding on interventions or making prognoses.

Currently there is no consistent method for documenting the state of the patient in the nursing documentation and so these judgements are usually not recorded. This situation may in part be due to the absence of an agreed classification system in nursing as discussed earlier (see page 37). Research evidence however supports the position that experienced nurses do make judgements about the state of the patient as a basis for their interventions (Jacavone & Dostal, 1992; Jenny & Logan, 1992; Narayan & Corcorran-Perry, 1997).

Hammond (1966) refers to inferences concerned with diagnosing the state of the patient as being either logical or intuitive. Logical inferences involve the clinician,
making an objective observation of data, drawing on theoretical knowledge to link
the state of the patient and observed signs and symptoms, and formal logic can be
applied (either by using a rule or a computer). The underlying process may be
described as a form of template matching where a template of the disease is held in
memory and matched with the patient’s signs and symptoms to achieve the diagnosis
that fits the clinical data (Hammond, 1966).

In contrast intuitive inferences are made when patterns of signs and symptoms are
recognised in clinical situations but the clinician’s understanding of the underlying
mechanisms may vary, and the inferences tend to be based on data derived without
the use of instrumentation (Hammond, 1966, p.30). Hammond proposes that nurses’
inferences about the state of the patient rely on intuition more than logic according to
the above definitions. Hammond argues that nurses’ inferences would be difficult to
substitute with a computer, are more likely to be based on previous experience than
theoretical knowledge, and that data used in inferences would tend not to be derived
from technical measurement.

Currently the literature on nursing assessment concentrates on the identification of
patient problems (and strengths) (Holland et al., 2003), or is directed towards making
a nursing diagnosis (Rubenfeld & Scheffer, 1995) rather than the description of the
state of the patient. Within the UK the problem identification perspective is most
common, but in the USA the nursing diagnosis approach is widely accepted. The
North American Nursing Diagnosis Association (NANDA) defines the term nursing
diagnosis as

“A clinical judgment about an individual, family, or community response to actual
or potential health problems/ life processes which provides the basis for definitive
therapy toward achievement of outcomes for which the nurse is accountable.”
(Carpenito, 1991, p.6).

Although problem identification or nursing diagnoses may be important in nursing
assessment they do not capture all facets of the assessment process. Significantly, the
NANDA classification system for nursing diagnoses has not been widely accepted outside the USA (Hogston, 1997).

A number of reasons may account for the slow uptake of the system. Firstly, the NANDA definition of nursing diagnosis may represent a restricted view of nursing practice and the purpose of assessment. Nursing diagnoses focus on problems and/or health needs and the activities nurses undertake independently (Rubenfeld & Scheffer, 1995). However many nursing activities relate to the patient’s medical diagnosis and monitoring the patient’s response to medical interventions. In critical care the nurse’s assessment serves a number of purposes such as identifying the patient’s current clinical state (diagnostic judgement), detecting a change in state (evaluative judgement), predicting future clinical states such as likelihood of cardiac arrest (prediction/prognosis) and monitoring the patient’s response to treatment (another evaluative judgement). All of these areas draw on the nurse’s diagnostic skills.

Secondly, diagnostic categories should be linked to theoretical concepts but many diagnostic concepts within the Nursing Diagnosis taxonomy represent “primitive, pre-theoretical ideas with a minimal knowledge base” (Gordon, 1990, p.5). As nursing diagnoses are used to describe specific patient problems, they may not be linked to any theoretical concept and consequently they may not generalise well to other situations (Gordon, 1990). Nursing diagnoses should not be viewed as the end product of assessment, however they may provide information useful in the assessment of the patient’s overall clinical state.

Thirdly, philosophical objections to nursing diagnosis have been made. The nursing diagnosis approach is founded on the assumption that patients’ needs and experiences may be classified according to a previously developed list of categories, where the nurse is judging category membership. However having a pre-set list of categories may not be congruent with an individualistic and holistic approach to care (Lützén & Tishelman, 1996; Kim, 1983b). Whilst this might be legitimate in the problem
identification task the clinical task of identifying the patient's clinical state and
describing it would seem to require a more individualised approach than using a
prescribed list of problems.

A further limitation in the nursing process and nursing diagnosis approaches to
report that nursing process and nursing diagnosis adopt a menu-driven rather than a
knowledge-driven search for information to be used in assessment. This is a
significant point because clinical expertise seems to depend on knowledge of a
particular domain and this influences the information search and generation, and
evaluation of hypotheses in the process of assessment. Barrows and Feltovich (1987)
contend that most doctors use a combination of a hypothesis or problem focused
inquiry and a more routine menu-driven one in which body systems are reviewed. An
interesting question concerns whether nurse clinicians using a menu-driven approach
such as early warning scores also conduct a search of their domain-specific
knowledge when assessing a patient. Further research is needed into nurses’ domain
specific knowledge and the effects this could have on the early recognition of critical
illness or prediction of cardiac arrest.

Nursing assessment results in the formulation of clinical judgements. Lamond et al.,
(1996) identify causal, descriptive, evaluative and inference judgements based on the
underlying psychological process being used. The classification used in the current
research focuses on the clinical nature of the judgement.

Medical Diagnosis. A statement expressing a diagnosis of disease/illness for the
purposes of medical treatment or prognosis. Medical diagnoses draw on classification
schemes in the form of typologies of diseases/illnesses. The doctor uses the available
evidence to evaluate various diagnostic hypotheses, aiming to select one diagnostic
hypothesis thereby categorising the presenting case as an instance of a particular
disease or illness.
Diagnosis of the current state of the patient. A statement expressing a judgement of the current clinical condition/state e.g. as acute/stable, acute/unstable, critical/stable, critical/unstable, terminal or moribund. This would be classified as a likelihood judgement by Yates (1990) as there is an element of uncertainty present. A probabilistic form of clinical reasoning is used to infer the patient’s most likely current clinical state from the data presented by the patient.

Problem identification. A statement resulting from the process of categorising patient problems by drawing on practical and theoretical knowledge, a particular conceptual model of nursing, or a taxonomy as in Nursing Diagnosis.

Change in state. A statement based on comparison of the current with the previous clinical state (Feinstein, 1987) that could also be viewed as an evaluative judgement. Evaluative judgements are often expressed using a quantitative analogy (e.g. that the condition is better, the same, or worse than before).

Prognostic Judgements. A statement expressing a judgement about the chances of particular events happening. Predictions or prognostic judgements were identified as important within Crow and Spicer’s (1995) study of nursing judgements. Prognostic judgements draw on the current clinical state to predict a future clinical state. For example, the current research investigates the clinical states clinicians’ use to predict patients at risk of critical illness and to guide selection of interventions. Prognostic judgements may be classified as likelihood judgements (Yates, 1990) because they refer to judgements about the chances of particular events happening in cases where uncertainty is acknowledged.

Other types of judgements include:

Causal judgements. Statements about factors that have caused particular problems (Lamond et al., 1996).

Judgements about the timing of particular interventions. This refers to Kim’s (1983a) agenda decisions previously described on page 47.
3.5 Clinical Data and Cues

Distinctions are often made between subjective and objective measurements of clinical phenomena. Thomas et al., (1991) succinctly describe clinical data based on personal observations as subjective data and those based on processes of physical measurement as objective data. Subjective symptoms refer to phenomena that can only be perceived by the individual experiencing them and include sensations noted by the person such as pain, dyspnoea and their feelings, mood, or beliefs (Wulff & Gotzsche, 2000). Physical signs noted by clinicians during assessments using observation or palpation are regarded as subjective physician data (Hammond 1996b).

Objective measurements are used for phenomena that can be witnessed by other observers such as height, weight and pulmonary crackles (Wright & Feinstein, 1992). Paraclinical data is the term used for all laboratory results and information derived from tests not performed by the clinician; these data can be descriptive as in chest x-ray shadows, or quantitative as in blood urea and electrolytes (Wulff & Gotzsche, 2000). Thomas et al., (1991) criticise the assumption that subjective data might be less valuable than objective data because the former are derived using human judgement and the latter are developed using technical devices or physical measurement. Tests regarded as objective may have high rates of error making it unwise to assume that they produce valid results; the validity and reliability of each test or assessment needs to be assessed before the quality of tests relying on subjective versus objective data can be compared.
At this stage the term cue will be analysed and a definition proposed for how it is used in the current research.

Dictionary definitions of cue include: -

1. *An attribute of an object or event to which an organism responds*, typical examples being the size or shape of a visual stimulus to which a response may be conditioned. 2. *A dimension or aspect of a proximal stimulus on the basis of which an organism makes inferences about a distal stimulus*, typical examples being the monocular and binocular depth cues on the basis of which depth perception occurs (Oxford Dictionary of Psychology 2001, p. 178-179).

According to Cooksey (1996a, p.368) a cue is

"*Any numerical, verbal, graphical, pictorial, or other sensory information which is available to a judge for potential use in forming a judgement for a specific case and/or which is available in the ecology for making predictions about the value of a distal criterion*”.

Thomas et al., (1991, p.124) define cues as

"*Information used by the clinician to solve a clinical problem*, and a critical cue as "*An item of information used by the clinician to solve a problem that has particular importance for deciding between choices for a diagnosis or intervention*”.

Within psychology any environmental input to an organism is termed the stimulus, but this implies passivity that is rejected by Tolman and Brunswik in the 1940s. They maintained that the organism cognitively acts on the incoming information and that the object of perception may be related to other objects (Hammond et al., 1986). Tolman and Brunswik (as cited in Hammond et al., 1986) favoured a sign-significante theory rather than a stimulus-response theory. Sign-significante or cue refer to the way in which perceptual ideas emanate out from the individual toward elements in the environment, in contrast to the stimulus concept which points inward.
Thus when investigating human judgement the concept of cue captures the relations between the individual and the environment more fully than the concept stimulus. This view of a cue accords more with the second of the dictionary definitions above and Cooksey's definition.

Tolman and Brunswik consider the relationship between proximal cues and the distal or inferred state to be the most basic unit of cognition (Hammond et al., 1986). Brunswik thought that psychologists studying human judgement should pay much more attention to environmental characteristics and to the area between the proximal or given cues and the depth variables in the judgement task, also termed the zone of ambiguity (Hammond et al., 1986). Human judgement is complex because surface data are often imperfectly related to depth variables. There is uncertainty between cause and effect, the relationship between surface and depth variables may take on a variety of forms (linear, curvilinear), with curvilinear judgements being more difficult than the former (Hammond et al., 1986). Hammond and colleagues explain that cue information might be organised in judgements using one of the following processes; adding cues, averaging cues, or by the use of particular patterns. Although clinicians often report using patterns of cues Hammond and colleagues contend that more straightforward organising principles may be better predictors of judgements.

3.4.1 Operational definition of the term cue.

The current research adopts Hammond's definition of cue defined as the information (tangible indicators or surface data) used by the clinician to infer the intangible or actual patient state (Hammond, 1996b). The cues consist of clinical indicators, signs, symptoms, attributes and other information such as age, that are available in the particular situation and which are perceptible to the individual making the judgement. The cues selected depend on the particular focus of the judgement or on what is being inferred. The cues are used to infer the current clinical state, and to note when a change in state has occurred. This information can be entered into prognostic judgements. There are different types of cues used in judgements of the patient’s clinical state after Hammond (1996, p.284): Objective data refer to clinical
measurements and paraclinical/laboratory data; subjective data include data gained through the clinicians’ observation or palpation, patient’s symptoms based on the patient’s self-report, and the patient’s history. Information is termed a cue when it is associated with or reliably indicates a particular clinical state.

The rationale for focusing on cues used in judgements is based on the assumption that the clinical state is recognisable - that there are surface cues that are related to the depth conditions in the judgement task (Hammond et al., 1975). Often this is a probabilistic relationship; the cues do not indicate a state with certainty (Hammond, 1996b). Rarely can one cue denote one state therefore the judge relies on a number of fallible indicators. In some cases cue redundancy/overlapping cues may feature. Also a set of cues may not be complete, the precise relationship between cues and the object of interest may be difficult to specify, and there may be changes/instabilities in the environment (Kleindorfer et al., 1993). The weighting of cues may differ from one clinician to another a factor that merits further research into clinical judgement to determine if these differences are clinically significant. It is also important to know if it is the presence, absence, or particular values of cues that is important. The pattern of cues and how they develop over a time period may also be relevant.

3.5 Intuition, analysis and the cognitive continuum

The research thesis that experienced clinicians frequently use subjective indicators of the patient’s clinical state in the early recognition of deterioration and prediction of critical illness or cardiac arrest suggests that these clinical judgements may be more intuitive than logical. Intuition as a form of nursing knowledge has been highlighted in the nursing literature (Agan, 1987; Benner, 1984; Rew, 1988). Svarimäki and Stenbock-Hult (1996) consider intuition a difficult concept and discuss the philosophical, and epistemological dimensions that impact on its use in nursing. According to Svarimäki and Stenbock-Hult, intuition can be viewed philosophically as a metaphysical concept corresponding to an appreciation of an inner truth, as advanced comprehension or logic, or as knowledge that is obvious to the individual
but cannot be externalised for others to examine. Epistemologically, intuition may correspond to feelings, insight or global knowledge, and alternatively it is construed as pattern similarity (Svarimäki & Stenbock-Hult, 1996). Within nursing the conception of intuition depends on the underlying philosophical dimension. Benner's (1984) philosophical position is closest to advanced comprehension, whereas Agan (1987) leans more towards the metaphysical view. Rew (1988) argues that intuition is important in nurses’ decision-making and that further research is required into how nurses’ combine objective and subjective data. Hammond (1996a) presents an alternative conception of intuitive judgement that emphasises the nature of the judgement task rather than the person.

Intuition and analysis have long been accepted as two distinct forms of cognition (Hammond, 1996a). Analytical thought is commonly defined by its use of a systematic, conscious, and logical process, in sharp contrast to intuition where a solution is arrived at without the use of a conscious, logical and systematic approach (Hammond, 1996a). Two different theories of cognition both refer to analytic and intuitive forms of cognition- The Dreyfuses’ model of levels of skill, and Cognitive Continuum Theory (CCT) (Hamm, 1988). Within the Dreyfuses’ five-stage model ranging from novices through to expert clinicians, novices are more dependent on following rules and so use analytic cognition, whereas experts are expected to use intuition. In contrast Cognitive Continuum Theory, holds that human judgement/inference can be studied using a general theory of cognition and tasks that places judgements on a continuum from intuition at one pole through to analysis at the other (Hammond, 1996a). As the current research is mainly concerned with the judgement task, particularly the cue composition of clinical judgements, CCT is considered most relevant.

Within the study of human judgement and decision making there has been a clear preference for analytical over intuitive cognition as the former can be clearly defined, can be examined using logic and mathematics, and arguments can be examined for their rationality as the process is visible (Hammond, 1996a). Intuition has tended to
be viewed negatively because it lacks analysis (Cooksey, 1996a). Rather than being in competition Hammond contends that pure intuition and pure analysis represent the opposite ends of a cognitive continuum with intervening points representing a balance between varying degrees of intuition and analysis.

Cognitive Continuum Theory (CCT) builds on earlier work by Brehmer and represents the theoretical development of Social Judgement Theory (SJT), the latter being a model for studying judgement, rather than a theory of judgement (Cooksey, 1996a). Judgement Analysis arose from SJT and provides research methods for the examination of judgement tasks that are more quasirational (reflecting a mixture of analysis and intuition inducing characteristics in the judgement task) (Cooksey, 1996a).

Hammond (1996a) presents five premises underpinning CCT. Firstly, that various modes of cognition can be arranged on a continuum from intuition through to analysis with the choice of modes corresponding to the particular circumstances. Secondly, that aspects of intuition and analysis are both found in the middle of the continuum, quasirational cognition. Thirdly, that judgement tasks can be arranged along a continuum depending on the mode of cognition they bring on. Fourthly, that individuals may alter their mode of cognition if a solution is not found, and fifthly that pattern recognition and knowledge of functional relationships between given cues and a state to be predicted are involved in human cognition (Cooksey, 1996a).

Cooksey (1996a) summarises some of the main differences between intuition and analysis as highlighted by Hammond (1996a). Intuition is characterised as quick information processing with simultaneous use of a number of cues whereas analysis comprises slow information processing and cues used in order. Judgement processes in intuition cannot be traced whereas in analysis the process can be traced. Intuition places a minimal load on the judge whereas analysis requires a large amount of effort. The nature of cues is also different. In intuition there is a reliance on visual and non-verbal cues and these are often processed at the perceptual level. For example Benner
(1984) highlights the role of perceptual cues in expert nurses' intuitive judgements. In analysis quantitative cues predominate and the focus is on measurement. Quasirational cognition draws on aspects from the intuitive and analytic poles depending on the situation.

The task continuum ranges from intuition inducing through to analysis inducing, with quasirational inducing tasks in the middle reflecting a combination of intuition and analysis inducing characteristics. According to Hammond (1996a) and Cooksey (1996a) intuition inducing tasks have a number of possible solutions, they contain a large number of cues (more than five) that are simultaneously displayed, and a cue can often substitute for another cue. Analysis inducing tasks have few possible solutions, a limited number of cues are presented in order, and all cues tend to be important. Intuition inducing tasks tend to be more ambiguous than analysis inducing tasks and accuracy is greater with analysis inducing tasks. Intuition inducing tasks have limited time for judgements compared to analytical tasks where time pressures may be less immediate.

Tasks that present with multiple fallible cues, as in some cases of deterioration to critical illness, would tend to be located near the intuition-inducing pole of the cognitive continuum. Tasks presenting with cues that are known to be direct predictors of particular states (in the form of quantitative measures and mathematical equations) and where predictions can be traced or defended theoretically, would tend towards the analytical pole of the cognitive continuum (Hammond, 1996a). Intuition is often induced when there is no identifiable organising principle and when there is minimal time available for decision making. Analytical thinking is more likely to occur when an organising principle is accessible, when there is greater time available to work out a solution and perhaps when an earlier intuitive solution has failed.

Hammond (1988) investigates dynamic tasks where a change in the position of the judgement task on the task continuum induces a particular type of cognition. Hammond argues that a match between judgement task and mode of cognition
increases judgmental accuracy. The current study focuses on dynamic tasks in nursing and so the predictions of cognitive continuum theory, that the characteristics of the judgement task would induce a corresponding cognition, could be tentatively explored.

Persisting with intuition would be inadvisable if the judgement task contained analysis-inducing elements. The task characteristics associated with early recognition of critical illness may be an example of a task likely to induce intuitive cognition if multiple fallible cues are appraised through the senses and if there are severe time constraints. At a later stage the task of recognition of critical illness may become more structured with more quantifiable measures of physiological deterioration available. At this stage more quasirational modes of cognition may be induced - the physiological early warning scores are examples of current guidelines used in this type of task. However severe time limits may still reduce the potential for this type of decision task to become an analytical one, therefore a mixture of intuitive and analytical thinking may be the optimal cognitive strategy.

An evidence based health care culture requires clinicians to make the composition of their judgements and decisions explicit (Lamond & Thompson, 2000). The status of clinical data based on subjective assessment is questioned more than objective measures. Feinstein (1983) argues that it should be possible for softer data to be more scientifically acceptable if they take on the most important attribute of hard data, consistency. Consistent data are defined as data where repeated observations by the same or other observers yield the same results (Feinstein, 1983). Feinstein argues that the techniques associated with scientific research, in which there is a preference for hard data and objective measurement processes, do not address research foci such as the subjective state of the patient. In the latter a person is the measurement instrument and the observations are recounted in words, not numbers. It is argued here that both the objective and subjective state of the patient are important in judgements of patient condition in transition states from acute to critical illness or cardiac arrest. So it is not a question of hard data being better than soft data, in some cases soft data may...
provide more information. Dowie (1989) debates the value attached to harder and softer data in medical decision making. Dowie argues that the extent to which harder data are better data in particular situations is an empirical question that requires testing. If softer data, such as perceptual cues of colour or clamminess, and interactive cues such as patient responsiveness, add positive discriminatory power to the early diagnosis of deteriorating clinical states and prediction of critical illness or cardiac arrest then these cues should be identified and integrated into early warning scores.

3.6 Conclusion
This chapter examined various approaches to the study of judgement and decision making and focused particularly on the study of diagnostic judgement. It was argued that Social Judgment Theory (SJT) (Hammond et al., 1975) and the Inference/Correspondence Model of Diagnostic Judgment (Hammond, 1996b) were particularly suited to the analysis of the cue composition of nurses’ judgements about the state of the patient. The organisation of knowledge, domain-specific knowledge and expertise were also discussed because SJT and the Inference/Correspondence Model do not claim to examine the internal representation of knowledge.

The processes of assessment and diagnosis were discussed from the medical and nursing perspectives, and it was argued that nursing’s diagnostic judgements focus more on diagnosing the current clinical state of the patient than on medical diagnoses. The key terms of assessment, judgement, and cues were analysed and defined for the current research. Types of judgements were also identified and defined according to their clinical nature. The chapter concluded with an exploration of the relevance of Cognitive Continuum Theory (Hammond, 1996a) to the current study.

As the cue composition of clinicians’ judgements is the focus in the current research the next chapter reports on a systematic review that was undertaken to identify the predictor cues for critical illness and cardiac arrest reported in the research literature.
Chapter 4

Identification of cues for the prediction of critical illness and cardiac arrest in general ward patients: A review and synthesis of evidence.

4.1 Background information

Previous systematic reviews on critical illness and cardiac arrest focused on indications for admission to ICU (Bone, McElwee et al., 1993), readmission to ICU (Rosenberg & Watts, 2000), survival after resuscitation (Ebell et al., 1998) and interventions in high-risk surgical patients (Boyd, 1999). Hayes and Black et al., (2000) focused on outcome measures in adult critical care. McArthur-Rouse (2001) undertook a narrative review of critical care outreach and early warning scoring (EWS) systems and recommended further investigation of the latter as their effectiveness had not yet been demonstrated, and the presentation of critical illness could be more complicated than the scores suggested. Two major reports (Audit Commission, 1999; DH, 2000) led to the expansion of critical care services to include patients at risk of critical illness outside the critical care areas and the development of critical care outreach and medical emergency or patient at risk teams. A key issue is how patients with developing critical illness are identified and referred for specialist help at ward level; a number of early warning scores are now in use across the UK. The current review was undertaken to identify, analyse and synthesise the evidence for predictors of critical illness and cardiac arrest in general ward patients, and to investigate the cue composition of existing early warning scores.

Evidence from both the quantitative and qualitative research paradigms was included in this review and the analysis and synthesis of both types of evidence was undertaken separately. The quantitative paradigm has informed many studies concerned with the prediction of critical illness and cardiac arrest, and the qualitative paradigm has influenced studies focused on the cues that are valued by clinicians and used in judgements. If clinicians draw on different cues to the known predictors of critical illness and cardiac arrest in the early stages of developing critical illness it is important to identify these cues, examine their use, and assess their predictive power.
This information may increase understanding about the nature of clinical judgements in the early prediction of critical illness and cardiac arrest, and could potentially lead to earlier preventive interventions and improved patient outcomes. The current review included general ward patients, and patients with unplanned admission or readmission to ICU where factors leading to admission/ readmission could be identified in the pre- ICU ward location.

4.2 Aims of the review
The main aims were to undertake a systematic search of the literature to identify cues that predict critical illness and cardiac arrest in adult patients in general wards, to record how frequently the various cues were reported in papers, and to examine early predictors of critical illness and cardiac arrest.

4.3 The objectives of the review were: -
1. To review the validity, reliability and clinical sensitivity of cues that have been used in the prediction of critical illness and cardiac arrest in general ward patients
2. To locate indexes used in the prediction of critical illness and cardiac arrest in general ward patients
3. To analyse the cue composition of the above indexes
4. To review the validity, reliability and clinical sensitivity of indexes used in the prediction of critical illness and cardiac arrest in general ward patients
5. To synthesise the evidence using a combination of narrative and tabular approaches (Mays et al., 2001).
6. To develop a preliminary coding framework outlining the major categories and cues to be used in the subsequent analysis of data collected in an empirical study.

4.4 Questions asked of each paper
1. Was the rationale for the selection of variables or cues investigated in the study based on clinical judgement or statistical methods?
2. Does the research specify the cues that are predictive of critical illness and cardiac arrest in adult patients in general wards?
3. Is there evidence of cues that may be early predictors of critical illness and cardiac arrest?

4. Has the validity, reliability and clinical sensitivity of the measures used in the prediction of critical illness and cardiac arrest been examined?

4.5 Conceptual framework for the systematic review

Acute and critical illnesses are two major categories of illness with differing degrees of severity, comprising various clinical states. Cardiac arrest is one of the clinical states of critical illness; it may be due to a primary cardiac problem or represent the final common pathway of a variety of critical illness states (Andreasson et al., 1998). Severity of illness refers to a particular dimension of the patient's clinical state that is useful when differentiating between acute and critical illness in the general wards. Severity of illness can be conceptualised along a continuum ranging from no illness at one pole through mild, moderate to severely ill and moribund at the opposite pole. Acutely ill patients could be located at the mild to moderate points on a severity of illness continuum, whereas critically ill patients would be located at the severe or moribund points.

The DH guidelines refer to the consequences of illness severity and identify four levels or categories to describe patients' clinical states, and the type of unit in which the patient should be placed (DH, 2000, p.10). Acutely ill patients are subdivided into level zero and level one, and critically ill patients are described as either level two or three. The current review is concerned with the early identification of patients with clinical states in transition from acute to critical illness. According to the DH (2000) guidelines this would refer to patients moving into the level one category and patients in transition to a higher level, or more severe critical illness.

Particular dimensions of severity of illness are identified according to the Stein, Perrin and Pless et al., (1987) framework for the definition of severity of illness (section 2.2, pp.17-18). These include biological severity (including physiological reserve), physiological severity, functional severity, psychological status, and personal characteristics; temporal factors are also considered important. The
A framework that guided the systematic review is shown in Figure 4. The classification of indicators of the patient’s clinical state is based on the various dimensions of severity of illness. Physiological severity is likely to be an important dimension, but additional information derived from psychological severity, functional severity and the time sequence in which cues present may also be significant. Physiological reserve is a complex dimension that is difficult to measure directly in practice; clinicians use substitute information such as functional status, psychological status, medical and social/personal history when making inferences about the patient’s physiological reserve.

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<thead>
<tr>
<th>Antecedents</th>
<th>Clinical Sub-States</th>
<th>Indicators of clinical states</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases / Illnesses</td>
<td>Cardio-vascular instability Respiratory instability Neurological instability Haematological Biochemical or Metabolic instability Renal instability/ failure Gastro-intestinal haemorrhage Other states Combinations of above states</td>
<td>Paraclinical data Objective measures Clinician subjective and behavioural data Functional status Psychological factors Patient self report Temporal aspects</td>
<td>Early Intervention Prevention of Cardiac Arrest or Critical Illness</td>
</tr>
</tbody>
</table>

**Figure 4:** Model of clinical sub-states preceding critical illness or cardiac arrest, the indicators used in the prediction of critical illness or cardiac arrest, and the optimum effect of early intervention.
4.6 Definition of terms

- **Cardiac Arrest** or cardiopulmonary/ cardio respiratory arrest is defined as absent pulse, and loss of blood pressure and spontaneous respiration.

- **Critical illness** refers to illness states that are life-threatening (or within levels two or three of the DH, 2000 descriptors).

- **Early post-operative complications** refer to acute problems occurring within 48 hours of surgery.

- **ICU readmission** refers to patients requiring readmission to ICU within a single hospitalisation.

- **In-hospital mortality or outcome** refers to patient deaths in hospital, and patient survival.

- **Cardiovascular instability** is defined as the clinical state when physiological and clinical abnormalities reflect haemodynamic instability. Abnormal values would include: Systolic blood pressure <90 mmHg or >200 mmHg; Pulse rate <50 beats per minute or >130 beats per minute; Urine output <100 mls in 6 hours or <500 mls in 24 hours (Buist *et al.*, 1999).

- **Respiratory instability** is defined as the clinical state when physiological and clinical abnormalities are primarily reflected in respiratory indicators. Abnormal values would include: Respiratory rate >30 respirations per minute or <10 respirations per minute; $O_2$ saturation <90%; $PaO_2$ <10 kPa; $PaCO_2$ >6 kPa; stridor / upper airway obstruction (Buist *et al.*, 1999; McGloin *et al.*, 1999).

Other clinical states leading to critical illness or cardiac arrest include neurologic, haematologic, metabolic, renal dysfunction, sepsis, malignancy and various combinations of all the above. The current review focused on generic predictors of critical illness and cardiac arrest and the specific clinical states of cardiac and respiratory instability.

*Indicators of clinical states* refer to the clinical data or *multiple fallible indicators* used by clinicians to infer the patient's clinical state (Hammond (1996b). The indicators include objective data (physiological measures, laboratory data), clinicians'
subjective/behavioural data or physical signs (from observation or palpation), the patient’s report of symptoms, and the patient’s history.

- **Physiological measures** refer to measurements of vital signs, laboratory data, results of investigative procedures such as electrocardiograph (ECG) and x-ray.

- **Clinician subjective or behavioural data** includes items such as colour, pallor, sweating, tiredness, lethargy, and mental alertness/level of consciousness. Psychological refers to indicators reflecting the patient’s psychological or emotional state such as anxiety or mood. Functional refers to the patients’ ability to perform activities of living. Temporal refers to the pattern of changes/presentation of indicators over time.

- **Patients’ self-report** of symptoms would refer to complaints such as dyspnoea and nausea.

### 4.7 Search strategy

The goal was to undertake a comprehensive, unbiased and systematic search for research studies that addressed the review questions (Khan et al., 2001). The search included the following:

1. Searching electronic databases
2. Manual searching of selected journals,
3. Manual searching of abstracts from selected conference proceedings
4. Checking the reference lists of published reviews for further references,
5. Snowballing from references,
6. Personal contacts with researchers

#### 4.7.1 Searching electronic databases

As no single database is likely to record all relevant papers (Glanville, 2001) the search focused on a number of bibliographic databases as follows:

1. Medline (National Library of Medicine, USA); searched on-line using Ovid software.
2. CINAHL (CINAHL Information Systems USA; Citation Index of the Nursing and Allied Health Literature): searched on-line using Ovid software.
Other sources included:

2. The NHS R&D list of funded studies, 2001 and 2002,

During the conduct of the searches the *Explode* command was used to maximise retrieval of papers indexed at the extremities of the MeSH *tree* or indexing system (Greenhalgh, 2001). Text word searching was also performed on selected terms. Prepared search strategies and filters were consulted- Centre for Evidence Based Medicine, Oxford http://cebm.ir2.ox.ac.uk/docs/searching.html, and Institute of Health Science Library, Oxford http://wwwlib.ir2.ox.ac.uk/caspfew/filters accessed in December 2001, and http://www.phru.org.uk/~casp/caspfew/few/filters accessed November 2002.

Brazier and Begley (1996) compare literature searches in nursing on Medline and CINAHL databases and conclude that Medline should be the first choice for subjects other than the organisation of nursing, and this was confirmed in the current review as Medline produced more relevant papers than CINAHL. However in Medline around 50% of articles are not classified accurately by subheading and so relevant articles could be excluded when the *limit set* command is applied (Greenhalgh & Donald, 2000). To minimise this effect the retrieved articles were browsed on screen rather than using the *limit set* option provided that the numbers of papers were not too unwieldy. Electronic searching of the above databases was judged to have been completed when no new references meeting the inclusion and quality criteria were being identified- a stage that was reached in November 2002.
Systematic reviews have predominantly drawn on randomised controlled trials (RCTs) which are widely accepted as the *gold standard* research design for the evaluation of interventions, but the systematic approach can be applied to all types of research designs (Altman, 2001). In the current review limiting the search to RCTs would have identified few research studies potentially for inclusion. Therefore prognostic, retrospective, and qualitative research studies were included. Altman (2001) reports that searching for prognostic studies for inclusion in systematic reviews could be more problematic than searching for RCTs, yet it should still be possible to develop sensitive search strategies to capture prospective studies. The best single term for searching prognostic studies in Medline is *explode cohort studies* (MeSH) (McKibbon et al., 1999 as cited in Altman, 2001), and this was applied in the current search strategy.

### 4.7.2 Manual searches of selected journals.

### 4.7.3 Manual searches of abstracts from conference proceedings.

### 4.7.4 Searches of reference lists of published reviews.
The reference lists of published reviews were checked for further references (Audit Commission 1999; DH 2000; McArthur- Rouse, 2001; Rosenberg & Watts 2000)

### 4.7.5 Snowballing from references.
References identified in reference lists of included papers were followed-up.
4.7.6 Personal contacts with researchers.
Individual researchers working in this subject area were also contacted if known to
the researcher. Contacts included an MET project study leader, who was an A&E
medical consultant, an MET study project nurse at a local NHS Trust hospital, and
two Critical Care Nurse Consultants from two other hospital trusts.

4.8 Study Selection Criteria

4.8.1 Inclusion Criteria

Population: Adult patients in general wards, or patients with unplanned admissions
and re-admissions to ICU recently transferred from general wards, aged over 19
years, to 80 years and over.

Focus: Cues that predict critical illness and cardiac arrest in adult general ward
patients.

The outcome of interest: Early identification of critical illness, referral to MET/ other
specialist teams or doctors for emergency intervention, prevention of cardiac arrest,
and reduced numbers of unplanned admissions or re-admissions to ICU.

Purpose: Identification of predictors of critical illness and cardiac arrest.

Study Quality: The review included a range of studies from the hierarchy of study
design evidence (The Oxford CEBM Levels of Evidence (Phillips, Ball & Sackett et
and qualitative research studies. Papers included in the review met the review
inclusion criteria, with the exception of three qualitative studies focused on intensive
care clinicians. Papers were also required to meet the quality criteria identified for
each major category of research design to at least a reasonable level (where
reasonable was defined as; three or less criteria not met (Appendix 1). Morgan et al.,
(1997) and Stenhouse et al., (2000) provided insufficient information for quality
rating but were included in the review because they were considered clinically
significant studies of early warning and modified early warning scores.

Language: Only papers published in English were reviewed.
4.8.2 Exclusion Criteria
Studies of patients drawn from a population other than general ward patients.
Studies of patients with ages outside the inclusion criteria for age.
Studies of patients with primary cardiac disease.
Studies of indexes or scores that referred to patients in locations outside the general wards. ICU/ HDU studies were included if they referred to cues that presented when the patients were located in the general ward.
Studies that did not focus on the examination of cues that predict critical illness and/or cardiac arrest in general ward patients.
Studies that were of poor quality (less than 50% of criteria met) according to the pre-specified quality criteria (Appendix 1).
Studies not published in the English language.

4.9 Stages in the search process
The major stages in the search process are shown in Figure 5.

Stage 1a Exploratory searches identified the most sensitive terms for use in the final search strategy. Boolean operators, language and age limits were applied to the final searches and 5750 papers were identified for potential inclusion from a total of 2,806,178 papers initially identified by the main search terms.


Figure 5: Stages in the search process
Sensitivity refers to the chances of retrieving relevant papers and specificity refers to the chances of excluding irrelevant papers (CEBM, 2001). Initially when the searches were sufficiently broad to produce good hit rates of suitable papers, a significant number of irrelevant papers were also uncovered. This may have been due to the problems associated with developing sensitive search strategies for heterogeneous patient groups and locating prognostic studies. The assistance of a university librarian was sought at an early stage for advice on structuring searches on the Medline and CINAHL databases. Multiple searches were then undertaken to address the different elements of the review questions. Gradually a more refined electronic search strategy was developed and searches yielding improved sensitivity and specificity were achieved (Appendix 2).

The databases, Medline (M) and CINAHL (C), and the key terms searched are shown below. The totals in brackets refer to the total numbers of papers identified for possible inclusion in the review prior to the application of limits (age and English language).

Totals for initial liberal searches undertaken between February and December 2001


2. Severity of illness /or diagnosis-related groups /or prospective studies /or intensive care /or critical illness (146009 M), severity of illness index (24971 M; 1103 C), cohort studies (280223 M), health status indicators (24144 M for years 1993-2001).

3. Nursing assessment /or outcome and process assessment (health care) /or risk assessment (84233 M for years 1997-2001 only).

1. Critical illness (4128 M; 552 C), internal medicine (4368 M), diagnosis/or critical care/ or intensive care/or preoperative care/ or subacute care/ or heart arrest (1565229 M), critical care (3300 C), subacute care (499 C), heart arrest (nu,di,ep ) (7989 M), heart arrest (1358 C), cardiopulmonary arrest or cardiac arrest.mp. (676 C), critical care/ or intensive care.mp (7267 C).

2. Aetiology filter on Medline causality, cohort studies, risk (516770 M)


Text word searches were performed on the following terms:
Transition index(es), change index, patient at risk index, clinimetrics, premonitory signs, prognosis, prediction, outreach, medical emergency team, early warning score, unexpected admission, risk.

Author searches included:
Searches of authors of conference reports on relevant topics, and where an author was known to have undertaken research within the scope of the review.

The boolean operator command or was used to add data sets together, with the and command being used to obtain papers placed in both sets (the intersection between two sets). For example the major terms of critical illness, internal medicine, diagnosis, critical care, intensive care, preoperative care, subacute care, or heart arrest were searched separately and the or command produced totals for sets that were added together. These data sets were then combined with an aetiology filter on Medline using the and command to identify articles that appeared in both the particular clinical sets and the aetiology sets. The search terms used on CINAHL differed from those used on Medline as terms that were productive on Medline were often less successful on CINAHL. For example critical illness produced small
numbers of references on CINAHL and the term critical care produced more. Search field suffixes for Ovid such as ti (title), tw (text word) were used when appropriate. The limits of human, English language, and adults >19 years were applied at the final stage. In some cases the mp command was used on CINAHL to limit the set to papers where a particular term appeared in the title, cinahl subject heading, abstract, or instrumentation. Following application of boolean operators and the human, language and age limits a total of 5750 papers were identified for possible inclusion at the end of stage 1a.

Further searches using a range of terms were excluded from the final review as they were either less sensitive or less specific for the review question, or papers overlapped with the literature retrieved above. The less sensitive terms were quality assurance /or evaluation of care, prediction of mortality, prediction of morbidity, prediction of functional status, hospital mortality, post operative complications, cardiopulmonary resuscitation, respiratory insufficiency, clinical competence, decision making, diagnostic reasoning, judgement.

In stage 1b the total number of papers identified in stage 1a was reduced to 685 papers potentially for inclusion by scrolling through the titles and abstracts to exclude papers that focused on subjects beyond the current review. 5065 papers were excluded as they focused on subjects beyond the current review.

Of the 685 papers identified above, 634 were subsequently excluded in stage 1c because critical analysis of the abstracts demonstrated that the foci were outside the review inclusion criteria, or they were duplicates of papers in this set. Papers excluded at this stage focused on long term survival after cardiac arrest (Herlitz et al., 2000), long term follow-up in acutely sick elderly patients (Saltveldt et al., 2002), outcome in patients refused admission to ICU (Joynt et al., 2001), mortality in ICU admissions after case-mix adjustment by the APACHE III score (Pappachan et al., 1999), mortality in surgical intensive care patients after CPR (Smith et al., 1995), and end of life decisions (SUPPORT investigators [anonymous] 1995).
In stage two of the search, full text versions of the remaining 51 papers and the inclusion/exclusion criteria were applied. Quality assessment of the papers was undertaken and papers were rated good, reasonable or poor using checklists (Appendix 1). A decision was made to include papers as core research, background papers, or to exclude. 38 core and nine background papers were identified for inclusion and five papers were excluded. The excluded papers included two that either did not focus on cues or did not meet the review quality criteria (Coombs & Dillon 2002; Daly et al., 1998), and three papers that were beyond the scope of the current review (Desbiens et al., 1999; Hayes & Black et al., 2000; Schultz et al., 1996).

In stage three further papers were identified by searching selected journals, conference abstracts, making personal contacts, by following up references in major reports and snowballing from papers identified for inclusion in the review. The abstracts of Heart and Lung, Intensive and Critical Care Nursing, Journal of Advanced Nursing, and The International Journal of Nursing Studies were searched from 1990-2001 to identify relevant nursing papers for inclusion (some papers had already been identified through the Medline and CINAHL databases). Manual searching of conference abstracts of the European Society of Intensive Care Medicine Annual Congresses 1998-2000, and UK Intensive Care Society Meetings 1997-2001 was undertaken. These papers tended to have minimal information on cues, but where possible published research reports relating to these abstracts were obtained. Further references were obtained from reference lists and bibliographies of all the papers identified for inclusion in stages one and two. References were also retrieved from major review and policy documents and considered for inclusion. Where papers potentially met the inclusion criteria full text papers were obtained, the papers were critically analysed and the inclusion criteria and quality criteria were applied. Thus seven significant studies published before 1990 were included in the final review, which could be viewed as a weakness in the review methodology. Review papers, and policy documents were also included when they made contributions to the review
question. A systematic review of grey literature (internal reports, non-peer reviewed journals, theses) (Greenhalgh, 2001) was not undertaken due to resource constraints. 27 core papers and eight background papers meeting the criteria for inclusion were added to the papers already included at stage two. Papers excluded at this stage either failed to meet the review quality criteria (Donaldson et al., 1997) or focused on subjects beyond the review (Deyo et al., 1984; Franklin & Rackow et al., 1988; Gonnella et al., 1984; Le Gall and Lemeshow et al., 1993; Rodriguez et al., 1997; Rogers and Fuller 1997).

The final review consisted of a total of 65 core papers and two major policy documents (Audit Commission, 1999; DH, 2000). 16 papers were identified as background research or theoretical literature and 15 papers were excluded. The Endnote 4 programme (1988-2000 Institute for Scientific Information) was used with Ovid in the extraction of bibliographic information for references included in the review.

The details of the search process are summarised overleaf in Table 1.
Table 1. Summary Table of Search Process: Selection of papers for inclusion in systematic review

<table>
<thead>
<tr>
<th>Stage 1a</th>
<th>Total no. papers</th>
<th>Hits</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic search to identify potential citations. Search on key terms and application of Boolean operators and age limits. (Totals for initial liberal search on key terms reported in search strategy p. 75)</td>
<td>2,806,178 papers identified via major search terms.</td>
<td>5,750 papers identified for possible inclusion after application of Boolean operators and age limits.</td>
<td>2,800,428 papers were excluded.</td>
</tr>
<tr>
<td>Stage 1b</td>
<td>5750 papers</td>
<td>685 papers identified</td>
<td>5065 excluded as titles/abstracts indicated subject not within current review.</td>
</tr>
<tr>
<td>Titles and abstracts of potentially relevant papers were scrolled through.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1c</td>
<td>685 papers</td>
<td>51 papers</td>
<td>634 papers excluded - abstracts indicated papers outside review inclusion criteria, or duplicates of papers identified in this set.</td>
</tr>
<tr>
<td>Further critical analysis of abstracts and application of the review inclusion/exclusion criteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td>51 papers</td>
<td>38 core papers, 8 background papers</td>
<td>Excluded 5 papers- did not meet inclusion criteria or quality criteria:</td>
</tr>
<tr>
<td>Retrieval of full text papers potentially meeting inclusion criteria. Critical appraisal of full text papers and application of inclusion/exclusion criteria, and quality criteria.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td>38 core and 8 background papers from stage 2.</td>
<td>27 core and 8 background papers added in stage 3. Review included -65 core papers, 2 major policy papers. 16 background papers.</td>
<td>Excluded 15 papers at this stage that did not meet review inclusion or quality criteria.</td>
</tr>
<tr>
<td>Relevant studies included in review plus additional papers identified via manual searching journals and reference lists of papers identified in search of on-line databases.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.10 Quality appraisal

4.10.1 Quantitative paradigm

Many relevant studies for the current review were based on prognosis, or symptom prevalence. The Oxford CEBM Levels of Evidence (Phillips, Ball & Sackett et al., 1998, http://minerva.minervation.com/cebm/docs/levels.html accessed 30/11/02) includes all the major types of medical studies and was used in the current review for the assessment of levels of evidence. In contrast the CRD Hierarchy of Study Design Evidence of Khan, ter Riet et al., (2001) mainly focuses on intervention studies and is narrower in scope than that required here. However quality appraisal involves more than assigning the papers to a particular place on a hierarchy of evidence on the basis of study design (Greenhalgh, 2001); the papers were therefore examined for methodological quality and according to their contribution to the evidence for predictors of cardiac arrest and critical illness.

Within the review and synthesis of research evidence the following definitions were applied in the quality assessment of quantitative studies (Khan et al., 2001, p.5). Firstly internal validity refers to the extent to which the results of a study come close to the truth - a prerequisite for external validity. Secondly, external validity or generalisability refers to how well the effects observed in a study would apply in other situations. Thirdly, study quality (methodological quality) refers to the measures taken to minimise biases, with particular emphasis on internal validity and how the design and conduct of the research affected the outcome. Fourthly, bias (systematic error) occurs when results are systematically different from the true results. Finally, clinical usefulness (Laupacis et al., 1994) examines how similar the study patients are to the patients encountered in the clinician’s own practice, and if the results would contribute to the clinician’s decisions about interventions or overall practice. The quantitative studies were categorised according to the particular level of evidence they represented in the levels identified by the Oxford Centre for Evidence-based Medicine (Phillips, Ball & Sackett et al., 1998, pp.1-2)
4.10.2 Qualitative paradigm

Qualitative researchers are divided into those who favour traditional positivist quality criteria when evaluating research and others that draw on idealist or constructivist perspectives to argue either that criteria should not be applied, or that alternative criteria are needed. Some researchers contend that a single version of reality cannot be captured by language and that individuals will have different interpretations of events making it inappropriate to try to reach agreement, whereas others accept that criteria can be applied but should be adapted for the interpretivist position (Seale, 1999). The qualitative studies included in the review were located within the interpretivist perspective and the definitions of rigor used in the evaluation of their quality were *creditability, transferability and confirmability* (Lincoln & Guba, 1985; Murphy *et al.*, 1998; Miles & Huberman, 1994; Popay *et al.*, 1998).

*Creditability* is substituted for the conventional research criterion of *internal validity* according to Lincoln and Guba (1985). It refers to how much sense the findings make, and how well the focus of research is represented (Miles & Huberman, 1994). Research needs to be conducted in a manner that ensures the findings are trustworthy. Assuring creditability would involve using techniques of *prolonged engagement* or adequate time spent in the field, *peer debriefing* or opportunity to recount how the study is unfolding and to develop current thinking, analysing *negative cases*, and by undertaking *member checks* (Lincoln & Guba, 1985).

*Transferability* replaces *external validity* in the qualitative research paradigm. The issue is whether the conclusions of a study would apply elsewhere. Lincoln and Guba (1985) contend that the onus for ensuring transferability to other settings from the original research site falls on the person seeking to generalise the findings. Lincoln and Guba recommend that evidence to support the similarity of the contexts should be examined before transferring research or assessing *fittingness* in other settings. *Thick description* of the original research site is therefore necessary for assessing transferability of research (Murphy *et al.*, 1998; Miles & Huberman, 1994).
Confirmability in qualitative research replaces the usual criteria of objectivity and neutrality in the quantitative paradigm (Murphy et al., 1998). The goal is to demonstrate that the researcher has not been unduly biased and imposed his own conclusions. Rather, the research conclusions should relate to the subjects and research situation (Miles & Huberman, 1994). The audit trail is used to examine the extent to which the research process was dependable or consistent, stable across researchers and over time, and that the findings could be confirmed.

4.10.3 The quality appraisal process

The studies identified were examined for methodological rigor to ensure that poor quality studies were excluded from the review (with the exception of two papers that provided insufficient data for quality rating, as noted on p.73). The aim was to ensure that the methods and results reported in the selected studies were sufficiently valid to provide useful information. Particular attention was given to the validity of studies, uncovering any reasons for differences in study results greater than that attributed to chance, and reporting enough information for individuals to be able to judge how relevant the review would be to their practice (Evans, 2001). Initially systematic review quality assessment had focused on the appraisal of RCTs, but guidelines for the evaluation of observational and qualitative studies are now available (Khan et al., 2001; Mays & Pope, 1996; Mulrow & Oxman, 1997; Popay et al., 1998).

Pre-identified criteria were used for the separate quality evaluation of quantitative and qualitative research papers (Appendix 1), and for clinical indexes (section 4.16.1, pp. 127-128). Papers were judged as good, reasonable or poor depending on whether they met all criteria, most (three or less criteria not met), or few criteria (more than three criteria not met), respectively. The results of the assessment of research papers are presented in Appendix 3: Quality assessment of all primary research and review papers included in the review. Papers were also ranked in a hierarchy of evidence (Appendix 4: Hierarchy of evidence) according to the research design- with the exception of qualitative papers that did not fit directly within these hierarchies (Mays et al., 2001). Data extraction summary sheets, Table 2, were completed for all studies.
identified at stage three of the search (included, background and excluded papers)-
(Appendix 5).

**Table 2:** Data extraction sheet (data entered using a *FileMaker Pro 5.5* database
developed specifically for the task).

<table>
<thead>
<tr>
<th><strong>Publication details</strong></th>
<th>Name, year, publication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject or study</strong></td>
<td></td>
</tr>
<tr>
<td>characteristics</td>
<td>Patient group, clinical state</td>
</tr>
<tr>
<td><strong>Verification of study</strong></td>
<td></td>
</tr>
<tr>
<td>eligibility</td>
<td>Correct population, type of study</td>
</tr>
<tr>
<td><strong>Sample details</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Target population,</td>
</tr>
<tr>
<td></td>
<td>Inclusion, exclusion criteria</td>
</tr>
<tr>
<td></td>
<td>Recruitment procedures (participation rates if available)</td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brief summary of research method</td>
</tr>
<tr>
<td></td>
<td>If RCT- details of treatment and control groups</td>
</tr>
<tr>
<td><strong>Statistical analysis and results</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Techniques used</td>
</tr>
<tr>
<td></td>
<td>Unit of analysis</td>
</tr>
<tr>
<td></td>
<td>Number followed up</td>
</tr>
<tr>
<td></td>
<td>Discrete data (events, totals, p-value) and continuous data (mean, SE, SD, numbers, p-value)</td>
</tr>
<tr>
<td></td>
<td>Survival data</td>
</tr>
<tr>
<td></td>
<td>Details of treatment and control groups (RCTs), comparison groups in observational studies</td>
</tr>
<tr>
<td></td>
<td>Cues that were predictive of the clinical state</td>
</tr>
<tr>
<td><strong>Conclusions/ comments on methodological quality of study.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design- place in hierarchy of evidence</td>
</tr>
<tr>
<td></td>
<td>Validity/ reliability issues</td>
</tr>
<tr>
<td></td>
<td>Quality rating – good/ reasonable/ poor</td>
</tr>
<tr>
<td><strong>Notes</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Include/ exclude/ background</td>
</tr>
</tbody>
</table>
The transparency of processes used in the systematic review and synthesis of evidence is assisted by the publication of an audit trail for the various stages in the review. This includes the summaries of papers mentioned above (Appendix 5) and worked examples for each stage in data analysis and conclusion drawing.

4.10.4 Inter-rater reliability

*Inter-rater reliability* refers to the extent to which two independent raters agree when independently coding the same data (Robson, 2002b). Inter-rater reliability checks were performed on a sample of seven papers out of the final sample of 61 papers. An experienced critical care practitioner/tutor used the coding framework and independently coded papers for all the predictor cues. The check coding method described by Miles and Huberman (1994) was used to calculate percentage agreement between the researcher and the independent coder as follows:

\[
\text{Reliability} = \frac{\text{number of agreements}}{\text{Total number of agreements and disagreements}}
\]

The results are reported in Appendix 6. There was a high level of agreement at 92% indicating that the researcher’s findings were largely reproducible.

4.11 Strategy for the analysis and synthesis of evidence.

Synthesising research evidence from quantitative and qualitative studies, and from a range of methods in health care is a challenging task (Forbes & Griffiths, 2002; Mays *et al.*, 2001). The position held in the current review is that quantitative and qualitative research studies can be used as evidence of cues. In view of the contrasting philosophical orientations in quantitative and qualitative paradigms separate analysis and synthesis of research evidence from these paradigms was undertaken.

The range of research methods employed and the heterogeneity of subjects studied made statistical meta-analysis inappropriate. Evidence found in weaker studies would normally be excluded from systematic reviews and statistical meta-analysis,
but where such research constitutes the majority of evidence for clinical practice rigorous methods of synthesising this evidence need to be developed. Mays et al., (2001) refer to narrative, tabular and statistical approaches to the synthesis of research evidence. Narrative synthesis refers to the presentation of the findings of primary research as text using sub-headings and the category of tabular synthesis refers to the use of tables containing statistical summaries of the results of the studies included in the review (Forbes & Griffiths, 2002). Statistical synthesis refers to the combination of findings in primary studies using the techniques of meta-analysis (Forbes & Griffiths, 2002). Within narrative synthesis, tabular synthesis, theory-led, analytical and triangulation methods can be used (Mays et al., 2001).

The papers finally included were categorised as follows:
- 65 core papers (included 60 quantitative and five qualitative papers)
- 16 background papers (the subject was within the scope of the review but they did not focus on cues in detail)
- 15 papers were excluded at this stage (as the focus was beyond the scope of the current review).

4.11.1 Critical Appraisal of Papers for Predictors of Clinical States
In addition to quality appraisal the papers were scrutinised for the cues measured and the cues identified as predictive of the clinical states of cardiopulmonary arrest, critical illness, early post operative complications, readmission to ICU and mortality or outcome. A data extraction sheet was developed to record cues identified as predictive. A judgement was made about the strength of evidence for particular cues as strong/ moderate/ weak/ other. This involved appraising the overall quality of the study and the strength of the statistical evidence for particular cues as predictors of the clinical states of cardiac arrest, critical illness (included unplanned admission to ICU), post-operative complications, readmission to ICU, or outcome such as mortality. The criteria used are identified in the definition of fields in Appendix 7.
Many different cues were identified across the papers. The task of collating evidence for predictive cues was undertaken using a computerised data base package—FileMaker Pro 5 (FileMaker, Inc 1995, 1997-1999). A data entry sheet was developed for the various cues, and predictor cues in each paper were marked off in check boxes; examples are included in Appendix 8. The majority of studies included in the review provided weaker evidence than that required for statistical meta-analysis but a combination of narrative, and tabular approaches were used in the synthesis of research evidence. Narrative synthesis focused on the types and functions of indexes, the cue compositions of indexes, how cues were identified for investigation (either through clinical judgement or statistical methods), the range of predictor cues identified, and whether cues were predominantly diagnostic or predictive. A tabular synthesis was performed for cues identified as predictors (Mays et al., 2001). The main aim was to establish the frequency of reports of cues that predicted critical illness and cardiac arrest.

4.11.2 Type of cues reported in papers.
Wulff and Gotzsche (2000) categorise the purposes of clinical data as follows. Firstly, as diagnostic indicators to infer possible diagnoses such as the electrocardiograph (ECG) changes associated with myocardial infarction. Secondly, as prognostic indicators where clinical data are used to predict the course of a disease or illness, for example APACHE scores in critical illness. Thirdly, as clinical indicators where severity at a given point can be assessed and observations recorded to monitor changes in condition over time, such as respiratory rate and SPO$_2$ in patients with respiratory problems (Wulff & Gotzsche, 2000).

A diagnostic cue denotes a cue used to assign a patient to a particular class or diagnostic group. There are very few single diagnostic cues that indicate a particular disease with certainty and so clinicians rely on a number of uncertain cues when making diagnostic judgements (Hammond, 1996b). Diagnostic cues may serve four different purposes according to Sackett et al., (1991). Firstly in making a diagnosis of the cause of illness or disease diagnostic cues are crucial. Secondly they may be used
to estimate severity of illness (i.e. a state occurring in combination with the primary diagnosis indicating increased severity, such as heart failure in addition to myocardial infarction). Thirdly, diagnostic cues are used to predict the course of illness and the patient's prognosis, and finally, diagnostic cues guide therapeutic interventions either currently or in the future.

Prognostic judgements are made on the basis of prognostic cues. Prognostic cues include the patient’s diagnosis, the pathophysiological and clinical manifestations of the illness in the patient, the clinician’s knowledge of the likely course of the disease or illness, the patient’s response to therapy, and the patient’s physiological reserve inferred from factors such as age, medical history, and functional status. Camevali and Thomas (1993) refer to medical and nursing components of prognosis. The first component refers to areas where changes can happen such as pathology, pathophysiology, human responses such as functional capacities for daily living, and use of external resources. The second component refers to the types of outcomes (success, failure, and outcomes between these extremes), and the third component refers to the trajectory of change or the clinical course. Due to the multiple factors involved there can be great uncertainty in prognostic judgements. However prognostic judgements are very important in clinical practice as predictions of future serious clinical states provides for the possibility of earlier interventions, as in the onset of critical illness in general ward patients where the risk of cardiac arrest may be reduced.

Diagnostic and prognostic cues are therefore closely related. Clinicians need to know the patient’s current clinical state to predict a future clinical state, and consequently some of the prognostic cues used in prognostic judgements will be diagnostic in nature.

In the review the diagnostic groups were heterogeneous, as critical illness and cardiopulmonary arrest are possible consequences of many severe illnesses and conditions. A range of diagnostic indicators underpinned judgements about the
reasons for hospital admission, medical history and medical conditions. The diagnostic indicators were used prognostically to predict cardiopulmonary arrest, critical illness, and in-hospital mortality/outcome. The remaining predictive cues identified were of the *prognostic or clinical indicators* type. These cues did not tend to be unique to a particular clinical state, but were often found across the clinical states investigated.

4.12 Results, analysis and synthesis of evidence.
A narrative and tabular synthesis of evidence was undertaken for the core quantitative and qualitative papers that were selected for inclusion in the review. The main purposes were to identify, analyse and synthesise predictive cues, to specify the types of cues and to report on how frequently they were reported as predictors of the clinical states of cardiopulmonary arrest, critical illness, early post-operative complications, ICU readmission, and in-hospital mortality or outcome as previously defined. Papers were classified according to the type of clinical state(s) predicted as shown below in Table 3.

**Table 3: Summary of 65 core papers included in review according to clinical states**

<table>
<thead>
<tr>
<th>Clinical state</th>
<th>Number of occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction of cardiopulmonary arrest</td>
<td>14</td>
</tr>
<tr>
<td>Prediction of critical illness</td>
<td>27</td>
</tr>
<tr>
<td>Prediction of early post-operative complications</td>
<td>7</td>
</tr>
<tr>
<td>Prediction of ICU readmission</td>
<td>4</td>
</tr>
<tr>
<td>Prediction of mortality/outcome</td>
<td>29</td>
</tr>
</tbody>
</table>

Note: Some papers predicted more than one clinical state, such as cardiopulmonary arrest, critical illness and mortality, or ICU readmission and mortality/outcome.

To maintain the independence of samples four quantitative papers (11,14,49,58) were excluded from the statistical analysis of core papers as they drew on the same sample as another core paper (57).
All of the cues identified as predictive in the final 56 core quantitative papers were summarised according to their frequency of occurrence, and then reported as a percentage over all 56 papers, by the clinical states category, and the strength of the evidence for cues. The numbers of papers in the categories ranged from four through to 29 for the clinical states, and four to 29 on the strength of evidence for cues category (Appendix 9: Table A9.i Sample size for core quantitative papers by clinical states and strength of evidence).

The cues identified as predictive may be biased by the method through which cues were selected for inclusion in research studies initially - i.e. cues were selected on the basis of clinical judgement or expertise, by statistical methods, and in some cases using a mixture of both approaches. There were few strong studies according to the level of evidence hierarchy (Phillips, Ball & Sackett et al., 1998), a further reason for cautious interpretation of the evidence. By comparing the occurrence of cues within each of the clinical states’ categories to their occurrence in the remaining papers it was possible to discern apparent differences in the percentage rating of cues across the categories and to subject these to more detailed statistical analysis.

4.12.1 Core quantitative papers (56 papers).

Graph 1, on page 91, depicts the overall cues occurring in over 9% of the final 56 core quantitative papers included in the review. The cues identified most frequently over all core quantitative papers were blood pressure, respiratory rate, temporal, administrative factors, admission disease process, type of admission, level of consciousness, pulse, medical history and new complications.
Graph 1. Core quantitative papers

Frequency of cues occurring in over 9% of the final 56 core quantitative papers.
4.12.2 Predictors of cardiopulmonary arrest

Numbers shown in brackets refers to the numbers allocated to papers in the review—see Appendix 5: Data extraction summary tables.

Fourteen of the core quantitative papers focused on the prediction of cardiopulmonary arrest (papers 1, 3, 10, 17, 23, 28, 29, 34, 42, 57, 59, 63, 69, 70). Five studies were undertaken in the US, five in Australia, three in the UK, and one in Sweden. The sample sizes ranged from 47 (paper 63) to 1027 (paper 69) and included patients from all wards (papers 1, 3, 10, 17, 29, 34, 42, 59, 63, 69), medical wards only (papers 23, 57, 70), and ICU patients (paper 28) (For sample size statistics see Appendix 9). Methods used included prospective observational studies (papers 23, 28, 29, 34, 42, 57, 63), retrospective reviews (papers 10, 17, 59, 69), a prospective and retrospective review (paper 3), and a retrospective case-control study (paper 70). All papers were categorised as reasonable in quality with the exception of paper 70 categorised as good. The strength of the evidence for cues as predictors of cardiopulmonary arrest was judged weak in the majority of papers (1, 17, 23, 28, 34, 42, 59, 63, 69), and moderate in five papers (3, 10, 29, 57, 70). The timing of the recording of cues until the onset of a clinical event was recorded in the majority of cardiopulmonary arrest papers, Table 4.

Table 4: The time relationship of cues to events for cardiopulmonary arrest papers.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Cues noted</th>
<th>Time before event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Congestive heart failure, acute myocardial infarction, bradycardia and hypotension.</td>
<td>Just before cardiac arrest, time not defined.</td>
</tr>
<tr>
<td>3</td>
<td>Iatrogenic events</td>
<td>Within 24 hours before cardiac arrest.</td>
</tr>
<tr>
<td>10</td>
<td>Instability noted in 76% critical events (haemodynamic, respiratory, laboratory results, altered level of consciousness (LOC), abnormal temperature).</td>
<td>Instability present for more than 1 hour before event.</td>
</tr>
<tr>
<td>17</td>
<td>Signs and patient symptoms reported</td>
<td>Within 24 hours of MET call.</td>
</tr>
<tr>
<td>23</td>
<td>Documented deterioration in 99/150 cases</td>
<td>Within 6 hours of event.</td>
</tr>
<tr>
<td>28</td>
<td>Changes in respiratory rate</td>
<td>Within 24 hours before ICU admission.</td>
</tr>
<tr>
<td>29</td>
<td>Tachypnoea, decreased LOC,</td>
<td>Most frequent cues before admission to</td>
</tr>
</tbody>
</table>
tachycardia ICU.

34 MET criteria Time to event not reported.

42 Pre-defined early post-operative 100% occurred within 48 hours post operatively (median occurred within 15 hours).

42 emergencies

57 Doctors’ assessments of risk for Compared admission assessments with catastrophic deterioration on admission patient outcomes of hospitalisation.

59 84% had evidence of problems Within 8 hours of cardiac arrest (respiratory and level of consciousness)

63 Abnormal vital signs and laboratory Within 24 hours of cardiac arrest. results

69 MET score Recorded on 5 separate days.

70 Respiratory rate Within 72 hours of cardiac arrest.

Graph 2 shows the frequency of cues as percentages in the 14 papers predicting cardiopulmonary arrest. Respiratory rate was the most frequently reported predictor of cardiopulmonary arrest (86%, or 12 papers). Pulse and level of consciousness were the next most frequently reported predictors, each occurring in 64%, or nine papers. Blood pressure and temporal factors occurred in 57% or eight papers. Administrative factors, delayed response, and dyspnoea each occurred in 43% or six papers. The remaining cues identified related to 42 different cues, 17 occurred in only 7% or one paper. When compared to the graph for the total 56 papers the general trend was similar although some cues such as respiratory rate, pulse and level of consciousness, delayed response and dyspnoea appeared to be reported more frequently in the cardiopulmonary arrest papers.
Graph 2.
Cardiopulmonary arrest papers

Frequency of cues in the 14 papers predicting cardiopulmonary arrest.

- Overall minus cardio.
- Cardio.
Fisher's exact test was used to compare the incidence of particular predictor cues in cardiopulmonary arrest papers and non-cardiopulmonary arrest papers, Table 5.

**Table 5:** A simple 2x2 table with predictor present/ absent, cardiopulmonary papers/ other papers

<table>
<thead>
<tr>
<th>predictor absent</th>
<th>other papers</th>
<th>cardiopulmonary papers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>predictor present</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Fisher's exact test can be used to compare proportions in 2x2 tables with small expected frequencies (Altman, 1991). This is a hypothesis test and it assumes that the null hypothesis is true; that the row and column variables are unrelated (Altman, 1991). In the current research the null hypothesis tested was that a particular cue was equally likely to occur as a predictor in the clinical state papers and the non-clinical state or remaining papers. Fisher's exact test examines the probability relating to all possible combinations of the 2x2 tables with the same row and column totals as occurred in the observed data if the null hypothesis is true (Altman, 1991). The mathematical formula for Fisher's exact test is given as follows:

$$\frac{(a+b)!(a+c)!(b+d)!(c+d)!}{N!a!b!c!d!}$$

Altman (1991, p.256)

where $x!$ represents '$x$ factorial'. The formula is based on calculating all the different ways the $N$ individuals (papers in the current research) can be composed to give the observed row and column totals (Altman, 1991).

Fisher's exact test was computed and respiratory rate, level of consciousness, pulse, delayed response and dyspnoea were statistically significant at the $p<0.05$ level. This indicated that for these cues there was enough evidence for the null hypothesis to be rejected- there was a 95% chance that the differences observed reflected an actual difference in the occurrence of these cues in cardiopulmonary arrest compared to their occurrence in the other clinical states. Blood pressure and temporal factors did not reach a statistically significant level and so the null hypothesis was retained for these cues.
Table 6: Results for Fisher’s exact test computed for cues in cardiopulmonary arrest and non cardiopulmonary arrest papers.

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non Cardio. Papers number and (% to nearest whole number)</th>
<th>Cardio papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resp. rate</td>
<td>absent</td>
<td>30 (94%)</td>
<td>2 (6%)</td>
<td>32 (100%)</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>12 (50%)</td>
<td>12 (50%)</td>
<td>24 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC</td>
<td>absent</td>
<td>32 (86%)</td>
<td>5 (14%)</td>
<td>37 (100%)</td>
<td>0.009</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>10 (53%)</td>
<td>9 (47%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse</td>
<td>absent</td>
<td>32 (86%)</td>
<td>5 (14%)</td>
<td>37 (100%)</td>
<td>0.009</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>10 (53%)</td>
<td>9 (47%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed response</td>
<td>absent</td>
<td>39 (83%)</td>
<td>8 (17%)</td>
<td>47 (100%)</td>
<td>0.009</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>3 (33%)</td>
<td>6 (67%)</td>
<td>9 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>absent</td>
<td>42 (84%)</td>
<td>8 (16%)</td>
<td>50 (100%)</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>6 (100%)</td>
<td>6 (100%)</td>
<td>6 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>absent</td>
<td>24 (80%)</td>
<td>6 (20%)</td>
<td>30 (100%)</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>18 (69%)</td>
<td>8 (31%)</td>
<td>26 (100%)</td>
<td>0.375</td>
<td>0.268 (Ns)</td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporal</td>
<td>absent</td>
<td>28 (82%)</td>
<td>6 (18%)</td>
<td>34 (100%)</td>
<td>0.129</td>
<td>0.104 (Ns)</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>14 (64%)</td>
<td>8 (36%)</td>
<td>22 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column Total (%)</td>
<td>42 (75%)</td>
<td>14 (25%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key
Fisher’s exact test – at p = 0.05 and p< 0.05 level of significance
Ns- not significant at p<0.05.
4.12.3 Predictors of critical illness

Twenty three core quantitative papers (10, 17, 28, 29, 34, 35, 37, 40, 45, 46, 47, 54, 67, 74, 75, 82, 84, 85, 86, 87, 88, 95, 96) focused on the prediction of critical illness. Twelve papers were from the UK (papers 28, 29, 37, 46, 47, 75, 84, 85, 86, 87, 88, 96), five papers were from the US (papers 35, 40, 45, 54, 67), and six papers were from Australia (papers 10, 17, 34, 74, 82, 95). Fifteen papers were prospective observational studies (papers 28, 29, 34, 35, 40, 45, 47, 54, 67, 74, 75, 85, 86, 87, 88). Three papers were retrospective review studies (papers 10, 17, 46), one used prospective and retrospective approaches (papers 37), two were literature reviews (82, 96), and one paper was a theory/review paper (84). Quality appraisal led to the majority of papers being categorised as reasonable (papers 19, 28, 29, 34, 40, 45, 46, 54, 67, 74, 82, 86, 87, 88, 95, 96). Four papers were categorised to be of good quality (papers 35, 45, 75, 84), and two papers provided insufficient information for quality appraisal (papers 37, 85). The strength of evidence for cues as predictors was weak in sixteen papers (17, 28, 34, 37, 46, 47, 54, 74, 82, 84, 85, 86, 87, 88, 95, 96), and moderate in seven papers (10, 29, 35, 40, 45, 67, 75). The sample size statistics for papers within this category are shown in Appendix 9.

The time relationship of cues to the onset of critical illness was reported in some papers. Cues within 24 hours before critical illness events/unplanned admission to ICU were reported (papers 10, 17, 28, 74). Cues present within two hours of admission were used to predict gastrointestinal haemorrhage and admission to ICU (papers 35, 40). Cues within 48 hours of critical events were reported (papers 29, 46). Some papers identified abnormal cues but did not specify the timing of the onset of cues to subsequent event (papers 34, 37, 46, 54, 85, 86, 87, 88, 95). The remaining papers referred to admission characteristics and subsequent outcomes (papers 45, 67, 75).

Graph 3 shows the frequency of cues as percentages in 23 core quantitative critical illness papers (including unplanned admission to ICU). Blood pressure and respiratory rate occurred most frequently (each occurring in 57% or 13 papers). Administrative factors and pulse were the next most frequently reported predictors occurring in 52% or 12 papers. Temporal factors, type of admission, and level of consciousness were the next most frequent occurring in 48% or 11 papers.
Graph 3.
Critical Illness papers

Frequency of cues in 23 critical illness papers.

□ overall minus critical
□ critical
Graph 3 shows the general trend in the most frequently reported cues predicting critical illness was similar to the trend for the total 56 papers.

Fisher’s exact test was computed to identify predictive cues in critical illness that were statistically significantly different from the remaining papers and pulse was the only cue for which the null hypothesis could be rejected. The occurrence of pulse as a predictor in critical illness papers was compared to the non critical illness papers and reached a statistically significant level at p<0.05. Other cues, such as level of consciousness and respiratory rate shown below, did not reach the p<0.05 level of significance.

**Table 7**: Results for Fisher’s exact test computed for cues in critical illness and non critical illness papers.

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non critical illness Papers number and (% to nearest whole number)</th>
<th>Critical illness papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse</td>
<td>absent</td>
<td>26 (70%)</td>
<td>11 (30%)</td>
<td>37 (100%)</td>
<td>0.023</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>7 (37%)</td>
<td>12 (63%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>33 (59%)</td>
<td>23 (41%)</td>
<td>56 (100%)</td>
<td>0.023</td>
<td>0.017</td>
</tr>
<tr>
<td>LOC</td>
<td>absent</td>
<td>25 (68%)</td>
<td>12 (32%)</td>
<td>37 (100%)</td>
<td>0.089</td>
<td>0.061 (Ns)</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>8 (42%)</td>
<td>11 (58%)</td>
<td>19 (100%)</td>
<td>0.089</td>
<td>0.061 (Ns)</td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>33 (59%)</td>
<td>23 (41%)</td>
<td>56 (100%)</td>
<td>0.089</td>
<td>0.061 (Ns)</td>
</tr>
<tr>
<td>Resp. rate</td>
<td>absent</td>
<td>22 (69%)</td>
<td>10 (31%)</td>
<td>32 (100%)</td>
<td>0.105</td>
<td>0.073 (Ns)</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>11 (46%)</td>
<td>13 (54%)</td>
<td>24 (100%)</td>
<td>0.105</td>
<td>0.073 (Ns)</td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>33 (59%)</td>
<td>23 (41%)</td>
<td>56 (100%)</td>
<td>0.105</td>
<td>0.073 (Ns)</td>
</tr>
</tbody>
</table>

**Key**
Fisher’s exact test – at p= 0.05 and p< 0.05 level of significance
Ns- not significant at p<0.05.
4.12.4 Predictors of early post-operative complications

Six quantitative core papers (25, 43, 76, 86, 87, 88) focused on the prediction of early post-operative complications. Four studies (papers 25, 86, 87, 88) were undertaken in the UK, and two studies were Australian (papers 43, 76). The papers included five prospective cohort studies (25, 76, 86, 87, 88) and one case-control study (paper 43). All six papers were categorised as *reasonable* when the review quality appraisal criteria were applied.

The strength of evidence for cues was categorised as *moderate* in two papers (25, 76), and *weak* in the remaining papers (43, 86, 87, 88). Two papers focused on complications occurring within the first 48 hours post operatively (papers 25, 43), and four papers identified adverse events throughout the in-hospital post-operative period (papers 76, 86, 87, 88).

Graph 4 shows the frequency of cues as percentages in six early post operative complications papers. The small number of papers and their sample size statistics (see Appendix 9) limits the conclusions that can be drawn. For the six papers blood pressure was the most frequently reported predictor occurring in 83%, or five papers. Urine output, new complications, level of consciousness and type of admission were the next most frequently reported predictors occurring in 67% or four papers. The remaining 20 cues identified were found in one to three papers.
Graph 4.
Early post-operative complications papers

Frequency of cues in 6 early post-operative complications papers.
Fisher’s exact test was computed. The null hypothesis could be rejected for the cues of urine output and temperature as the differences reached a statistically significant level at $p<0.05$. Blood pressure, level of consciousness and the remaining cues did not reach a statistically significant level as predictors of post operative complications compared to the non post operative complications papers where $p<0.05$.

**Table 8:** Results for Fisher’s exact test computed for cues in early post operative complications and non early post-operative complications papers

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non post-operative complications papers number and (%) to nearest whole number</th>
<th>Post operative complications papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine Out</td>
<td>absent</td>
<td>45 (96%)</td>
<td>2 (4%)</td>
<td>47 (100%)</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>5 (10%)</td>
<td>4 (44%)</td>
<td>9 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>50 (89%)</td>
<td>6 (11%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>absent</td>
<td>46 (94%)</td>
<td>3 (6%)</td>
<td>49 (100%)</td>
<td>0.021</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>4 (57%)</td>
<td>3 (43%)</td>
<td>7 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>50 (89%)</td>
<td>6 (11%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>absent</td>
<td>29 (97%)</td>
<td>1 (3%)</td>
<td>30 (100%)</td>
<td>0.068</td>
<td>0.068 (Ns)</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>21 (81%)</td>
<td>5 (19%)</td>
<td>26 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>50 (89%)</td>
<td>6 (11%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC</td>
<td>absent</td>
<td>35 (95%)</td>
<td>2 (5%)</td>
<td>37 (100%)</td>
<td>0.165</td>
<td>0.094 (Ns)</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>15 (79%)</td>
<td>4 (21%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>50 (89%)</td>
<td>6 (11%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key**

Fisher’s exact test – at $p=0.05$ and $p<0.05$ level of significance

Ns- not significant at $p<0.05$. 

102
4.12.5 Predictors of ICU re-admission

Four core quantitative papers (6, 55, 56, 77) focused on the prediction of re-admission to ICU. All four papers were from the US. These included a prospective evaluation (paper 6), a secondary analysis of a prospective cohort study (paper 55), a systematic review (paper 56), and a retrospective case-control chart review (paper 77). The sample size statistics for papers within this category are reported in Appendix 9. Three papers were judged good according to the review's quality appraisal criteria, and one paper was reasonable (paper 6). The strength of evidence of cues was categorised as moderate for all four papers. The relationship between cues and subsequent readmission was investigated in all studies. APACHE II score on admission and a diagnosis of gastrointestinal haemorrhage were independent predictors of outcome in one paper (6). The mean Acute Physiology Score (APS) at ICU discharge was a predictor of readmission in one paper (55). Unstable vital signs at ICU discharge predicted ICU readmission according to the results of a systematic review (56). Respiratory rate and haematocrit at ICU discharge predicted readmission to ICU in one paper (77).

Graph 5 shows the frequency of cues as percentages in four readmission to ICU papers. Although the number of papers was small the sample size statistics were large (see Appendix 9). Across the four papers the Acute Physiology Score (APS) at the time of discharge from ICU was the most frequently reported predictor of ICU readmission occurring in 75% or three papers. The next most frequently reported predictors were gastrointestinal (GI) bleeding, haemorrhage, haematological indicators, age, administrative factors, the disease processes on admission, and respiratory rate each occurring in 50% or two papers. The remaining eight cues occurred in 25% or one paper.
Graph 5.
Readmission to ICU papers -
Frequency of cues in 4 papers for readmission to ICU

- overall minus ICU readmit
- ICU readmit

<table>
<thead>
<tr>
<th>Cue</th>
<th>Occurrence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>APACHE III</td>
<td></td>
</tr>
<tr>
<td>PAM index</td>
<td></td>
</tr>
<tr>
<td>SAS score</td>
<td></td>
</tr>
<tr>
<td>O2 Rx</td>
<td></td>
</tr>
<tr>
<td>CXR</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td></td>
</tr>
<tr>
<td>fluid balance</td>
<td></td>
</tr>
<tr>
<td>colour</td>
<td></td>
</tr>
<tr>
<td>restlessness</td>
<td></td>
</tr>
<tr>
<td>pt position</td>
<td></td>
</tr>
<tr>
<td>worse condition</td>
<td></td>
</tr>
<tr>
<td>pt self report</td>
<td></td>
</tr>
<tr>
<td>medication</td>
<td></td>
</tr>
<tr>
<td>demographic</td>
<td></td>
</tr>
<tr>
<td>ASA score</td>
<td></td>
</tr>
<tr>
<td>PAR score</td>
<td></td>
</tr>
<tr>
<td>SPO2</td>
<td></td>
</tr>
<tr>
<td>blood sugar</td>
<td></td>
</tr>
<tr>
<td>lethargy</td>
<td></td>
</tr>
<tr>
<td>nausea vomit</td>
<td></td>
</tr>
<tr>
<td>stability</td>
<td></td>
</tr>
<tr>
<td>psychological</td>
<td></td>
</tr>
<tr>
<td>physio reserve</td>
<td></td>
</tr>
<tr>
<td>TISS</td>
<td></td>
</tr>
<tr>
<td>pt distress</td>
<td></td>
</tr>
<tr>
<td>fits</td>
<td></td>
</tr>
<tr>
<td>seriously worried cancer</td>
<td></td>
</tr>
<tr>
<td>APACHE II</td>
<td></td>
</tr>
<tr>
<td>ECGs</td>
<td></td>
</tr>
<tr>
<td>airway obstruct</td>
<td></td>
</tr>
<tr>
<td>severity of illness</td>
<td></td>
</tr>
<tr>
<td>functional st. cardiac</td>
<td></td>
</tr>
<tr>
<td>EWS score</td>
<td></td>
</tr>
<tr>
<td>ABGs</td>
<td></td>
</tr>
<tr>
<td>chest pain</td>
<td></td>
</tr>
<tr>
<td>sepsis</td>
<td></td>
</tr>
<tr>
<td>biochem</td>
<td></td>
</tr>
<tr>
<td>dyspnoea</td>
<td></td>
</tr>
<tr>
<td>renal</td>
<td></td>
</tr>
<tr>
<td>temp</td>
<td></td>
</tr>
<tr>
<td>GI bleeding</td>
<td></td>
</tr>
<tr>
<td>haemorrhage</td>
<td></td>
</tr>
<tr>
<td>APS score</td>
<td></td>
</tr>
<tr>
<td>intuition</td>
<td></td>
</tr>
<tr>
<td>haematology</td>
<td></td>
</tr>
<tr>
<td>urine output</td>
<td></td>
</tr>
<tr>
<td>delayed response</td>
<td></td>
</tr>
<tr>
<td>respiratory cond.</td>
<td></td>
</tr>
<tr>
<td>MET score</td>
<td></td>
</tr>
<tr>
<td>neuro.</td>
<td></td>
</tr>
<tr>
<td>age demographic</td>
<td></td>
</tr>
<tr>
<td>new comp.</td>
<td></td>
</tr>
<tr>
<td>medi. history</td>
<td></td>
</tr>
<tr>
<td>pulse</td>
<td></td>
</tr>
<tr>
<td>LOC</td>
<td></td>
</tr>
<tr>
<td>type of adm.</td>
<td></td>
</tr>
<tr>
<td>disease process</td>
<td></td>
</tr>
<tr>
<td>admin.</td>
<td></td>
</tr>
<tr>
<td>temporal</td>
<td></td>
</tr>
<tr>
<td>RR</td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td></td>
</tr>
</tbody>
</table>
Fisher’s exact test was computed and the Acute Physiology Score (APS) was the only cue where there was sufficient evidence to reject the null hypothesis at the p<0.05 level. The Fisher’s exact test result is also reported for gastrointestinal (GI) bleed but it did not reach significance at p<0.05 for the null hypothesis to be rejected.

**Table 9:** Results for Fisher’s exact test computed for cues in readmission to ICU and non-readmission to ICU papers

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non readmission to ICU papers number and (%) to nearest whole number</th>
<th>Readmission to ICU papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>APS</td>
<td>absent</td>
<td>47 (98%)</td>
<td>1 (2%)</td>
<td>48 (100%)</td>
<td>0.008</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>5 (62%)</td>
<td>3 (38%)</td>
<td>8 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>52 (93%)</td>
<td>4 (7%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI Bleed</td>
<td>absent</td>
<td>47 (96%)</td>
<td>2 (4%)</td>
<td>49 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>5 (71%)</td>
<td>2 (29%)</td>
<td>7 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Column total (%)</td>
<td>52 (93%)</td>
<td>4 (7%)</td>
<td>56 (100%)</td>
<td>0.072</td>
<td>0.072 (Ns)</td>
</tr>
</tbody>
</table>

Key
Fisher’s exact test – at p= 0.05 and p< 0.05 level of significance
Ns- not significant at p<0.05.

**4.12.6 Predictors of in-hospital mortality/ outcome papers.**

Twenty nine core quantitative papers (4, 6, 9, 10, 12, 24, 26, 27, 29, 34, 38, 39, 46, 47, 50, 51, 55, 65, 68, 71, 72, 75, 76, 80, 86, 87, 92, 94, 95) focused on the prediction of in-hospital mortality/ outcome.

Ten papers were from the US (4, 6, 12, 24, 26, 29, 39, 50, 51, 55, 92), twelve were from the UK (27, 29, 38, 46, 47, 65, 68, 75, 80, 86, 87, 94) and seven were from Australia (9, 10, 34, 71, 72, 76, 95). The core quantitative papers in this set included prospective studies (4, 6, 9, 12, 24, 26, 29, 34, 38, 39, 47, 51, 55, 75, 76, 80, 86, 87, 92), retrospective studies (10, 46, 50, 68, 71, 95), analysis of a multi-centre intensive care database (27), development of a prediction model and validation study (94), and a non-randomised population study with an historical control (72). The review quality criteria for studies were applied and the majority of papers were **reasonable** in quality, and six papers were rated as **good** (24, 27, 39, 55, 75, 94). The strength of
evidence of cues was strong in four papers (24, 27, 39, 94), moderate in thirteen papers (4, 6, 10, 26, 29, 51, 55, 65, 68, 71, 75, 76, 80), and weak in fifteen papers (9, 11, 12, 14, 34, 38, 46, 47, 49, 50, 72, 86, 87, 92, 95).

The sample size statistics for papers within this category are shown in Appendix 9.

The times when cues were used as predictors of in-hospital mortality or outcome varied across papers. Six papers focused on factors present at hospital admission to predict in-hospital mortality/ outcome (12, 27, 38, 39, 75, 92). Twelve papers reported cues noted in the hours before a critical event (range one hour- 48 hours) (4, 10, 26, 29, 34, 46, 47, 50, 71, 76, 86, 87, 95). Six papers identified predictors of mortality after discharge from ICU (6, 55, 65, 68, 80, 94). Three papers reported on patients enrolled on particular studies at a specified time after hospital admission (24, 39, 51). Two papers compared mortality rates and unplanned ICU admissions in MET and non- MET locations (9, 72). All papers reported statistically significant results for a range of cues predicting in hospital mortality or outcome, except for the descriptive studies where significance was not examined (68, 86, 87, 95).

Graph 6 shows the frequency of cues as percentages in twenty-nine in-hospital mortality/ outcome papers. Blood pressure and type of admission were the most frequently reported predictors of in-hospital mortality and patient outcome occurring in 45% or thirteen papers. Administrative factors were the next most frequently reported predictor occurring in 41% or twelve papers. Disease process and age were the next most frequently reported predictors occurring in 38% or ten papers. Respiratory rate and temporal factors each occurred in 34% or ten papers. Medical history and pulse rate were each reported in 31% or nine papers. Generally the trend within the in-hospital mortality/ outcome papers was similar to the trend for the total sample of 56 core quantitative papers, a finding which could be expected given that the former made up over 50% of the total sample.
Graph 6.
In-hospital mortality / outcome papers

Frequency of cues in 29 in-hospital mortality / outcome papers

- overall minus mort. outcome
- mortality outcome
Fisher's exact test was computed and level of consciousness and age demographic were the only cues for which there was enough evidence to reject the null hypothesis at the significance level of $p<0.05$. LOC occurred less frequently as a predictor in in-hospital mortality/outcome papers than in the remaining papers and this was significant at the $p<0.05$ level (see Table 10 below). LOC may be more important in the earlier identification of patients with developing critical illness than in predicting mortality, and LOC is often included as a component of the APS score in in-hospital mortality/outcome papers. Age demographic occurred more frequently as a predictor of in-hospital mortality/outcome than in the other papers and this difference was significant at the $p<0.05$ level.

**Table 10: Results for Fisher’s exact test computed for cues in-hospital mortality/outcome and non in-hospital mortality/outcome papers.**

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non in-hospital mortality/outcome papers number and (%) to nearest whole number</th>
<th>In-hospital mortality/outcome papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher's Exact Test (2-sided)</th>
<th>Fisher's Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC absent</td>
<td>14 (38%)</td>
<td>23 (62%)</td>
<td>37 (100%)</td>
<td>0.048</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC present</td>
<td>13 (68%)</td>
<td>6 (32%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column total number (%)</td>
<td>27 (48%)</td>
<td>29 (52%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE demographic</td>
<td></td>
<td></td>
<td></td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE absent</td>
<td>26 (59%)</td>
<td>18 (41%)</td>
<td>44 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE present</td>
<td>1 (8%)</td>
<td>11 (92%)</td>
<td>12 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column total number (%)</td>
<td>27 (48%)</td>
<td>29 (52%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key
Fisher’s exact test for $p<0.05$ level of significance

**4.13 Strength of evidence for predictive cues**

Papers were categorised as providing *strong*, *moderate*, or *weak* evidence of cues as predictors of clinical states. Few papers reported *strong* evidence for particular cues. This may reflect the difficulties of designing robust, yet ethically sound, studies to
measure the phenomenon of clinical deterioration; for example conducting a randomised control trial would not be ethical if it involved withholding treatment from a particular patient group. Appendix 10: Table A10-i presents statistics for core quantitative papers. Sample size for the five most frequently reported cues in the papers categorised as strong, moderate and weak evidence of cues.

By analysing the frequency of predictors according to papers this effectively meant that all papers were treated equally within the categories. An alternative approach would have been to analyse cues according to the sample size of the studies. This approach was not adopted, as the purpose of the review was to identify the range of predictors of critical illness and cardiopulmonary arrest and to include studies that examined objective measures and subjective assessments of clinical state. The latter cues tended to appear in the smaller scale studies where patients’ clinical conditions were rated over time. However tables of sample size statistics have been reported for the clinical states and strength of evidence categories, and the summary sheets for papers identify the sample size in each study (Appendix 5). The review quality criteria also included sample size in the assessment of quality in papers, and as can be seen in Appendix 10, larger sample sizes are reported in the stronger papers.

Graph 7 shows the frequency of cues as percentages in the four core quantitative papers\(^{24,27,39,94}\) defined as strong in their strength of evidence. The sample sizes in the strong studies were large ranging from 4301 to 13924 as shown in Appendix 9. Within this category admission disease process and medical history were each found in 100% or all four papers. Age and type of admission were the next most frequently reported predictors each occurring in 75% or three papers. Administrative factors were identified as predictors in 50% or two papers and the remaining 17 cues were found in 25% or one paper.
Graph 7.
Strength of evidence papers - strong

Frequency of cues in the 4 core quantitative papers defined strong in strength of evidence.
Fisher's Exact Test was computed for cues in the *strong* evidence category. There was sufficient evidence to reject the null hypothesis for the cue age demographic, which reached a statistically significant level at $p<0.05$. There were just four papers in this sample limiting the scope for statistical analysis.

**Table 11:** Results for Fisher's exact test computed for cues in strong and non-strong papers.

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non strong papers number and (%) to nearest whole number</th>
<th>Strong papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher's Exact Test (2-sided)</th>
<th>Fisher's Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE demographic</td>
<td>absent</td>
<td>43 (98%)</td>
<td>1 (2%)</td>
<td>44 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>9 (75%)</td>
<td>3 (25%)</td>
<td>12 (100%)</td>
<td>0.028</td>
<td></td>
</tr>
<tr>
<td>Column total number and (%)</td>
<td>52 (93%)</td>
<td>4 (7%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graph 8 shows the frequency of cues as percentages in the 23 core quantitative papers defined as *moderate* in their strength of evidence (see definition of fields, Appendix 7). The most frequently reported predictors were administrative factors and type of admission (each with 43% or 10 papers). This was followed by temporal factors (39% or 9 papers). Blood pressure, respiratory rate, new complications, age and admission disease process each occurred in 35% or 8 papers. Graph 8 charts frequencies for all predictive cues.
Graph 8.
Strength of evidence papers - moderate

Frequency of cues in the 23 core quantitative papers defined as moderate in strength of evidence.
Fisher’s exact test was computed for cues in the moderate category compared to non moderate and pulse was the only cue where there was sufficient evidence to reject the null hypothesis at the p<0.05 significance level; pulse occurred more frequently in the non moderate category. Many papers in the non moderate category were also in the weak category which included a large number of descriptive/observational studies where pulse was possibly regarded as an important clinical sign.

Table 12: Results for Fisher’s exact test computed for cues in moderate and non-moderate papers.

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non moderate papers number and (%) to nearest whole number</th>
<th>Moderate papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse</td>
<td>absent</td>
<td>19 (51%)</td>
<td>18 (49%)</td>
<td>37 (100%)</td>
<td>0.082</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>15 (79%)</td>
<td>4 (21%)</td>
<td>19 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column total number and (%)</td>
<td></td>
<td>34 (61%)</td>
<td>22 (39%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key
Fisher’s exact test – at p= 0.05 and p< 0.05 level of significance

Graph 9 shows the frequency of cues as percentages in the 29 core quantitative papers (1,9,12,17,23,28,34,37,38,42,43,46,47,50,54,59,63,69,72,74,82,84,85,86,87,88,92,95,96) defined as weak in their strength of evidence (see Appendix 7: Definition of fields table,). The most frequently reported predictor was blood pressure (59% or 17 papers), followed by respiratory rate occurring in 52% or 15 papers. Pulse rate, LOC, and temporal factors were each found in 45% or 13 papers. Administrative factors were a predictor in 34% or 10 papers. Admission disease process and MET score were each found in 31% or 9 papers. Graph 9 charts the frequencies for all predictive cues in the weak evidence papers.
Graph 9.
Strength of evidence papers - weak

Frequency of cues in the 29 core quantitative papers defined as weak in strength of evidence.
Fisher’s Exact Test was computed and the MET score reached a statistically significant level (where \( p<0.05 \)) and the null hypothesis could be rejected. Blood pressure almost reached a statistically significant level as shown in Table 13.

**Table 13:** Results for Fisher’s exact test computed for cues in weak and non-weak papers.

<table>
<thead>
<tr>
<th>Cue</th>
<th>Cue absent or present</th>
<th>Non weak papers number and (%) to nearest whole number</th>
<th>Weak papers number and (%)</th>
<th>Row Total number and (%)</th>
<th>Fisher’s Exact Test (2-sided)</th>
<th>Fisher’s Exact Test (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET score</td>
<td>absent</td>
<td>28 (61%)</td>
<td>18 (39%)</td>
<td>46 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>1 (10%)</td>
<td>9 (90%)</td>
<td>10 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column total number and (%)</td>
<td>29 (52%)</td>
<td>27 (48%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td>0.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>absent</td>
<td>19 (63%)</td>
<td>11 (37%)</td>
<td>30 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>present</td>
<td>10 (38%)</td>
<td>16 (62%)</td>
<td>26 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Column total number and (%)</td>
<td>29 (52%)</td>
<td>27 (48%)</td>
<td>56 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.107</td>
<td>0.056 (Ns)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key**
Fisher’s exact test – at \( p=0.05 \) and \( p<0.05 \) level of significance

**4.14 Further statistical analysis:**
Confidence in how representative the results of the review sample are of the wider population under study was investigated. Inferential statistics are used to identify if any conclusions can be made about the study population based on the findings in the sample (Jordan *et al.*, 1998).

For any series of reviews based on different random samples of the study population each would make an estimate of the study population that could be plotted to derive the overall *sampling distribution* (Jordan *et al.*, 1998). Application of *central limit theorem* enables properties of the study population distribution to be uncovered. Estimates from many review samples will fall into a normal distribution and, with
sufficient sample size, the mean of this normal distribution will be approximately equal to the population mean; the standard deviation of this normal distribution is referred to as the standard error of the mean (Fielding & Gilbert, 2000). The central limit theorem can be applied to proportions, as in the current research, where the presence or absence of a particular cue makes up a binomial distribution consisting of just two outcomes (Jordan et al., 1998). If the sample of papers considered in the review can be seen as one of a number of potential samples used to estimate the occurrence in the study population, these estimates would lie within a normal distribution. This is a theoretical situation as it is unlikely that many reviews would be done, but the rationale enables calculation of the mean and standard error of the sample estimate (Jordan et al., 1998).

The standard error for proportion, SE(p), (Fielding & Gilbert, 2000 p239) is given by:

\[ SE(p) = \sqrt{\frac{p(1-p)}{n}} \]  

(2)

Where \( p \) is the measured proportion and \( n \) is the sample size.

To assess how much confidence can be placed in the sample estimates of cues as representing the study population confidence intervals can then be calculated.

For different levels of confidence, SE(p) is multiplied by different factors to obtain the appropriate confidence interval. The confidence interval is centred around the mean and gives limits within which the study population will lie according to the given confidence level. For example, suppose a 95% confidence level is chosen and 100 random samples were taken of the study population. It would then be expected that 95 of the 100 samples would contain the study population mean within their 95% confidence interval limits. To be more confident for the same sample size, to say the 99% level, the confidence interval is larger — to more often encompass the true study population mean (Fielding & Gilbert 2000; Jordan et al., 1998).
The factor for a 95% confidence interval is 1.96, giving the upper confidence limit as $p + 1.96 \times SE(p)$ and the lower confidence limit as $p - 1.96 \times SE(p)$, which to give both the mean and the 95% confidence interval can be written as $p \pm 1.96 \times SE(p)$.

The confidence intervals for the 56 core quantitative papers, and the sub sets of 14 cardiopulmonary arrest, 23 critical illness, and 29 mortality outcome papers were calculated at the 95% confidence interval. To identify which cues could be analysed further it was suggested that central limit theorem could be applied when

"$p$ and 1-$p$ are both greater than 5 / $n$ where $p$ is the proportion and $n$ is the sample size" (Altman, 1991 cited in Jordan et al., 1998, p.112).

The aim was to identify statistically significant differences between the cues within the various sets of clinical states and over all core quantitative papers (see Appendix 11 with tables of figures for calculating the applicability of the central limit theorem to the data). The results are presented below in Graphs 10-15 inclusive. Direct comparison of cue levels between one set of clinical states and another would not be statistically valid, as the sets were not totally independent of each other (as noted earlier some papers cover more than one category). Therefore the focus of the analysis was on the differences in the frequency of cues reported as predictors within the clinical states, and in the over all core quantitative data set.

4.14.1 Analysis of cues using the 95% confidence interval:
Taking the 95% confidence interval for the 56 core quantitative papers BP, respiratory rate, admission disease process, type of admission, administrative factors, temporal factors, medical history, pulse and LOC were statistically significantly different from the cues of dyspnoea, biochemistry, and sepsis. The overlaps in 95% confidence intervals for the cues of renal through to LOC indicate that for these cues, in this sample of papers, none could be considered significantly different. Graph 10 shows this in detail; BP was statistically significantly different from age through to sepsis; respiratory rate was statistically significantly different from MET scores through to sepsis. Temporal, administrative factors, admission disease process and type of admission were statistically significantly different from APS score through to...
sepsis; and LOC, and pulse were statistically significantly different from dyspnoea, biochemistry and sepsis.

In graph 11 the subset of 14 papers focused on cardiopulmonary arrest are shown with the 95% confidence intervals for cues that could be examined for statistically significant differences. None of the cues shown including BP, temporal, administrative, LOC, pulse, new complications, neurological condition, delayed response or dyspnoea were statistically significantly different from each other at the 95% confidence interval in this sample of papers.

In graph 12 the subset of 23 papers focused on predictors of critical illness are shown with 95% confidence intervals. All of the cues shown in graph 12 have overlapping confidence intervals and it is therefore not possible to state that one cue is statistically different from another in this sample of papers.

In graph 13 the subset of 29 papers focused on predictors of mortality/ outcome that could be examined using 95% confidence intervals is shown. All of the cues shown in graph 13 have overlapping confidence intervals and it is therefore not possible to state that one cue is statistically significantly different from another in this sample of papers.

In graph 14 the subset of 23 papers categorised as moderate according to the strength of evidence for cues have overlapping confidence intervals and once more it is not possible to state that one cue is statistically significantly different from the other cues shown.

In graph 15 the subset of 29 papers categorised as weak according to the strength of evidence for cues indicates that BP is statistically significantly different from medical history, new complications, neurological condition, delayed response, urine output and intuition in this sample of papers.
Graph 10.
Core quantitative papers - 95% confidence intervals

n = 56 papers

Measured occurrence and limits (%)
Graph 11. Cardiopulmonary arrest papers - 95% confidence levels

n = 14 papers

Graph 12. Critical illness papers - 95% confidence levels

n = 23 papers
Graph 13. In-hospital mortality/outcome papers- 95% confidence levels  

- Mort. Out. age demographic  
- Mort. Out. medi. history  
- Mort. Out. pulse  
- Mort. Out. LOC  
- Mort. Out. type of adm.  
- Mort. Out. disease process  
- Mort. Out. admin.  
- Mort. Out. temporal  
- Mort. Out. RR  
- Mort. Out. BP  

Measured occurrence & limits (%)  

Graph 14. Moderate papers - 95% confidence levels  

- Moderate APS score  
- Moderate haematology  
- Moderate age demographic  
- Moderate new comp.  
- Moderate medi. history  
- Moderate pulse  
- Moderate LOC  
- Moderate type of adm.  
- Moderate disease process  
- Moderate admin.  
- Moderate temporal  
- Moderate RR  
- Moderate BP  

Measured occurrence & limits (%)  

n = 29 papers  

n = 23 papers
Graph 15. Weak papers - 95% confidence intervals  n = 29 papers

- Weak intuition
- Weak urine output
- Weak delayed response
- Weak respiratory cond.
- Weak MET score
- Weak neuro.
- Weak new comp.
- Weak medi. history
- Weak pulse
- Weak LOC
- Weak type of adm.
- Weak disease process
- Weak admin.
- Weak temporal
- Weak RR
- Weak BP

Measured occurrence & limits (%)
Confidence intervals for strong papers were not calculated as none of the cues passed the Altman (1991) test for the application of central limit theorem and inclusion—see Section 4.14, p.115, and Appendix 11 (raw figures).

4.15 Analysis of most frequently occurring cues and their co-occurrences
For the most frequently occurring predictive cues, co-occurrences were examined. In graph 16 the cues are sorted and co-occurrences between them noted and grouped within ranges. The ranges are percentages of co-occurrence relative to the occurrence of the smaller frequency cue. Pulse and respiratory rate always occurred together. BP occurred in 75-99% of papers with pulse and similarly for LOC. Disease process and medical history occurred together in 75-99% of papers.

The next section reports on clinical indexes identified as predictors of the clinical states. The indexes comprised a number of separate cues that often appeared as cues in other papers included in the review (see Appendix 12: Cue composition of clinical indexes).
Graph 16. Analysis of most frequently occurring cues and their co-occurrences
4.16 Clinical Indexes

The clinical indexes reported in the final review papers were categorised according to their primary clinical function after Feinstein (1987), Table 14. The categories included indexes describing conditions (status, diagnostic indexes and ratings of clinical conditions), reporting changes in condition (change indexes), making predictions about a future state (prognostic indexes) and selecting interventions (therapeutic agents). Generally the papers included in the review focused on rating the current condition (diagnosing the state of the patient), or on predicting the future clinical state (prognostic indexes).

Within critical illness or cardiac arrest status indexes refer to the patients' diagnoses, if the clinical condition is rated acute, severe or recurrent, and the therapeutic interventions required. Recently sensitivity to change or the responsiveness of evaluative clinical or health status indexes has been the focus of attention (Jenkinson & McGee, 1998). Indexes of change can be developed to describe the relative importance of an attribute of a clinical state, for example changes in blood pressure, pain and dyspnoea (Feinstein, 1987). These can take a simple form using the original status index to compare states before and after treatment looking for dyadic change (Feinstein, 1987). For example urine output before and after the administration of diuretics would be an example of a dyadic change, or where more than two values of a single status index are used this would be termed polyadic.

Feinstein (1987) identifies a sub-category of change indexes called transition indexes which are particularly important for picking up changes in patients' conditions when they are still within the same status index category. Such an index could be important in the early identification of patients vulnerable to critical illness. In a monodiadic transition index a value for the previous state would not be required but this index could track changes in patients' respiratory state focusing on responses to oxygen and nebuliser therapy, by asking if their breathing feels better, the same or worse after treatment. Clinicians could rate a patient's breathlessness on a transition index to indicate if this is better, the same or worse. The total patient response could be rated
excellent or poor, or reported in a comparative way as unchanged, improved or deteriorating or given as a numerical ranking in a scale (Feinstein, 1987). The clinical indexes included in the review were examined for how they identified changes in patients' conditions.

Table 14: Clinical indexes reported in core quantitative papers in the systematic review according to their function

<table>
<thead>
<tr>
<th>Index</th>
<th>Function</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>APACHE II (including the Acute Physiology Score APS) (Knaus et al., 1985)</td>
<td>Prognostic index- prediction of mortality in ICU.</td>
<td></td>
</tr>
<tr>
<td>APACHE III (Knaus et al., 1991)</td>
<td>Prognostic index- prediction of mortality in ICU.</td>
<td></td>
</tr>
<tr>
<td>Early Warning Score (EWS) (Morgan et al., 1997; Subbe CP et al., 2001)</td>
<td>Rating of clinical condition- prediction of critical illness state.</td>
<td>Potential use as index of change in state, as a prognostic index to predict cardiac arrest and as a clinical guideline for intervention required.</td>
</tr>
<tr>
<td>Patient at risk score (PAR) (Goldhill DR, Worthington L et al., 1999)</td>
<td>Rating of clinical condition- prediction of critical illness state.</td>
<td>Potential use as index of change in state, as a prognostic index to predict cardiac arrest and as a clinical guideline for intervention required.</td>
</tr>
<tr>
<td>Medical Emergency Team score (MET) (Lee A, Bishop G, Hillman KM et al., 1995)</td>
<td>Rating of clinical condition- prediction of critical illness state.</td>
<td>Potential use as index of change in state, as a prognostic index to predict cardiac arrest and as a clinical guideline for intervention required.</td>
</tr>
<tr>
<td>Sickness Assessment Score (SAS) (Kennedy, Al-Mufti, Brewster, 1994)</td>
<td>Prognostic index- prediction of mortality in elderly surgical patients.</td>
<td></td>
</tr>
<tr>
<td>Therapeutic Intervention Scoring System (TISS) (Keene et al., 1983)</td>
<td>Rating of clinical condition- severity of illness based on therapeutic interventions required.</td>
<td>May have a prognostic function as increased TISS score reflects increased severity of illness.</td>
</tr>
<tr>
<td>Simplified Acute Physiology Score (SAPS II) (Le Gall et al., 1993)</td>
<td>Prognostic index- prediction of in hospital mortality.</td>
<td></td>
</tr>
</tbody>
</table>
Prognostic indexes predict a future clinical state rather than the current one (Feinstein, 1987). Prognostic indexes are usually status indexes that have a predictive role assigned to them. Clinimetric indexes take on the function of being clinical guidelines when they provide guidance on treatment actions. For example in a local hospital, patients with a MET score of eight or more should be referred to the Medical Emergency Team, or in the case of surgical patients they should be referred to the surgical registrar (Hodgetts, Ineson et al., 2000).

4.16.1 Evaluation of Indexes
The clinical indexes included in the review were examined for validity or clinical sensibility, and reliability or consistency (Feinstein, 1987) to assess the degree of confidence that could be placed in them as accurate ratings of clinical conditions or as prognostic tools.

Validity A valid assessment tool or clinical index measures what it professes to measure (Jenkinson & McGee, 1998). Validity can be assessed using different approaches such as: face validity, content validity, criterion validity and construct validity (Jenkinson & McGee, 1998). Face validity refers to how suitable the items in the clinical indexes are for the phenomenon being measured, that they make sense, and are understandable (Jenkinson & McGee, 1998). Content validity refers to the selection of items for inclusion and that weighting of the importance of items in the instrument or index is representative of the area being measured (Jenkinson & McGee, 1998). This is usually achieved through the consensus of a panel of experts and by reviewing the literature.

Construct validity refers to the extent to which actual measures of items match the intended theoretical construct (Coolican, 1999). Two aspects of construct validity are convergent validity and discriminant validity (Jenkinson & McGee, 1998). Within convergent validity the results using one measure should be related to other variables and measures of that construct (Jenkinson & McGee, 1998), for example if two different predictive indexes for ICU mortality were used it would be expected that the
results would be related. *Discriminant validity* contrasts with convergent validity because here it is expected that results would not be related when compared to data on distinct or unrelated constructs. Clinicians may assess the construct validity of an index by undertaking *validation by application*, where they consider if the index does what it is supposed to do in practice (Feinstein, 1987).

*Criterion validity* is concerned with the ability of a measure to correspond with *gold standard* measures (Jenkinson & McGee, 1998) however in many areas of clinical practice no such reference criterion is available (Feinstein, 1987). An example of criterion validity would be to compare clinician subjective ratings of patients' respiratory status and how they correspond to measures of Arterial Blood Gases regarded as the gold standard test for respiratory status.

*Reliability* A measure that is scientifically credible needs to consistently produce the same result when the measurement is performed again by the same observer (*intra-observer reliability*) or by another observer (*inter-observer reliability*) (Feinstein, 1987). The approach taken for reliability testing depends on the characteristics of the instrument and the aspect of the reliability concept considered most important (Harris, 2002). Reliability may be assessed for the *stability* of the measure over time through *test-retest reliability* measurements but the disadvantages of this is that attributes may change over time, the patient's condition may have changed between the two time-periods, or memory of the earlier test could interfere with results (Harris, 2002). *Internal consistency* can be used to assess how well items within scales in an instrument are correlated and is often assessed statistically using *Cronbach's alpha coefficient* (Jordan et al., 1998). This is more difficult in clinical indexes where multiple phenomena may be included. An important approach to reliability testing of clinical indexes such as Early Warning Scores for developing critical illness would be to test *inter-rater reliability*. This could involve the development of *parallel tests*, or *inter-rater reliability* with tests involving two independent assessors measuring the same clinical phenomenon at the same time, but this does not rule out the possibility of assessors being inaccurate (Harris, 2002).
Table 15: Evaluation of clinical indexes reported in quantitative papers in systematic review.

<table>
<thead>
<tr>
<th>Index</th>
<th>Validity</th>
<th>Reliability</th>
<th>Responsiveness</th>
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</thead>
<tbody>
<tr>
<td>APACHE II (including the Acute Physiology Score APS) (Knaus et al., 1985)</td>
<td>Content validity - 34 variables in the original APACHE score selected by clinical judgement (a panel of experts) and refined by statistical techniques (multivariate comparisons) and reduced to 12 variables for APACHE II. Validation by application—the performance of APACHE II predictions tested by comparing these with hospital mortality. Reference to construct validity-increasing APACHE II scores correlated with increased risk of hospital death.</td>
<td>Inter-observer reliability checks reported by others as 96% agreement, but these data were not reported in detail (Knaus et al., 1985). Cowen and Kelley (1994) commented on APACHE II’s reduced reliability when untrained data collectors are used.</td>
<td>Purpose of score-mortality prediction rather than clinical evaluative index. Changes within individual patients’ conditions over time not examined in the original paper. Each physiological variable would be assigned to scoring category of 0-4 for the APS, points added for age and chronic health points to derive total APACHE II score. Maximum possible score is 71 but at validation no patients scored more than 55.</td>
</tr>
<tr>
<td>APACHE III (Knaus et al., 1991)</td>
<td>Content validity - 20 variables selected based on clinical judgement. Weights of physiologic variables determined by multivariable logistic regression analyses. Validation by performance-APACHE III outcome predictions based on results of first day of ICU treatment ( r^2 = 0.41 ) and ROC 0.90 (similar to earlier APACHE scores)</td>
<td>Study of reliability of data collection based on APACHE II scores APS component had interclass correlation coefficient ( =0.90 ) and percentage agreement for patient age, gender, admission date and main system failure reported in the 90% range (APACHE III study results not available but re-analysis of APACHE III weighting reported similar, but evidence not cited)</td>
<td>Purpose- mortality prediction. Daily APACHE III scores enable ongoing risk estimates to be predicted. However this could introduce expectation bias where patients’ treatment could be altered based on the continuous information (Cowen and Kelley, 1994). The scoring system in APACHE III is more complex than the APACHE II system as additional weights were assigned to the extremes of physiological measures. Score ranges from 0 to 299.</td>
</tr>
<tr>
<td>Early Warning Score (EWS) (Morgan et al., 1997; Subbe et al., 2001)</td>
<td>No report on validity issues –retrospective and prospective analysis of ICU patients was used to identify a trigger threshold score of 5. Validation by application – earlier referral of suitable patients to HDU and ICU but no evidence provided to support this. Stenhouse et al., (2000) undertook EWS validation by application on surgical patients and after 1month</td>
<td>No reliability studies were reported in any of the EWS papers.</td>
<td>Scores of 0-3 assigned to variables enables overall score to be recorded at various points and change in score recorded. Trigger scores used to direct action.</td>
</tr>
<tr>
<td>Index</td>
<td>Validity</td>
<td>Reliability</td>
<td>Responsiveness</td>
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<tr>
<td>Patient at risk team score (PART) (Goldhill, Worthington et al., 1999)</td>
<td>Content validity- criteria for inclusion and for alerting PART based on clinical judgement of a panel of experts (surgical, medical, intensive care doctors and nursing personnel). Subbe et al., (2001) undertook validation by application in a medical patient population- score of 5 or more associated with increased risk of death, ICU admission and HDU admission. Patient &gt;70 years significantly more at risk of the above end-points than patients &lt;50 years.</td>
<td>No reliability studies were reported.</td>
<td>The PART protocol identifies criteria for patients at risk of critical illness and cardiac arrest and the alerting criteria for calling the PART. Score- 3 or more abnormal variables, or senior doctor concern, or when patient’s condition fails to improve doctor or senior nurse (in emergencies) may call team. Transitions in patients’ conditions could be recorded by comparing how many of the PART criteria are satisfied at any given times.</td>
</tr>
<tr>
<td>Medical Emergency Team score (MET) (Hourihan, Bishop Hillman et al., 1995).</td>
<td>Face validity- Calling criteria based on research evidence- clinical judgement of researchers. Validation by application- descriptive data reported.</td>
<td>No reliability studies were reported.</td>
<td>The MET does not have explicit numerical scoring system. However transitions in patients’ conditions over time could be recorded by comparing the criteria at any given points.</td>
</tr>
<tr>
<td>Medical Emergency Team score (MET)</td>
<td>Face validity check reported for data extraction form for retrospective review of case notes (Hodgetts, Kenward et al., 2002a). Reliability checks of data extraction summaries of 30 cases cross-checked firstly by an independent reviewer MET activation criteria developed and scoring system weighted by panel of experts ranging from 0 to 4. This numerical rating score enables transitions in patient condition to be quantified. Further validity</td>
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<tr>
<td>Index</td>
<td>Validity</td>
<td>Reliability</td>
<td>Responsiveness</td>
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<tr>
<td>(Hodgetts, Kenward et al., 2002a) and (Hodgetts, Kenward et al., 2002b)</td>
<td>Content validity- Calling criteria based on retrospective analysis of 118 patients with primary cardiac arrest where resuscitation took place, and control group of 132 non-arrest adult patients selected by stratified randomised sampling. The latter followed up for 2 weeks to identify outcome (Hodgetts, Kenward et al., 2002b). Abnormal variables in study group compared with the non-arrest control group. Regression analysis identified significant predictors of cardiac arrest and logistic regression identified abnormal breathing, pulse and reduced systolic blood pressure as significant independent predictors of cardiac arrest. Panel of experts decided on weighting of activation criteria for MET, these were plotted on a receiver operator curve -- activation score of 8 - 99% specificity, and 52% sensitivity (Hodgetts, Kenward et al., 2002b).</td>
<td>Reliability statistics not reported and then by a panel of four experts (reliability statistics reported as percentage agreements in classification of cases) (Hodgetts, Kenward et al., 2002a). The panel reviewed the case summaries independently to identify avoidable, potentially avoidable and unavoidable cardiac arrests.</td>
<td>testing required to assess the clinical sensitivity of score and the weighting system. Also the score is based on predictors of cardiac arrest, the authors suggest it may be suitable for predicting critical illness (Hodgetts et al., 2002b). This score requires further validity testing to assess performance in prediction of critical illness.</td>
</tr>
<tr>
<td>Sickness Assessment Score (SA) (Kennedy, Al-Mufti, Brewster, 1994)</td>
<td>Construct validity testing. Predictions with the SA were compared to APACHE II predictions in elderly patients requiring acute surgery. APACHE II score of 12 or more was no more accurate than SA positive (based on any of the 3 SA parameters being present) in this patient group.</td>
<td>Reliability checks not reported. All data collected by one of the researchers daily. Clinicians were blind to the SA score and the APACHE II to minimise the threat of alterations to treatment.</td>
<td>SA score and APACHE II score were both recorded on admission. In this study they were used as status indexes and as prognostic indexes for mortality.</td>
</tr>
<tr>
<td>American Anaesthesiologists Score (ASA, 1963) used in Gamil and Fanning (1991)</td>
<td>Content validity- score developed by panel of experts. (ASA classification of physical status score amended by the 1962 American Society of Anesthesiologists, Inc). 5 categories were identified from ASA I with no organic, physiological, biochemical or psychiatric disturbance, through to ASA V moribund. Bohrer (1997) reported many studies have demonstrated relationship between</td>
<td>Reliability studies were not reported in the original 1963 publication.</td>
<td>A status index that is used as a prognostic index to predict post-operative mortality and morbidity.</td>
</tr>
<tr>
<td>Index</td>
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<tr>
<td>Therapeutic Intervention Scoring System (TISS) (Keene et al., 1983).</td>
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<td></td>
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<tr>
<td>Pre- Arrest Morbidity Index (PAM) George, Folk, Cercelius et al., (1989)</td>
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<tr>
<th>Validity</th>
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<tbody>
<tr>
<td>higher ASA score and adverse events, and increased mortality, but the ASA has low specificity with many false positives.</td>
</tr>
<tr>
<td>Content validity- PAM and weighting based on research evidence- multivariate analysis. Prospective evaluation of 140 consecutive hospital patients who received cardiopulmonary resuscitation – records examined for individual factors, analysed to identify predictors of mortality using a range of approaches. Chi-square or Fisher’s Exact test used to identify individual factors, linear regression to identify correlation between continuous variables and CPR outcome, multivariate analysis step-wise logistic regression with survival of hospitalisation as the dependent variable on pre-arrest variables.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reliability</th>
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</thead>
<tbody>
<tr>
<td>Reliability studies were not reported in Keene et al., (1983).</td>
</tr>
<tr>
<td>Reliability studies were not reported.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsiveness</th>
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<tbody>
<tr>
<td>Cullen et al., (1994) devised an Intermediate TISS for non-ICU patients which they concluded to be useful for identifying medical patients with increased severity of illness i.e. the high risk medical patients. Limitations of this system- it assumes that all interventions listed in the score are available to clinicians and that medical interventions are being given for bona fide medical reasons. A third limitation is that the patient would need to have been recognised as requiring these interventions - i.e. not an early warning score for detection of primary deterioration.</td>
</tr>
<tr>
<td>Prognostic index- prediction of survival after cardiac arrest.</td>
</tr>
</tbody>
</table>
4.16.2 Clinical indexes according to their diagnostic or prognostic properties

The major indexes and how often they were reported as predictors of critical illness, cardiopulmonary arrest or mortality are summarised below, Table 16. Generally the dimensions of biological and physiological severity predominated in these indexes.

The apparent low frequency of indexes reported as predictors of critical illness and cardiac arrest may be due to the recent development of some of the indexes influencing how often they were measured in research studies. The main function of the indexes in the papers reported was prognostic, for the prediction of cardiopulmonary arrest, critical illness, and in-hospital mortality. No single index predicts cardiopulmonary arrest or critical illness with certainty and the APACHE systems are designed to predict mortality for groups of patients rather than individuals.

Table 16: Clinical indexes reported in quantitative papers in systematic review by clinical states predicted.

<table>
<thead>
<tr>
<th>Index</th>
<th>Clinical State</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>APACHE II (including the Acute Physiology Score APS) (Knaus et al., 1985)</td>
<td>Prediction of mortality in ICU.</td>
<td>Predicts groups of patients at greatest risk of mortality, not for individual predictions. Reported as a predictor in 4/56 papers (papers 10,28,35,65)</td>
</tr>
<tr>
<td>APS from APACHE II (Knaus et al., 1985)</td>
<td>Acute physiology score.</td>
<td>Reported as a predictor in 8/56 papers (6,45,53,56,67,80,92,94)</td>
</tr>
<tr>
<td>APACHE III (Knaus et al., 1991)</td>
<td>Prediction of mortality in ICU.</td>
<td>Predicts groups of patients at greatest risk of mortality, not for individual predictions. Reported as a predictor in 1/56 papers (paper 39)</td>
</tr>
<tr>
<td>Early Warning Score (EWS) (Morgan et al., 1997; Subbe et al., 2001)</td>
<td>Prediction of critical illness state, prediction of mortality (Subbe et al., 2001).</td>
<td>Reported as a predictor in 5/56 papers (37,75,83,86,88)</td>
</tr>
<tr>
<td>Patient at risk score (PAR) (Goldhill, Worthington et al., 1999)</td>
<td>Prediction of critical illness state, cardiac arrest and mortality.</td>
<td>Reported as a predictor in 2/56 papers (29,87)</td>
</tr>
<tr>
<td>Medical Emergency Team score (MET) (Hourihan, Bishop Hillman et al., 1995).</td>
<td>Prediction of critical illness state, cardiac arrest and mortality.</td>
<td>Reported as a predictor in 10/56 papers (9,24,42,43,65,71,72,74,82,93)</td>
</tr>
<tr>
<td>Sickness Assessment Score (SAS) (Kennedy, Al-Mufti, Brewster, 1994)</td>
<td>Prediction of mortality in elderly surgical patients.</td>
<td>Reported as a predictor in 1/56 papers (38).</td>
</tr>
<tr>
<td>Index</td>
<td>Clinical State</td>
<td>Comments</td>
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<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>American Anaesthesiologists Score (ASA) used in Gamil and Fanning</td>
<td>Prediction of mortality in surgical patients.</td>
<td>Reported as a predictor in 2/56 papers (21, 43).</td>
</tr>
<tr>
<td>(1991)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therapeutic Intervention Scoring System (TISS) (Keene et al., 1983)</td>
<td>Rates severity of illness based on therapeutic interventions needed.</td>
<td>Reported as a predictor in 3/56 papers (45, 67, 80).</td>
</tr>
<tr>
<td>Pre- Arrest Morbidity Index (PAM) George, Folk, Cercelius et al.,</td>
<td>Prediction of survival after in-hospital cardiac arrest and cardiopulmonary</td>
<td>Reported as a predictor in 1/56 papers (26).</td>
</tr>
</tbody>
</table>

4.16.3 The indexes and the time relationships to the prediction of events.  
The cue composition of the various clinical indexes is presented in Appendix 12. The APACHE II and III indexes use calculations based on the patient’s worst observations during the first 24 hours of ICU admission (Knaus et al., 1985; Knaus et al., 1991) focusing on the prediction of mortality rather than on clinical ratings to record and monitor changes in the patient’s condition. The Acute Physiology score (APS), a component of the APACHE systems, measures acute physiological variables and has been used widely. The APACHE II score was reported as a predictor in 7% or four papers out of 56 core quantitative papers. The APACHE III was reported as a predictor in 2% or one paper out of 56 core quantitative papers. The APS score was reported as a predictor in 14% or eight papers out of 56 core quantitative papers.

The EWS (Morgan et al., 1997; Subbe et al., 2001), PAR (Goldhill, Worthington et al., 1999) and the MET scores (Hourihan, Bishop Hillman et al., 1995) are clinical ratings indexes designed for monitoring and recording the patient’s condition at any appropriate time during hospitalisation. These scores are mainly used in the prediction of cardiopulmonary arrest and critical illness. The MET score was the most frequently reported predictor of all the scores cited in the core quantitative papers.

The SAS (Kennedy, Al-Mufti, Brewster, 1994) is used pre-operatively to predict post-operative mortality in elderly surgical patients but was reported as a predictor in only one study.
The ASA is used pre-operatively to identify surgical patients at high risk of post-operative mortality and was identified as a predictor in 4% or two papers out of 56 core quantitative papers (American Anaesthesiologists Score (ASA) as cited in Gamil and Fanning 1991; Lee et al., 1998).

The TISS was reported as a predictor in 5% or three papers out of 56. A higher TISS on day of discharge from ICU predicted post-ICU deaths in one study (Smith, Orts et al., 1999). In Wagner et al., (1987) TISS predicted the need for active treatment in ICU, and in McClish et al., (1895) a higher TISS was reported in medical ICU compared to ward based patients.

The PAM index (George, Folk, Cercelius et al., 1989) was reported as a predictor of mortality/ outcome post cardiac arrest in 2% or one out of 56 core quantitative papers and drew on 15 factors categorised as pre-arrest, during resuscitation and post arrest.

The selection of cues for inclusion in clinical indexes was usually based on clinical judgement by a panel of experts. However a recent MET study (Hodgetts et al., 2002a &b) based calling criteria on a retrospective review of patients who went on to cardiac arrest and cues were submitted to regression analysis. There were more subjective cues included in this medical emergency score than in most of the others reviewed (Hodgetts et al., 2002b).

The method of deciding on threshold scores for referral also varied. For example, an expert panel assigned scores to criteria that where then submitted to sensitivity and specificity checks using a receiver operator curve in one study (Hodgetts et al., 2002b). In other cases trigger scores were applied based on clinical judgement and there was substantial variation in the method used in various scores. For example the MET could be summoned by presence of any one of seven criteria in Bellomo et al., (2003). However, in Goldhill et al., (1999) at least three abnormal criteria, or decreased level of consciousness and either abnormal heart rate or respiratory rate, were required for the senior nurse to contact the patient’s medical team. Then if
required the Patient at Risk Team could be summoned by the doctor or in emergencies the senior nurse. The rapid introduction of early warning scores has meant that many scores are being tested through validation by application.

The National Outreach Forum (NORF) (2003) states that the false negatives for early warning scores are not systematically recorded. Basic information about sensitivity and specificity of early warning scores in practice is lacking. Inter-rater reliability studies were not reported for any of the early warning scores. The potential for errors in measurement technique that could affect the accuracy of basic observations used in early warning scores was generally not discussed. There are no data on the problem of variance in early warning scores related to problems with inter-rater reliability. Given that health care assistants now routinely perform many physical observations more data are required on variance in scores across staff with different levels of preparation. It is possible that patients at risk are missed (false negatives). A less serious problem is the classification of patients at a higher than necessary levels of risk (false positives). The problem of physical observations not being recorded has major implications for patient safety where basic care is not performed (Goldhill et al., 1999; Chellel, 2002).

4.17 Analysis and synthesis of themes and cues identified in qualitative studies. Five qualitative studies were included in the review and they focused on two main areas. Firstly, on the prediction of critical illness using the phenomenon of deterioration in general ward or intensive care unit patients (Cioffi, 2000b; Grossman & Wheeler, 1997; Minick, 1995; Smith, 1988); and secondly, on the context of ward-based critical care nursing (Cutler, 2002). Three studies were conducted in the US (Grossman & Wheeler, 1997; Minick, 1995; Smith, 1988), one in Australia (Cioffi, 2000b) and one in the UK (Cutler, 2002). Data extraction summary sheets for these papers can be found in Appendix 5.

The research methods used included qualitative descriptive and grounded theory approaches (Cioffi, 2000b; Grossman & Wheeler, 1997; Minick, 1995; Smith, 1988),
and ethnographic research (Cutler, 2002). The sample sizes of studies ranged from 6-33 participants and were drawn from experienced ward or intensive care nurses. The quality appraisal criteria of creditability, transferability, confirmability (Lincoln & Guba, 1985) and the items identified in the qualitative research quality appraisal tool (Appendix 1) were applied to these studies, Table 17. As none fully met all of the pre-set quality criteria the evidence presented should be regarded as tentative until more substantial research evidence is available.

### Table 17: Quality appraisal summary of qualitative papers.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Quality appraisal (number of criteria met)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cioffi, 2000b; Smith, 1988</td>
<td>Some criteria met.</td>
<td>Did not link to theory. Sample not described in detail. No audit trail. Context described briefly. Methods section was brief. Analysis and interpretation of data described briefly. Creditability - scope for greater use of member checks, searching for negative cases, information about researcher’s role in fieldwork. Confirmability was enhanced by involvement of two clinical nurse specialists. Transferability - would need fuller description of research site to aid this.</td>
</tr>
<tr>
<td>Grossman and Wheeler, 1997</td>
<td>Some criteria met.</td>
<td>Minimal links to theory. Sample was described. Brief description of context. Appropriate method. Analysis stage was described and reliability checks were reported on 1/3 transcripts giving an inter-rater reliability of 88%-analyses were confirmable. Member checking was performed. Transferability would require more detail about research site.</td>
</tr>
<tr>
<td>Minick, 1995</td>
<td>Some criteria met.</td>
<td>Some links to concept of caring. Sample recruited from several US ICUs, described briefly. Context not described in detail. Analysis reported briefly, some evidence of search for negative cases. Creditability- used participants' own terms. Confirmability- some member checking. Transferability- limited as context not described in depth.</td>
</tr>
<tr>
<td>Smith, 1988</td>
<td>Some criteria met.</td>
<td>No explicit links to theory. Sampling strategy not described in detail. Brief description of methods and analysis. Creditability- quotations not traceable to participants. Member checking not reported. No audit trail which limits confirmability of findings. Small sample size and absence of detailed description of the sites limits transferability of findings.</td>
</tr>
<tr>
<td>Cutler, 2002</td>
<td>Some criteria met</td>
<td>Some links to theory. Sampling strategy was explained. Context was described. Descriptive codes used in analysis. Analysis described. Member checking contributed to creditability. Small sample relates to one ward limiting transferability of findings.</td>
</tr>
</tbody>
</table>

A qualitative meta-synthesis (Jensen & Allen, 1996) was not performed in view of the heterogeneity of the populations and methods, the limited sample sizes, and the small number of studies. The main themes reported in each study are therefore presented separately.
4.17.1 Qualitative papers and main themes identified

Cioffi (2000b) explored nurses' recognition of patients who needed emergency intervention in an Australian teaching hospital. Research participants comprised a purposive sample of registered nurses (n=32) qualified for at least five years, with experienced of calling the Medical Emergency Team (MET). The units studied included medical, surgical, renal, gynaecological, coronary care, and orthopaedics.

The main themes identified were nurses detecting a change in the patient state by comparing current state with a previous one, and exploration of the MET criterion seriously worried about a patient (Cioffi, 2000b). Four characteristics of patients causing concern were identified; patient self-report of feeling not right, and nurse observation of colour changes, agitation, and observations. Changes over time were noted and the characteristics were usually found in combination. Nurses used touching, observing, listening, feeling or sensing, and knowing to recognise that a problem was developing. Past experience, knowledge of the patient and usual progress patterns were important elements in recognising patients at risk. The MET category seriously worried about a patient was used even in the absence of objective signs or measures indicating that factors other than objective physiological measures were involved in such judgements.

Grossman and Wheeler (1997) identified patient cues used by expert critical care nurses in judgements about deterioration or recovery in selected medical intensive care patients. A convenience sample of 33 expert nurses with at least two years critical care experience was drawn from a US Medical Intensive Care Unit.

Grossman and Wheeler (1997) used the constant comparative method to analyse data. The three diagnostic groups – heart failure/ post myocardial infarction, acute gastrointestinal bleeding, and pulmonary oedema- were analysed separately. Cues were identified and placed on a continuum for recovery or deterioration for each diagnostic group. The themes of recovery or deterioration were illustrated with early, imminent and late cues. Early, imminent and late signs of deterioration and recovery
were identified for each diagnostic group. The earliest signs of deterioration across the three conditions were found in cues relating to the patients’ self report, behavioural signs such as skin colour changes, restlessness and mental status changes, and signs of increasing anxiety reflecting changes in psychological status. Across the three conditions physiological measures (vital signs) were not cited as early indicators of deterioration. Multiple cues were used in the judgement process; practitioners looked for trends and patterns in cue presentation.

Minick (1995) studied the processes used by critical care nurses in the early recognition of patient problems. Interviews were conducted with a convenience sample of 30 critical care nurses in several US hospitals, with experience ranging from 6.5-30 years in total and the majority were degree graduate nurses. Qualitative data analysis for the interview transcripts was described as coding data, development of categories and themes. A qualitative data management computer programme was used. Participants’ own terms were used to code material in an attempt to enhance research creditability and two key participants confirmed the researcher’s analysis. In all cases the concept of caring came into the early recognition of problems and the theme perception of early recognition engendered through caring was identified. Further themes were making the connection, or recognising the problem, and missing the connection referring to delay in recognition. Missing the connection was used in this research as a negative case for comparison with examples where making the connection was achieved. The themes were illustrated with narratives. Caring about patients was closely related to the nurse’s use of perceptual skills to recognise early warning signs. Nurses relied on subjective assessments, and subtle signs or intuition when there were no significant objective signs to guide care. Combining multiple cues was also reported; cues on their own were often not significant but when combined with other information they were considered more important.

Smith (1988) explored critical care nurses' perspectives on the phenomenon of deterioration in critically ill patients using Glaser and Strauss’s Grounded Theory qualitative research methodology and a two part design. A purposive sample of six
experienced critical care nurses from two US hospitals were recruited but the term 
experienced was not defined. Interviews were transcribed and labelled with 
descriptors and themes. Thirteen thematic categories were developed from interview 
responses in part one. The themes mainly covered intuitive judgements that the 
patient’s condition was changing and the search for evidence to support these 
judgements. In part two nurses rated investigator generated possible characteristics of 
deterioration from one, most essential to three, not a part of the phenomenon and 
these were then given overall ranking from one to 23. The items included perceptual 
cues and physiological indicators of a change in state. Smith (1988) referred to the 
changing nature of the process of deterioration and the nurse’s role in the prediction 
of deterioration. Patient cues to deterioration were derived from a range of domains 
including physiological, emotional, communication, cognition, spiritual, and /or 
combinations of these.

The areas of agreement in parts one and two included the initial sense that something 
was wrong, awareness of a change in state such as worsening, and the need to closely 
observe the patient (Smith, 1988). The method of data analysis was not described in 
detail, and potential threats to the creditability of findings were not reported in detail. 
Items with the same average group score in part two were not ranked equally, and 
there was no explanation of how the items were ranked separately e.g. sense that 
something is wrong and feeling of concern ranked one and two respectively, but they 
had the same average group score. The small sample size limits transferability of 
findings, types of ICUs/ patient population were not fully described (thick description 
of the research sites was omitted also limiting transferability). Creditability was 
affected by the absence of independent analysis by a second person, and the selection 
of items for part two may have been open to investigator bias. The absence of an 
audit trail means that the potential for researcher bias cannot be examined and limits 
the confirmability of findings.

Cutler (2002) studied the culture and context of ward-based critical care nursing in 
one 34 bed surgical ward using an ethnographic case study approach. The
judgemental sample (Fetterman, 1998 as cited in Cutler, 2002) comprised seven participants. Data collection consisted of semi-structured in depth interviews. The local staffing situation and problems relating to this were reported (thick description of the site was thus considered). The interviews were transcribed verbatim by the researcher. Nurses validated that each transcript was accurate and that participants permitted its use in analysis a form of member checking. Descriptive names were used in the analysis of text and selected participants checked the names for their creditability also a type of member checking.

The findings were reported under context and three categories from the literature-compatibility, relative advantage and practical applicability (Cutler, 2002). Verbatim quotes illustrated the categories. Context described medical and nurse staffing. Nurses reported that many of their patients were very dependent or seriously ill. The staffing of the ward was perceived as inadequate for the needs of the patients whereas the DH (2000) and Audit commission (1999) reports had emphasised the need for the education and training of ward-staff (Cutler, 2002). Compatibility referred to how learning equipped the nurse for the demands of the organisation. Assessment skills were valued, both in picking up new problems in regular and in one-off monitoring situations. The cues involved in clinical judgements were not examined in detail. Role boundaries between medical and nursing staff were a source of conflict. Collaboration with medical staff was reported as sub-optimal, nurses reported knowledge deficits in junior doctors, and stated how nurses shared their knowledge for the patient’s benefit. Doctors didn’t always review patients the nurses were concerned about, and nurses cited this as evidence of poor collaboration. Relative advantage referred to how knowledge empowered the nurses, for example knowledge of physiology enabled them to make accurate clinical judgements and take action. Cutler (2002) suggested the cognitive skills required in clinical judgement contrasted with the behavioural competencies foci in DH (2000). The findings related to one surgical ward and seven participants at a particular point in time therefore limiting transferability to other settings.
Across the five qualitative papers a range of cues were identified as predictors of deterioration or critical illness as shown in Table 18 below.

**Table 18: Summary of cues identified in qualitative papers- n=5.**

<table>
<thead>
<tr>
<th>Cue</th>
<th>Number of occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical History</td>
<td>1</td>
</tr>
<tr>
<td>Medication</td>
<td>1</td>
</tr>
<tr>
<td>Intuition</td>
<td>3</td>
</tr>
<tr>
<td>Pulse</td>
<td>2</td>
</tr>
<tr>
<td>BP</td>
<td>1</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>1</td>
</tr>
<tr>
<td>Temp</td>
<td>1</td>
</tr>
<tr>
<td>GI Bleeding</td>
<td>1</td>
</tr>
<tr>
<td>Colour</td>
<td>3</td>
</tr>
<tr>
<td>LOC</td>
<td>1</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>1</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>1</td>
</tr>
<tr>
<td>Nausea/ vomiting</td>
<td>1</td>
</tr>
<tr>
<td>Patient distress</td>
<td>3</td>
</tr>
<tr>
<td>Restlessness</td>
<td>1</td>
</tr>
<tr>
<td>Patient position</td>
<td>1</td>
</tr>
<tr>
<td>Rambling</td>
<td>1</td>
</tr>
<tr>
<td>Thirst</td>
<td>1</td>
</tr>
<tr>
<td>Clammy</td>
<td>1</td>
</tr>
<tr>
<td>Cold</td>
<td>1</td>
</tr>
<tr>
<td>Lethargy</td>
<td>1</td>
</tr>
<tr>
<td>Seriously worried</td>
<td>2</td>
</tr>
<tr>
<td>Patient self-report</td>
<td>1</td>
</tr>
<tr>
<td>Psychological</td>
<td>2</td>
</tr>
<tr>
<td>Temporal</td>
<td>4</td>
</tr>
<tr>
<td>New complications</td>
<td>1</td>
</tr>
<tr>
<td>Original condition worse</td>
<td>1</td>
</tr>
</tbody>
</table>

4.18 Discussion

A key finding from the systematic review is that the predominant focus of quantitative papers is on cues that can be measured objectively. Published research may be biased towards cues that are measurable, and independently verifiable which may partially explain the relatively low frequency of occurrence of cues such as
colour, patient position, restlessness, and psychological factors. The findings reported in the qualitative papers suggest that subjective clinician and behavioural cues may also be important in nurses' clinical judgements: The most frequently reported cue was temporal factors (four papers), followed by intuition, colour, and patient distress (three papers). The results from these papers should be regarded as tentative because they did not meet all of the review quality criteria.

The heterogeneous nature of the papers and the method of analysis employed, where the reporting of cues as predictors in papers was the major focus rather than detailed calculations based on study sample sizes, may have affected the results. The large range of cues reported in both quantitative and qualitative papers suggests that many cues are relevant in the prediction of the clinical states reported in this review.

Cardiopulmonary arrest, critical illness, readmission to ICU and mortality reflect major clinical states potentially resulting from a range of medical conditions. Accordingly it is not surprising that a large range of cues have been reported as predictors in the latter clinical states. Gastrointestinal haemorrhage (GIH) is a distinct clinical sub-state of critical illness that can be accurately predicted using a few cues (Inayet et al., 2000; Kollef et al., 1997).

The final sample size of core quantitative papers may explain why it was not possible to discern small differences between cues – differences smaller than the confidence intervals. But on the other hand a larger sample may still provide similar results. The sample size of papers would need to be much larger to significantly change the confidence interval as this varies with the square root of the number of papers in the sample. To half the range of the confidence interval in this study would require 240 papers rather than 60 (56 finally included in the analysis). The large range of cues identified and the degree of overlap demonstrated through the analysis of confidence intervals lends support to the hypothesis that the clinical judgements concerned with predicting the above clinical states are complex and uncertain. Clinical indexes were reported as predictors, the most notable being the MET score (see summary Graph 1,
p.91, for cues in over 9% of core quantitative papers). However it is impossible to say whether the frequency of occurrence is related to the predictive ability of a particular index or to how often the index was investigated in research studies.

The combinations of cues and whether they are additive or multiplicative in judgements would be an important area for future research. The examination of co-occurrences in the most frequently reported predictors in the core quantitative papers (shown in Graph 16, p.124) suggests that some predictive cues appear in combinations.

The different cues that were predictive of the clinical states varied in how much advance warning they provided. Cues such as type of admission, medical history, admission disease process, age, functional status prior to admission can be recorded at an early stage, but some of the physiological measures may be late signs of developing critical illness (such as abnormal BP, respiratory rate, and pulse). Other information such as clinicians’ subjective assessments of colour, restlessness, patient position, LOC, lethargy, functional status, changes in condition over time, or judgements of severity of illness may be particularly important in the earlier identification of high-risk patients. Only a few of the latter cues e.g. temporal changes, LOC and judgements of severity of illness were frequently reported as predictors in the 56 core quantitative papers.

The cue composition of clinical indexes used in the prediction of critical illness or cardiac arrest reflected mainly objective measures of physiological state (Lee et al., 1995; Morgan et al., 1997; Goldhill et al., 1999; Subbe et al., 2001). However Hourihan et al., (1995) and Hodgetts et al., (2002b) include clinician concern and some subjectively assessed clinical signs. For example Hourihan et al., (1995) identify that the worried category was used for patients with chest pain, nausea and pallor, haemorrhage, aggression, abnormal blood sugars, and disconnection from traction or ventilator. Hodgetts et al., (2002b) recommend that new sweating, and new pallor would be included in the doctor or nurse concern criterion. Other clinical
symptoms of a subjective nature were chest pain, abdominal aortic aneurysm pain, and shortness of breath (Hodgetts et al., 2002b). Changes in Glasgow Coma Score (GCS) were cited as one of the physiological factors in the Hodgetts et al., (2002b) MET activation criteria. Further work on the clinician concern criterion is required (Hodgetts et al., 2002b) as it appears to cover a wide range of items where it is used.

Current EWS also vary in the method of calculation used to identify patients at risk. EWS that accord points to various criteria with a pre-set trigger score, and instructions on patient referral, have been termed track and trigger warning systems (Morgan et al., 1997; NORF, 2003; Stenhouse et al., 1999; Subbe et al., 2001). There is considerable variation in the scoring systems; they include single parameter, multiple parameter, aggregated weighted, and combination scoring systems (NORF, 2003). Scores where just one abnormal value is sufficient to trigger the critical care outreach team include the Harlow Outreach Team Tool (NORF, 2003), and one criterion is enough to trigger the Medical Emergency Team in Bellomo et al., (2003). Examples of multiple parameter scores are the System for evaluating the sick (S.E.C.S) (NORF, 2003), and the patient-at-risk protocol (Goldhill et al., 1999). The Modified Early Warning Scoring System (MEWS) (NORF, 2003) and the Medical Emergency Team Calling Criteria (Hodgetts et al., 2002b) use an aggregated weighted scoring system. In this system indicators are awarded points from zero to three, and a score of four currently triggers the critical care outreach team. Other systems use aspects of single or multiple parameter systems together with aggregated weighted scoring, such as the Kingston Hospital Deranged Physiology Scoring System (NORF, 2003).

Indicators such as blood pressure, heart rate and temperature have natural variations, whether this be moment to moment, or minute to minute in blood pressure or heart rate, or diurnal variations in the case of temperature (Harris, 2002). If vital signs are recorded intermittently they may not reflect the overall state of the patient. In addition to natural variability there may be knowledge deficits or poor technique. Doctors and nurses may lack understanding of factors influencing interpretation of pulse oximetry
data on the saturation of haemoglobin with oxygen in arterial blood (SpO2) (Stoneham et al., 1991). The Glasgow Coma Scale (GCS) may be inaccurate and unreliable when used by inexperienced staff (Rowley & Fielding, 1991), and blood pressure, heart rate and respiratory rate may also be inaccurately recorded in practice due to faulty technique or poorly maintained equipment (Harris, 2002).

If the amount of variance in measures used in the calculation of patients at risk is unknown, then it is not possible to know the probability of a particular score being correct. For example a score of two may really mean the patient’s condition is somewhere between one and three, but it is unknown where they actually are; this could make a difference to the action taken.

Further psychometric and clinimetric testing of early warning scores is required. Currently scores are validated through use, but more rigorous examination of the validity of scores for particular groups of clients is needed, and inter-rater reliability requires more careful analysis than has occurred to date. For example the criteria included in Hodgetts et al., (2002b) were based on an analysis of cardiac arrest patients compared to controls who did not have cardiac arrest, but this score is used more broadly to detect critical illness and cardiac arrest. Consequently blood sugar was omitted from the initial calling criteria because it did not reach a statistically significant level in cardiac arrest cases.

Research papers often refer to samples of general ward patients rather than differentiating between medical and surgical patients (for example, Buist et al., 1999; Goldhill, Worthington et al., 1999; Schein et al., 1990; Smith & Wood, 1998; Sterling et al., 2002). The terms medical and surgical tend to be categories used for the organisation of care rather than reflecting the severity of patients’ conditions and so papers were not separated out during the analysis of cues. The various early warning scores tend to be used on medical and surgical ward patients, further suggesting that severity of illness is the issue rather than the categories of medicine or surgery.
Of the papers that focused specifically on medical patients respiratory rate was a significant predictor of cardiac arrest (Fieselmann et al., 1993). For patients with gastrointestinal haemorrhage significant predictors of critical illness (admission to ICU) were raised prothrombin time (PT) INR (>1.2), hypotension (<90mmHg), new neurological problems, and APACHE II scores greater than or equal to 15 within two hours of admission (Inayet et al., 2000). Subbe et al., (2001) undertook a prospective evaluation of a modified early warning score in medical emergency admissions. Older patients (age may be an indirect indicator of physiological reserve), and patients with low blood pressure, raised pulse or raised respiratory rates were at significantly greater risk of reaching the pre-defined end-points of HDU or ICU admission, cardiac arrest or death at 60 days (Subbe et al., 2001).

A variety of cues were identified in surgical studies. For example, significant associations were found between serious post-operative adverse events, age and unscheduled surgery (Bellomo et al., 2002). Kennedy et al., (1994) reported that a positive sickness assessment score comprising any one of the indicators of systolic BP < 100 mm Hg, severe chronic disease or compromised immune state, and not independent and self-caring predicted mortality in elderly surgical patients.

The review findings support the hypothesis that severity of illness is an important mechanism in the development of critical illness or cardiac arrest. The dimensions of severity of illness reported across the sixty-one core papers included biological severity, physiological severity, temporal factors and administrative/ organisational factors and functional severity, personal and psychological factors.

Biological severity was reflected in the cues of physiological reserve, gender and biological age. Age was one of the frequently reported predictors across the 56 core quantitative papers (see Graph 1, p.91). These cues were not reported in the qualitative papers; it is a matter for investigation in study two whether the cue of intuition refers to some of these areas.
Physiological severity was reflected in the cues of admission disease process, type of admission, medical history (planned, unplanned, medical or surgical), diseases and illnesses (including neurological, renal, sepsis, respiratory, haemorrhage, cardiac, and cancer), and in the physiological indicators. The latter included BP, respiratory rate, pulse rate, LOC, urine output, fluid balance, temperature, arterial blood gases, SPO$_2$, biochemistry, haematological values, and blood sugar. Admission disease process, medical history, various medical conditions and physiological indicators were major components in some of the clinical indexes reported in the current review, and physiological indicators featured in all clinical indexes. Cues linked to physiological severity were frequently reported as predictors in the fifty-six core quantitative papers (see Graph 1, p.91). Apart from LOC, behavioural cues were reported infrequently in the core quantitative papers. This contrasted with the findings in the qualitative papers where cues such as colour and patient distress were reported as predictors in three out of five papers.

Functional severity was reflected in the cue of functional status. This was not frequently reported as a predictor in the core papers included in the review. Functional status may either be unreliable as a predictor (however it was frequently reported as a predictor of mortality/outcome- see Graph 6, p.107), or it may be less likely to be included as a variable in research in the first place.

Personal/psychological characteristics were included in the cues psychological and patient distress. Neither cue was frequently reported as a predictor in the fifty-six core quantitative papers either because they were not reliable predictors or because they were seldom measured in research studies. Roach, Connors et al., (1998) however reported that depressed mood predicted mortality in seriously ill hospitalised adults. Qualitative evidence was provided for the cue, psychological and patient distress (Cioffi, 2000b; Grossman & Wheeler, 1997; Smith, 1988) indicating that this dimension may be important in the early prediction of deterioration and critical illness.
Temporal factors were represented in the cues temporal factors, and new complications. Across all papers temporal factors were frequently reported as predictors (see Graph 1, p.91 and Table 18, p.142). This evidence supports the hypothesis that change in clinical state over time is an important cue in the prediction of the clinical states studied here.

Administrative/ organisational factors were reflected in the cues administrative and delayed response. Both categories of cues were frequently reported as predictors in the core quantitative papers (Graph 1, p.91). Developments such as early warning scores used to summon the MET or PAR teams (Lee, Bishop et al., 1995; Morgan et al., 1997; Goldhill, Worthington et al., 1999) and educational initiatives such as the ALERT courses (Smith, 2003) are evidence of attempts to target such issues.

Based on the cues identified in the systematic review and the severity of illness conceptual framework for the early identification of cardiac arrest and critical illness in general ward patients a preliminary coding framework (Appendix 13) was identified for the analysis of data in the empirical study (study two).

4.19 Conclusion
Generally the review findings demonstrated that objective measures of physical state, past medical history, admission disease process, temporal factors, and type of admission (planned or unplanned) were the main cues reported. With the exception of level of consciousness and dyspnoea the quantitative core papers did not tend to refer to the subjective clinician, behavioural or patient self-report cues that were reported in some of the qualitative papers. No single cue predicts critical illness or cardiac arrest in all situations, but a number of cues were frequently reported
The following research questions arose from the systematic review and were addressed in an empirical study (study 2).

1. What cues do clinicians consider important in judgements of patient condition?
2. Which cues do clinicians consider to be important in the prediction of deterioration in condition in the clinical outcome states of critical illness or cardiac arrest?
3. Are subjective clinician, behavioural signs or patient self report signs considered important in judgements of patients' conditions in the clinical outcome states of critical illness, cardiac arrest or acute illness and vulnerable to physiological instability and deterioration to critical illness or cardiac arrest?
4. How accurate are clinicians' diagnoses of clinical condition and predictions of deterioration as reported by clinicians themselves?
5. Do clinicians report single cues or combinations of cues to predict cardiopulmonary arrest, or critical illness?
6. What are the psychological characteristics/properties of cues considered important in judgements of patient condition?
7. Which dimensions of severity of illness do clinicians report when predicting cardiopulmonary arrest or critical illness?
8. Do the cues considered important differ according to the clinician’s location/patient group?

The next chapter discusses the research methodology for the research focusing particularly on the empirical study which addressed the above research questions.
Chapter 5
Methodology
The philosophical perspective and the research design

5.1 Introduction
Nursing research draws on a range of philosophical perspectives. The researcher generally selects the perspective that is most suited to the research problem being investigated and their own personal views on what counts as knowledge. Within the current study making this choice involved balancing the contribution of the natural sciences, particularly physiological processes with its orientation towards positivist perspectives, and the researcher's interest in the cues clinicians considered important, reflecting a position that was closer to the interpretivist and phenomenological philosophical perspectives.

Crotty (1998) identifies four aspects to be considered when planning research: epistemology, theoretical perspective, methods, and methodology. Firstly, epistemology refers to the theory of knowledge integral to the theoretical perspective and the research design. Secondly, the theoretical perspective describes the philosophical position adopted that has implications for the methodology or research design and the particular assumptions about logic that this entails. Thirdly, methods refer to the ways in which data are collected and analysed; and finally, methodology is the term used to describe the research design and how the various elements of the study link together to address the research questions and achieve the research goals (Crotty, 1998). The current chapter introduces the epistemology, theoretical perspective, methodology and methods guiding the overall research. The characteristics of qualitative research are also discussed at this stage because the empirical study adopted a qualitative approach.

5.2 Epistemology
The particular epistemology the researcher selects provides the foundation for the type of knowledge that can be developed (Crotty, 1998). The objectivist epistemology
views meaning and meaningful reality as independent of consciousness and so research focuses on gaining an objective understanding, the objective truth, of the people studied (Crotty, 1998). Patton (2002) presents positivist, realist and analytic induction approaches as examples of truth and reality-oriented correspondence theory. Common to these approaches is the assumption that there is a real world with patterns that can be found and predicted, and where the goal of research is to find methods that accurately describe or correspond with the real world (Patton, 2002).

Alternatively constructionism contends that there is no such objective truth, rather meaning or truth is based on the construction of meaning in the mind; this is a popular position in qualitative research (Crotty, 1998). Qualitative enquiry from the constructionist perspective anticipates that different individuals and groups would present contrasting views on a subject (Patton, 2002). Within constructionism meaning is constructed out of the object. A further contrasting epistemology is subjectivism in which meaning is attached to the object by the subject but the object plays no role in the development of meaning (Crotty, 1998).

The particular epistemological stance strongly influences the research approach adopted. If the focus is on an objective truth a study may be designed to identify and measure it. However if the focus is on the meaning of events to individuals the process used will seek to gain an understanding from the subjects' perspective. The quantitative studies included within the systematic review (study 1) are mainly objectivist and within the positivist/post-positivist perspectives whereas the qualitative studies are more constructionist and located within an interpretivist perspective. The objects of the systematic review include identification of the most frequently reported predictor cues for clinical states, the strength of the evidence for particular cues, and qualitative synthesis of qualitative research evidence. The qualitative interview study (study 2) explores the subjective experience of clinicians and the structure of clinicians' clinical judgements as they infer the clinical state of the patient. The focus is on cues that clinicians consider most important in judgements, the meaning individuals ascribe to actions, their intentions, and the
context in which judgements are made. The intention is to draw on the clinicians' accounts to investigate the relationship between cues, clinical judgements and clinical events to begin to identify any processes or mechanisms that may be operating in these situations. The clinical judgements are also examined within the context of a conceptual framework based on a broad interpretation of severity of illness.

5.3 The Theoretical Perspective

Different theoretical perspectives inform the development of knowledge. The systematic review (study 1) refers to literature from across theoretical perspectives and the empirical study (study 2) is located within the **critical realist** perspective. The main theoretical perspectives that influenced the current research are discussed here.

Positivism

The positivist position asserts that the social sciences should draw on the methods used by the natural sciences (Bryman, 1988; Hughes & Sharrock, 1997). Positivism holds that phenomena must be available to the senses to be considered as knowledge, and consequently phenomena that cannot be observed directly, or measured indirectly using instruments, are excluded (Bryman, 1988); within psychology this would mean that only *classical behaviorism* would be legitimate (Harre, 2002). There is no accommodation for *feelings* or *subjective experience* in this account of social scientific knowledge if they cannot be observed (Bryman, 1988). Scientists within the positivist tradition focus on facts, and values or meanings are beyond their concern (Bryman, 2001; Hughes & Sharrock, 1997). Theory is tested mainly using a *hypothetico-deductive method*; hypotheses or predictions are deduced from theory before data collection and the researcher tries to falsify these using empirical evidence (Bowling, 1997). If predictions are confirmed then the theory is supported, but if data disprove the hypothesis it must be revised or rejected (Murphy et al., 1998).
The positivist philosophy of science is attributed to the French philosopher Comte in
the 19th century (Harper & Hartman, 1997). Within positivist science empirical
observations were viewed as the foundation for theoretical laws and knowledge
(Hughes & Sharrock, 1997). In the 1920s a group known as the Vienna Circle
developed logical positivism in which the scientific method was characterised as both
logical and empirical (Hughes & Sharrock, 1997). Whereas Comte had advocated
that the methods of natural science be used in the social sciences, the Vienna Circle
was more concerned with the application of mathematics to philosophy (Crotty,
1998). Logical positivism had a profound influence on scientific disciplines including
medicine and nursing up to the 1960s (Harper & Hartman, 1997). Scientific
knowledge within the logical positivist perspective is concerned with the search for
universal laws, by testing logically deduced hypotheses empirically using explicitly
defined concepts and variables so that replication and falsification can be attempted
(Patton, 2002). This conception of scientific knowledge generally demands more
certainty than social phenomena can provide and was largely rejected as a foundation
for social science research in the latter half of the 20th century (Patton, 2002).

A number of scientists and philosophers challenged the absolutist views of logical
positivism and suggested a more temperate version of positivism; they have been
called post-positivists. The post-positivists question positivist assertions that scientific
knowledge is totally objective and the only sound type of knowledge (Crotty, 1998).
Their conception of scientific knowledge is more moderate; probability replaces
certainty of claims, objectivity is expressed in levels rather than total objectivity, and
truth is not aspired to in absolute terms (Crotty, 1998). The quantitative studies
included within the systematic review (study 1) are located within the post-positivist
perspective. Crotty (1998) refers to Heisenberg’s uncertainty principle that states the
impossibility of accurately reporting the location and momentum of a sub-atomic
particle in quantum physics thus making certain prediction of a future state
impossible; physics began to refer to relative statements rather than absolute
statements. Whilst Heisenberg’s position focuses on epistemology and the capacity of
individuals to know something, another physicist, Bohr argues that the problem is

154
more an ontological one based on the actual properties of sub-atomic particles (Crotty, 1998). The possibility of uncertainty in physics is therefore acknowledged. Popper's principle of falsification places current knowledge in the tentative position of knowledge that has yet to be refuted; Popper also argues that science develops through a process of trial and error (Hughes & Sharrock, 1997).

Kuhn (1970) argues in his book, *The Structure of Scientific Revolutions*, that science develops in an entirely different way to that purported by Popper. Kuhn asserts that scientists hold on to particular frameworks or paradigms and normal science operates within these, until a major change stimulates the overthrow of the prevailing paradigm and replaces it (Hughes & Sharrock, 1997). Science therefore has social dimensions and members of the scientific community share concepts, values and standards for judging the merit of scientific work (Hughes & Sharrock, 1997). An even more radical view is presented by Feyerabend who challenges the unconvincing philosophical foundations of positivist science stating that it, like other sources of knowledge, is based on a system of beliefs including the social, political and cultural (Crotty, 1998).

During the 1970s alternatives to positivist science in nursing became more widely recognised enabling the exploration of issues that reflected nursing's commitment to a holistic philosophy (Harper & Hartman, 1997). *Interpretivism* was one of the most influential of these perspectives.

**Interpretivism**

Within interpretivism the application of the scientific model to the study of the social world is rejected as individuals are not considered the same as objects in the natural sciences; the focus is on the investigation of subjective meanings of social situations (Bryman, 2001; Hughes & Sharrock, 1997). The qualitative studies included in the systematic review (study 1) are located within the interpretivist perspective. Whereas positivism in the social sciences would be concerned with explaining human behaviour, interpretivism's focus is on understanding human behaviour (Bryman,
Phenomenology is one of the philosophical approaches within the interpretivist perspective and aims to provide detailed accounts of aspects the subjects' are conscious of, to examine the range of their experiences and uncover their essential meanings (Kvale, 1996). The focus is on the individual's initial and direct experience of phenomena before thoughts, interpretations, or meanings are attached to them (Crotty, 1998).

Realism
Quantitative research is often associated with realism and qualitative research with idealism although in practice some quantitative researchers have idealist views and some qualitative researchers draw on a realist perspective (Murphy et al., 1998). Realism shares two characteristics with positivism; the first concerns the belief that "the world has an existence independent of our perception of it" (Williams & May, 1996 p.81). And secondly, it is committed to the use of the same methods in the natural and social sciences. This contrasts with idealism which argues that the social world is understood in terms of individuals' representations of it and that no search can reveal what is actually real in the social world (Williams & May, 1996). Idealists would not deny the possibility of an external existence but they question whether it is possible to know reality and furthermore they argue that there are multiple realities (Murphy et al., 1998).

Critical realism or transcendental realism is a particular type of realism that presents an alternative to positivism or interpretivism (Bhaskar, 1975; Harré & Secord, 1972). The critical realist perspective asserts that "...social phenomena exist not only in the mind but also in the objective world and that some lawful and reasonably stable relationships are to be found among them" (Miles & Huberman, 1994 p.4).

These stable relationships are derived from the links between phenomena that are then used to formulate constructs that underpin real situations (Miles & Huberman, 1994). Although invisible these constructs may still be valid (Miles & Huberman, 1994). Observability of something increases our confidence that it exists but its
existence does not depend on our observations of it (Sayer, 2000). Critical Realists argue that in addition to observability, there is a causal aspect (Collier, 1994). To investigate the existence of something that cannot be directly observed it may be necessary to focus on the product or observable effects and then a viable explanation may be possible for a mechanism that has come into effect under particular conditions (Sayer, 2000). In the empirical study (study 2) the mechanism of increasing severity of illness cannot be observed directly but the effects of transition to critical illness or cardiac arrest can be explored by asking clinicians to recount the cues that were evident. Further research would be required to test any preliminary findings. There is growing recognition that the critical realist perspective can inform research in practice oriented professions (such as social work and nursing) (Robson 2002b).

Theory and observations are interdependent within the critical realist position (Harré, 1981). Facts become apparent in a situation because a theory is being used to pick out significant items, and a process of categorisation occurs (Harré, 1981). The philosophical approach guiding the empirical study (study 2) draws on critical or ‘transcendental’ realism.

Miles and Huberman (1994) state that there is a subjective phenomenological dimension to social life agreeing with the interpretivists on this point, but they claim to transcend this position by developing and testing theories that describe the real world. Transcendental realists aim to reach beyond the subjective and phenomenological accounts of actions in situations (episodes) to provide explanations of the processes and mechanisms that give rise to these particular events (Miles & Huberman, 1994), they are interested in the structured relations underpinning actions (Porter, 2002). They strive towards a causal description of the elements at work where research evidence is scrutinised to check that each event is an example of the causal explanation proposed (Miles & Huberman, 1994).

The critical realist perspective can therefore inform research into clinical judgement where the clinicians' accounts are examined to provide an insight into the cue
composition of their clinical judgements; the clinical judgement process and mechanisms that may contribute to the clinical events.

5.4 Qualitative and quantitative approaches to research
Qualitative and quantitative research are often presented as completely separate models of the research process largely because they occupy the contrasting epistemological positions of interpretivism or positivism, implying that they belong to alternative paradigms (Bryman, 1988). On the other hand some argue that the research issue should determine whether quantitative or qualitative research is most appropriate, and that technical rather than epistemological issues are more important in the choice of approach (Bryman, 1988; Murphy et al., 1998). Within the systematic review (study 1) evidence from both paradigms is examined because the aim is to identify predictor cues reported in quantitative studies and cues clinicians' considered important in qualitative studies. A qualitative approach is used in the empirical study (study 2) because the aim is to gain an insight into the cues' clinicians consider important in their judgements as these may differ from those reported in quantitative studies.

The place of theory in quantitative and qualitative research presents a further contrast between quantitative and qualitative research. Generally quantitative research works through a process of deduction and tests theory, whereas qualitative research tends to be inductive and focuses on theory generation (Bryman, 2001). Although qualitative research is characterised as inductive and useful for hypothesis generation, it often uses deduction (Murphy et al., 1998). Miles and Huberman (1994) in particular highlight the potential of qualitative methods for testing hypotheses. Differences in the ontological position concerns whether social elements can be considered as objective with an existence external to the individual, or as social constructions based on the mind and actions of individuals; quantitative research is thus aligned with objectivism and qualitative research with constructionism (Bryman, 2001).
With an emphasis on the technical features associated with data collection and analysis, qualitative research is defined as:

"the collection, analysis and interpretation of data that are not easily reduced to numbers. These data relate to the social world and the concepts and behaviours of people within it." (Murphy et al., 1998, p.iii).

In contrast quantitative research

"... usually emphasises quantification in the collection, and analysis of data" (Bryman, 2001, p.506).

Qualitative research is judged by its richness and depth; qualitative data are termed soft in comparison to the data collected in quantitative research (Corbetta, 2003). Quantitative research aims to produce precise, reliable, rigorous and unambiguous or hard data (Corbetta, 2003).

The characteristics of qualitative research shall now be explored in detail because the study to elicit the cues clinicians considered important in judgements of patient condition was essentially a qualitative study informed by a critical realist perspective.

5.4.1 Characteristics of qualitative research

Mason (1996) identifies three features for a working definition of qualitative research. The first feature is the philosophical position that is generally towards an interpretivist perspective about the social world. The second feature is that data collection methods are adaptable to the social context; and thirdly, data analysis and explanations are rich in detail and context so that holistic approaches to data analysis are more widely used than statistical ones.

Qualitative research may be described as naturalistic, a term used to denote “non-experimental research in naturally occurring settings” (Pope & Mays, 1996, p.3). Due to this naturalistic focus carefully collected qualitative data can provide access to real life issues (Miles & Huberman, 1994). Qualitative research takes the subjects’ perspective and attempts to see things from their point of view (Bryman, 1988). Max
Weber's concept *Verstehen* or understanding is often used to describe qualitative research and refers to both the understanding of subjective meanings of actions, and the motivation behind them (Bryman, 1988). Analysis is primarily concerned with words that are organised and examined to discern patterns (Miles & Huberman, 1994). The researcher is concerned with the translation of informants' meanings according to the theoretical framework of the research, but needs to avoid distorting the observations with prior assumptions (Murphy *et al.*, 1998). Whilst a theoretical framework assists in the development of theoretical insights in research Maxwell (1996) cautions against the imposition of a theory on data because qualitative research should examine the participants theories and perspectives.

### 5.4.2 Qualitative data

Qualitative data can take the form of observations that provide *thick description*, interviews that focus on quotations about personal views and experiences, and documents (Patton, 2002). Various strengths of qualitative data have been identified. Qualitative data focus on natural events in context to provide descriptions that are close to real life (Miles & Huberman, 1998). These descriptions can be used to challenge previously held assumptions about apparently ordinary situations (Murphy *et al.*, 1998). There is a commitment to holism where the group or social unit is the focus (Murphy *et al.*, 1998). *Emergent designs* leave options for data collection to evolve during the study and are often preferred to pre specified designs (Miles & Huberman, 1994; Murphy *et al.*, 1998; Patton, 2002). To understand the phenomenon the researcher tends to become directly involved with the people, the setting and the events (Patton, 2002). Qualitative data can be used to develop hypotheses in new research areas, to test hypotheses, and to complement or explain quantitative data collected in the same location (Miles & Huberman, 1994).

Within qualitative research, the researcher draws on concepts to attach meanings to the data (Miles & Huberman, 1994), but often the concepts are not well defined or they are not fully understood (Dey, 1993). This was the case in the current research where the concepts of severity of illness, critical illness, physiological stability and
clinical judgement required definition and critical analysis during the planning stage; the outcomes of these deliberations are reported in chapters two and three. Across quantitative and qualitative research data are really produced rather than collected; a series of judgements are made when the researcher picks out data for collection and decides how they will be used (Dey, 1993). For example interview data may be converted into different types of interview transcripts depending on the intended purpose (Arksey & Knight, 1999; Miles & Huberman, 1994). In quantitative studies the researcher makes a decision about what will be measured and how the data will be treated or analysed.

5.5 Methodology
A theoretical framework based on Social Judgement Theory (SJT) and Hammond's inference/correspondence model of diagnostic judgement (Hammond et al., 1975; Hammond 1996b) supports the investigation of clinical judgements in the recognition and prediction of critical illness or cardiac arrest. SJT assumes that judgements are the product of the integration of cues from the environment (Cooksey, 1996b). SJT contends that individuals do not experience objects in the environment directly, rather they use cues collected by their perceptual system to make inferences about distal objects in the environment (Brehmer, 1988). Judgement Analysis refers to the research methods associated with SJT (Cooksey, 1996). The inference framework of diagnostic judgement represents the application of the Lens model and SJT to diagnostic judgements and is particularly suited to research questions concerning how judgements are made and their accuracy (Hammond, 1996b).

As stated in chapter three a Judgement Analysis study comprises a number of stages (see section 3.1.3 p. 36). The current research corresponds to the stages up to the inclusion of cues in judgement profiles (Cooksey, 1996b). Cooksey (1996a) argues that a judgement analysis investigation's success depends on the identification and inclusion of the necessary cues in the judgement profiles administered to judges. Cooksey (1996a) presents a number of strategies for identifying the relevant cues.
These include the objective analysis of the ecology either through the analysis of historical records, where the cues and outcome of judgements are known, or through the systematic review and analysis of published research. Further methods include the survey/interview method, document analysis, and verbal protocol analysis. Judges who are familiar and experienced in the kinds of judgements under investigation can be approached through survey or interview methods.

The current research adopted two main approaches to cue identification. Firstly, a systematic review and synthesis of research evidence of predictor cues for critical illness and cardiac arrest was conducted (chapter 4). Secondly, a qualitative interview study with experienced clinicians asked them to refer to specific cases and to recount the cues they considered important in the diagnosis of the patient’s current and predicted clinical state.

Cooksey (1996a) notes possible biases that could affect cue identification in the current study where self-report is used. These include illusory correlation and availability heuristics (Tversky & Kahneman, 1982). Illusory correlation is where the individual’s personal experience refers to a relatively small number of cases. They may identify a particular cue because they have met it in other cases, but over a larger number of cases it might be less significant. Availability heuristics refer to the ease with which examples can be remembered giving rise to a number of biases. Where examples of a class can be recalled easily they may seem to occur more frequently than others that are more difficult to retrieve (Tversky & Kahneman, 1982). Clinicians may report the most memorable rather than the most typical cases. The strategy of including a range of experienced medical and other clinicians in the interview study, and conducting a systematic review of the literature and synthesis of evidence aimed to reduce the possibility of failing to identify an important cue.

The current research makes use of a pre-structured design after Maxwell (1996) that demonstrates the links between the aims of the thesis, the conceptual context, the research questions, the methods to be used and how threats to validity are addressed.
Maxwell (1996) and Miles and Huberman (1994) present the advantages and limitations of a pre-structured design. Advantages include the effective use of time and personnel, but pre-structuring may reduce flexibility and responsiveness to ideas emerging during data collection. Some researchers may associate a pre-structured design with positivist science and opt for unstructured approaches (Maxwell, 1996). The choice of a structured design in the current research was in keeping with the philosophical perspective of critical realism. Specifying the research design also encouraged the researcher to reflect on the suitability of the proposed methods for the particular research questions (Maxwell, 1996).

5.6 Research methods
Maxwell (1996) states that qualitative research methods comprise the formation of the research relationship with participants, sampling considerations, the methods of data collection and how data are to be analysed. These issues will now be discussed with reference to the empirical study (study 2). A description of the main research site, the wider research context and ethical issues are also included in the discussion of research methods.

5.6.1 The research relationship developed with research participants
This covers a number of aspects: negotiating access to the research sites, gaining ethics approval for the research, and establishing research relationships with research participants. The research proposal was submitted to the Director of Nursing Services and Medical Consultant at the clinical site, as part of the process of negotiating access to the research site. With the full support of the Director of Nursing Services and Medical Consultant (Appendix 14) the research proposal was submitted to the Local Research Ethics Committee in October 2000, and to the University of Surrey Advisory Committee on Ethics in January 2001. Ethics approval was confirmed in December 2000 and February 2001 respectively (Appendix 15).
The research relationship established with participants is the route through which qualitative research is carried out (Maxwell, 1996). It was important to establish the researcher's position as that of an interested colleague who valued the opinions of research participants. The letter of introduction outlined the researcher's current role as a part-time lecturer in nursing studies and part-time post-graduate research student, and outlined the purpose of the study (Appendix 16). Previous experience as a clinical nurse specialist in acute medicine and as a link tutor for more than 10 years in acute medical ward areas meant that the researcher was familiar with the acute medical setting. Critical care experience in cardiac surgery, respiratory and neurological intensive care, both as a clinician and as a teacher, meant that the researcher had knowledge and experience of critical illness and cardiopulmonary arrest cases.

When interviewing nurses the researcher did not tend to refer to earlier experience in intensive care nursing. This background provided personal motivation for conducting the research study; assessment of the physical state of the patient is a crucial activity in critical care nursing. Although this experience provided an in depth understanding of the critical care perspective, emphasising this could have been discouraging for some clinicians. Nevertheless the researcher considers that her background in critical care was vital for posing relevant questions and gaining useful data about the cases the clinicians presented.

For all participants it was important to emphasise that the research focus was the cues clinicians' considered important in their clinical judgements. Any references to the researcher's particular theoretical position, or cues considered important, could have posed a threat to the validity of the study and so these were not revealed during the course of the interviews.

The research relationship was maintained by providing participants with verbal updates on the progress of analysis, opportunities to read and comment on the interview transcripts, and circulation of a report on the study findings upon which
they were invited to comment (see section 7.10, pp.291-292). The researcher also provided regular updates on the progress of the research to the university ethics committee and the research governance bodies at the clinical research site.

5.6.2 Description of the main research site and the wider research context

The main research site is a 700-bed district general hospital in the South of England which includes 210 medical beds, and 86 beds for elderly care and stroke rehabilitation. In 1999 the hospital had a catchment population of approximately 365,000 and there were 32,348 adult admissions (Hodgetts, Kenward et al., 2002a). There was considerable local interest in the prediction of critical illness and cardiac arrest. At the time of ethics approval a research project to investigate In-Hospital Cardiac Arrest Prevention led by a Professor of Emergency Medicine and Trauma was in progress at the main research site (Hodgetts, et al., 2002a). The In-Hospital Cardiac Arrest Project established Medical Emergency Team Calling Criteria based on an analysis of medical notes of patients who had developed in-hospital cardiac arrest over a 12-month period compared to a control group who did not experience cardiac arrest (Hodgetts, et al., 2002b). This process resulted in the identification of activation criteria for a Medical Emergency Team including objective measures and the subjective cues of shortness of breath, acute abdominal pain, chest pain, GCS (Glasgow Coma Score) and nurse concern. Hodgetts et al., (2002b) found nurse concern to be a significant predictor of cardiac arrest.

The current study was designed to further investigate the information clinicians draw on when they make the judgement that they are concerned about a patient and predict critical illness or cardiac arrest. A preliminary review of case notes of the cardiac arrest cases included in the Hodgetts et al., (2002b) study was undertaken by the researcher in January and February 2001 and established that more subtle clinical information (i.e. information other than objective measures) was not well documented by nurses. Documentary analysis was ruled out as a viable method for cue identification. The researcher concluded that a qualitative interview study would be required to elicit the cues considered important in clinical judgements. Feinstein
(1987) comments that clinicians may initially believe that the cues they use to judge a patient's condition are too intuitive to be externalised, but upon further questioning they may be able to dissect these intuitive judgements and report the cues that contributed to their judgement.

The care of critically ill patients had become a national issue with the publication of the Audit Commission report (1999) Critical to Success and the Department of Health report (DH, 2000) Comprehensive Critical Care. The latter called for the creation of critical care networks across geographical areas to plan and implement improvements in critical care services at trust level (DH, 2000). Also with the publication of the Nursing Contribution to the Provision of Comprehensive Critical Care for Adults (DH, 2001) a detailed plan emerged for nursing initiatives required to support critical care services nationally, particularly the implementation of early warning systems and critical care outreach services.

Following the completion of the MET research project a critical care outreach team was launched in Spring 2002 at the clinical site used in the current research. Critical care outreach team clinicians were not in post at the time data collection commenced for the current study. The critical care outreach team was introduced to complement the work of the MET. As soon as a MET score of four is recorded (Appendix 17) clinical staff are instructed to refer patients to the critical care outreach team. Following an initial trial in medical wards the service was extended to surgical wards and went Trust wide after six months. Currently the critical care outreach team receives between 600-800 referrals a year excluding follow up of ICU patients or multiple visits to the same patients (by including these multiple visits, the total would exceed 1500). Follow up visits to former ICU patients who have returned to the ward total approximately 600. A programme of staff training accompanied the introduction of the critical care outreach service across the hospital departments and this is ongoing (personal communication with a critical care outreach charge nurse, March, 2004).
Medical emergency or early warning scores had recently been introduced within the three NHS Trusts represented by the clinicians accessed at the university research site. In addition two surgical nurses from the private sector were undertaking a high dependency nursing course in preparation for new high dependency facilities and were also included in the sample.

5.6.3 Ethical issues

The research proposal outlined the research design and addressed ethical issues. Murphy *et al.*, (1998) highlight three analytical levels at which the ethics of research could be considered, the most abstract being the distinction between *utilitarian or consequentialist ethics*, and *deontological or Kantian ethics*. In the former, research would be justified if the benefits outweighed potential harmful effects, and in the latter, consequences are not sufficient to justify research, the process and how people are treated must be judged acceptable. The next level refers to Beauchamp and colleagues' ethical principles of autonomy or self-determination, nonmaleficence, beneficence and justice (Murphy *et al.*, 1998). The principle of autonomy refers to the requirement to respect other people's values and choices. The principle of nonmaleficence states that it is wrong to intend to harm another person, beneficence requires a commitment to remove anything harmful and to extend benefits to others, and the justice principle requires that all should be treated equally. At the third level, principles are put into practice in research guidelines using the principles of informed consent, confidentiality, the rights and welfare or research subjects, and that benefits should outweigh the risks for subjects (Murphy *et al.*, 1998; Smith, 1975).

The research detailed the process for establishing informed consent by describing how research participants would be recruited, how their informed consent to participate would be elicited, and how participants' subsequent consent to use data collected in interviews would be gained. The principle of confidentiality addressed how anonymity of participants and confidentiality of information about clinicians and patients would be maintained. The Medical Research Council ethics principles (MRC, 2000) were also upheld in this study. Assigning a number to each informant
and ensuring that references to their names were removed from the interview transcripts protected anonymity and confidentiality. Patients’ names were not recorded and raw data from interviews used to illustrate points were selected on the basis that they illustrated typical rather than memorable cases to preserve patient anonymity and confidentiality. The rights and welfare of subjects is a particular concern in qualitative research as findings are published (Murphy et al., 1998). The research addressed this through the earlier member checking of a sample of interview transcripts and rigorous attention to how results were reported so that individuals remained anonymous and that themes and issues were debated rather than personal perspectives. The rationale for the study also identified the likely benefits of the research. Particular issues arising in the ethics of qualitative interviewing are discussed later in section 6.3.3, pp. 205-206.

Having situated the study within the local and national contexts, and outlined the ethical considerations, the next section discusses the process used to identify the study sample in the empirical study.

5.6.4 Sampling decisions

A statistical approach to sample selection was discounted because the researcher considered that this would miss many of the informants who could contribute most to the research, and identify others who were not interested or were unwilling to participate in interviews. A purposive sampling (Patton 2002, p.230) approach was therefore used in the current study.

The aim was to select informants who would be rich sources of information on cues used in judgements of patient condition in critical illness and cardiac arrest in general medical ward patients and in contrasting groups of patients. The inclusion of the latter groups assisted in beginning to define the boundaries for the theory. Miles and Huberman (1994) advocate the search for outlying cases to gauge whether the main patterns are found in other settings. The sample therefore comprised experienced general medical nurses across a range of medical wards (cardiac, respiratory,
neurology/ stroke unit, haematology, elderly care, and the medical acute admission unit) and other contrasting groups of clinicians, including coronary care, critical care and surgical ward nurses. Participants were recruited from various levels in the nursing hierarchy and included staff nurse, sister and senior sister levels (grades E to G).

Within the purposive sample a *theory based or theoretical sampling approach* was followed (Miles & Huberman, 1994; Murphy *et al.*, 1998; Patton, 2002). There is some confusion in the literature about the definition of *theoretical sampling* but it is helpful to identify two separate approaches within this overall sampling strategy.

The first approach, and the one adopted in the current study sees *theoretical sampling* in general terms (Murphy *et al.*, 1998). Participants are included because the researcher considers they are relevant to the research question, theoretical perspective, analytical approach, and above all to the eventual account or explanation (Mason, 1996). The concern is to obtain a sample which will assist with testing theory, and providing explanations (Mason, 1996).

A theory developed before data collection was used to guide the selection of participants (section 2.2, p.17). A sampling framework identified potential research participants and within that the events, outcomes, and processes that were appropriate to the study's purpose. The *study group* or *case* comprised clinicians involved in judging patients' conditions in transition states from acute to critical illness or cardiac arrest with a particular focus on medical patients. The events to be focused on were cardiac arrest or critical illness cases and these were to be compared with non cardiac arrest or critical illness cases (to include vulnerable to critical illness or cardiac arrest, acute illness, chronic illness, palliative or terminally ill cases). The patient outcomes were: survived, died or transferred to another unit, outcomes that were frequently cited in the systematic review papers reported earlier (chapter 4). Finally, the process to be studied was clinical judgement particularly the cues considered important in
judgements of patient condition and if clinicians' judgements were reported to be accurate by comparing these to the reported patient outcome.

Informants were therefore selected *purposely* on the basis that they represented the views of clinicians' in medical and contrasting contexts and could contribute information on the research topic. Clinicians were also selected *theoretically* in medical contexts, and in surgical and critical care contexts to examine the conditions in which the research thesis applied (Murphy et al., 1998). The research thesis being that:

*Experienced clinicians frequently make accurate predictions of critical illness and cardiac arrest using cues that are present before measurable indicators of physiological deterioration are evident.*

It was anticipated that critical care nurses would have a different perspective than general ward nurses because most of their patients would already be defined as critically ill by their admission to critical care.

In the second approach *theoretical sampling* is viewed as synonymous with the “progressive theoretical sampling” of grounded theory research (Murphy et al., 1998). Glaser and Strauss (1967) define *theoretical sampling* as a process of data collection where the researcher concurrently gathers, codes and analyses data and then decides what further data should be collected to build up the theory that is becoming apparent. Theoretical sampling is thus sampling for the purpose of developing theory and specifying conceptual categories rather than sampling to achieve a representative sample (Charmaz, 2003).

In both of the approaches to theoretical sampling described above case sampling should be *theoretically driven*; either with theory identified before data collection as in the current study, or developed during the research as in grounded theory approaches (Miles & Huberman, 1994). In both approaches sampling is *iterative* and proceeds in a cyclical way as the researcher seeks out people and situations in an attempt to answer the research questions (Miles & Huberman, 1994).
Information about the study was forwarded for distribution at ward level to the medical wards and to surgical wards at the clinical site, and to two separate cohorts of nurses undertaking a critical care/high dependency module at the university. A letter of introduction asked those who were interested in participating to respond in writing providing their contact details (Appendix 16). The researcher then made contact with participants that had declared an interest in the study.

The majority of interviews took place at the clinical site. However nurses were also accessed at the university for two main reasons. Firstly it proved difficult to access surgical ward nurses at the clinical site where nurses reported staffing difficulties during the period of data collection. Secondly, it was not possible to access intensive care unit staff at the clinical site due to major re-organisation of the unit. However the biographical data for the study sample indicate that nurses accessed at the clinical and university sites were broadly similar in demographic characteristics and years of work experience (see Tables 19 & 20, pp. 172-173). Data collection occurred mainly during a four month period in 2001 and a further five interviews were conducted following preliminary data analysis.

5.6.5 Criteria for inclusion of participants

Participants were recruited to the study if they met the following criteria:

1. At least three years experience since initial nurse registration. Nurses with at least three years of experience would have been exposed to the events that were the focus of the study, and it was expected that they would be able to recount these experiences to the researcher.

2. Currently working in an acute hospital ward or critical care area. Accident and emergency nurses were not included due to the limited resources of the current study.

A number of reasons were cited by clinicians that declined to participate. Some were unwilling to participate in a research interview. The nurses, who were eligible to participate but decided not to do so, were thanked for their time. Surprisingly those
who volunteered reported that they were not unduly concerned about the use of a tape-recorder, but this may have been a factor that dissuaded others from volunteering. A future study could make it clear that the researcher could take notes during the interview rather than use a tape-recorder, and this might increase the number of volunteers. However, the use of a tape-recorder can contribute to the reliability and validity of data. Tape recordings provide data than can be verified by a second researcher. They can minimise the potential for information loss that can occur during note taking (provided that the equipment is fully functioning), and they may enhance the interview dynamics because the interviewer can focus on listening carefully to responses and posing questions.

**Table 19: Interview study participants- summary of biographical data, n = 32**

<table>
<thead>
<tr>
<th></th>
<th>Senior Sister (number)</th>
<th>Sister F Grade (number)</th>
<th>Staff Nurse E Grade (number)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>7</td>
<td>17</td>
<td>29</td>
</tr>
<tr>
<td>Male</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Age ranges frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>40-49</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>50-59</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total age range median</td>
<td></td>
<td></td>
<td></td>
<td>30-39</td>
</tr>
<tr>
<td>Critical care experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>11 nurses had critical care experience. Range 18 mths-20yrs</td>
</tr>
<tr>
<td>Years experience since qualification range</td>
<td>8-18yrs</td>
<td>8-28yrs</td>
<td>3-27yrs</td>
<td>3-28yrs</td>
</tr>
<tr>
<td>Mean length of time since qualification</td>
<td>12yrs</td>
<td>18yrs</td>
<td>11yrs</td>
<td>12yrs</td>
</tr>
<tr>
<td>Length of time in current speciality range</td>
<td>2-11yrs</td>
<td>3-11yrs</td>
<td>3-20yrs</td>
<td>2-20yrs</td>
</tr>
<tr>
<td>Mean length of time in current speciality</td>
<td>6yrs</td>
<td>8yrs</td>
<td>6yrs</td>
<td>6yrs</td>
</tr>
</tbody>
</table>
Thirty-two nurses volunteered to take part in the study. The sample comprised nineteen clinicians from a range of general medical wards, the main focus of the study, contrasting groups were from general surgery, surgical high dependency and recovery ward (eight clinicians), and critical care (intensive care and mixed medical and surgical high dependency, and coronary care) (five clinicians). The majority of informants were interviewed in their own time at the end of their period of duty, or during a lunch break. Five were graduate nurses, and 27 participants were educated to diploma or certificate level. Five participants also held post registration qualifications in coronary care, intensive care, or elderly care nursing. Although the study sample appeared typical according to the age ranges and levels of experience of informants included, it is not known how representative this sample was of the population studied.

Table 20: Comparison of clinicians accessed at clinical and university sites, n = 32

<table>
<thead>
<tr>
<th></th>
<th>Accessed at clinical site</th>
<th>Accessed at university site</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female</td>
<td>22</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td>male</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Age range</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-29yrs</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>30-39yrs</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>40-49yrs</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>50-59yrs</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Median age range</strong></td>
<td>30-39yrs</td>
<td>30-39yrs</td>
<td>30-39yrs</td>
</tr>
<tr>
<td><strong>Years experience since qualification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>3-28yrs</td>
<td>3-27yrs</td>
<td>3-28yrs</td>
</tr>
<tr>
<td>mean</td>
<td>12yrs</td>
<td>11yrs</td>
<td>12yrs</td>
</tr>
<tr>
<td><strong>Length of time in speciality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>2-11yrs</td>
<td>3-20yrs</td>
<td>2-20yrs</td>
</tr>
<tr>
<td>mean</td>
<td>6yrs</td>
<td>7yrs</td>
<td>6yrs</td>
</tr>
<tr>
<td><strong>Critical care experience - frequency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>

Key- Critical care experience includes intensive care, high dependency or coronary care.
Clinical cases reported by clinicians were categorised according to the main medical condition or body system affected, Table 21. In 59 / 109 cases one main medical condition/ body system disorder contributed to the patient’s clinical outcome-state. Two or more medical conditions/ body system disorders contributed to the clinical outcome-state in 49 cases. In one case the patient’s medical condition/ body system disorder was unknown but the patient subsequently suffered a cardiac arrest.

Table 21: The main medical conditions for patient cases, n = 109.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>59</td>
</tr>
<tr>
<td>Female</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total number cases</strong></td>
<td><strong>109</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical condition / body system affected</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>1</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>2</td>
</tr>
<tr>
<td>Haematologic</td>
<td>7</td>
</tr>
<tr>
<td>Post-operative</td>
<td>17</td>
</tr>
<tr>
<td>Sepsis</td>
<td>12</td>
</tr>
<tr>
<td>Malignancy</td>
<td>11</td>
</tr>
<tr>
<td>Metabolic</td>
<td>5</td>
</tr>
<tr>
<td>Immune</td>
<td>2</td>
</tr>
<tr>
<td>Renal</td>
<td>3</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>13</td>
</tr>
<tr>
<td>Neurologic</td>
<td>9</td>
</tr>
<tr>
<td>Respiratory</td>
<td>32</td>
</tr>
<tr>
<td>Cardiac/cardiovasc.</td>
<td>44</td>
</tr>
<tr>
<td>Condition not reported</td>
<td>1</td>
</tr>
</tbody>
</table>

Cases were also categorised according to the clinical outcome-state, which was defined as the most serious clinical state of the patient during the event/ situation described by clinicians. These states were cardiac arrest, critical illness, acute illness and vulnerable to deterioration, acute illness, chronic illness and terminal illness/ palliative care. The definitions used for cardiac arrest and critical illness can be found in section 4.6, p.69. Acute illness refers to patients with an illness where signs and symptoms have a rapid onset, the condition can be severe, and normal function can be impaired (Mosby's Medical Nursing & Allied Health Dictionary, 2002). Acute illness
and vulnerable to deterioration refers to patients with acute illness also judged to be at risk of physiological instability, critical illness or cardiac arrest. Chronic illness is defined as an illness that is ongoing and may affect the patient's physical, psychological, social or spiritual functioning. Chronic illness may co-occur with the other categories of illness. Terminal illness or palliative cases refers to patients with advanced diseases where there is no potential for recovery or cure. Patients in the latter category could also be critically ill but these cases differ from other critical illness cases because there is no potential for recovery. The total number of critical illness and cardiac arrest cases, compared to non-critical illness or cardiac arrest cases, and the location of interviews at the clinical or university site, are shown in Table 22.

**Table 22:** Total number of cases for clinical outcome states (according to location of interview as clinical site or university site), n= 109

<table>
<thead>
<tr>
<th>Patient cases by outcome states</th>
<th>Critical illness and cardiac arrest cases</th>
<th>Acute illness and vulnerable to deterioration, acute, chronic or terminal illnesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical site</td>
<td>58</td>
<td>36</td>
</tr>
<tr>
<td>University site</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Total number of cases</td>
<td>69</td>
<td>40</td>
</tr>
</tbody>
</table>

5.6.6 Data collection methods

It is through research data collection methods that research questions are investigated. Maxwell (1996) stresses the importance of finding the method that will be the best and most productive in the particular setting. The current research comprises two separate studies; the systematic review identifies the cues reported in the research literature, whereas the empirical study using semi-structured qualitative interviews asks clinicians about the cues that they consider important. It is acknowledged that participant observation could have been used as a further source of data but this would have required many hours of observation to pick up a sufficient number of incidents of deterioration to critical illness/cardiac arrest. Interviews remain the primary way to access the cues considered important, the focus here. At an early
stage the interview questions were pilot tested to check that they were suitable for accessing the information required. The use of interviews as a method of data collection will be discussed further in the chapter on research methods (chapter 6).

5.7 Data analysis
The data analysis procedures for the systematic review and qualitative interview study are reported in detail in chapters four and six respectively. An overview of the data analysis strategies is provided here. The systematic review used quantitative content analysis/ tabular approaches and narrative approaches in the analysis and synthesis of research evidence. A computerised database package *FileMaker Pro* 5 supported the content analysis of review papers for predictor cues. Narrative synthesis methods were used for the qualitative papers included in the review.

The analysis of qualitative interview data was accomplished using qualitative content analysis comprising a combination of coding and categorising analysis and contextualising analysis (Maxwell, 1996). According to Maxwell categorising refers to the coding of data and development of categories with comparisons being made within and across the categories; this is a common technique in qualitative research. The purpose is to establish theoretical concepts or themes drawing on existing theory and views from the research participants (Maxwell, 1996). Contextualising analysis represents an alternative approach where data are analysed within context. However adherence to a contextualising approach alone would limit the potential for theoretical understanding (Maxwell, 1996).

The interview data were coded using a coding scheme that was initially developed through the systematic review and subsequently modified in the light of the interview data. To facilitate the coding process a computerised data analysis package QSR NUD*IST* 4 (Qualitative solutions and research Pty Ltd., 1997) was used. A contextualising process was also required to answer the research questions that were concerned with whether single cues or combinations of cues were considered.
important in particular cases and the time relationships between different types of cues and clinical events. The researcher was particularly interested in the cues considered early predictors of critical illness or cardiac arrest; the analysis therefore had to focus on temporal dimensions of clinical judgements and when different cues were considered important. For this phase in analysis NU*DIST 4 was found to be less useful; its strengths lie within the categorising perspective. Various matrices and tables were developed to assist in the display of information so that any trends in data could be discerned.

5.8 Assessing quality in research

The quality strategy involved consideration of the quality criteria of validity, reliability and generalisability across both studies. The quality issues relating to study one (systematic review) were discussed earlier (sections 4.10.3 & 4.10.4, pp. 83-85).

The empirical study to be reported in chapters six and seven adopted qualitative interviewing methods. The application of quality criteria to qualitative research has been much debated. An important factor in this debate is the range of philosophical perspectives that underpin qualitative research and how this impacts on quality criteria. Approaches can be broadly categorised as those advocating alternatives to the traditional scientific criteria for qualitative research, and those applying traditional criteria from quantitative research to qualitative research (Murphy et al., 1998). Regardless of the perspective adopted qualitative researchers need to be concerned with the quality, trustworthiness and authenticity of conclusions (Miles & Huberman, 1994). Whilst some researchers oppose the application of positivist research quality criteria to qualitative research Seale (1999) argues they can stimulate thinking about methodology. The terms of validity, reliability and generalisability are now defined and implications for the current research are addressed.
5.8.1 Validity

Validity is concerned with how well an indicator measures the concept of interest (Fielding & Gilbert, 2000). Mason (1996, p.24) presents a definition of validity that mirrors the traditional research perspective where validity refers to "observing, identifying, or measuring what you say you are". Working within the traditional positivist approach to validity LeCompte and Goetz (1982, p.43) state that "validity necessitates demonstration that the propositions generated, refined or tested match the causal conditions which obtain in human life".

Lincoln and Guba (1985) reject the positivist criterion of validity and a single reality, and instead present the idea of many realities that are constructed by the mind. Lincoln and Guba argue that trustworthiness of findings and conclusions should be addressed by demonstrating their credibility. Lincoln and Guba (1985) refer to a range of methods to enhance the credibility of findings including prolonged engagement and negative case analysis before the ultimate member-checking test.

Hammersley (1992, p.69) adopts a subtle realist position and defines a valid or true account as one that "represents accurately those features of the phenomena that it is intended to describe, explain or theorise". The validity of findings and conclusions is determined by how convincing the evidence is to support them (Hammersley, 1992). According to Hammersley (1992) three considerations guide the assessment of this evidence. Firstly, the concern is with how plausible and credible the claims are, based on current knowledge. Secondly, the amount and strength of evidence supplied should be related to how important the claim is, if it is of major or minor importance; and thirdly, the type of claim is important, whether the aim is description or explanation (Hammersley, 1992). Examining claims that describe phenomena requires demonstration that the categories used fit the data and that categorisation is accurate, basically showing that the claims are consistent with the empirical data (Hammersley, 1992). In both the systematic review and the empirical study the aim was to describe phenomena and to show that the categories applied to data were suitable and that the procedure was carried out correctly and consistently.
According to Kvale (1996) validity should be concerned with how well the propositions made stand up to attempts to falsify them rather than the more traditional view where validity refers to how well an objective reality has been portrayed. Kvale (1996) refers to Miles and Huberman (1994) to make the point that the quality of the research work and how the investigator engaged in “checking, questioning, and theoretically interpreting the findings” become the important issues.

Murphy et al., (1998) list five principles for judging the validity of research findings. These include the provision of clear accounts of the method of data collection, the process of data analysis, how the researcher’s presence affected the data collected and how the findings were affected by the research process, termed reflexivity. Two further approaches concern how negative cases were addressed, and how fair dealing or getting the views of individuals from different levels in the organisation was undertaken to minimise the threat of elitism (Murphy et al., 1998). Negative cases are reported in chapters six and seven, and clinicians from different levels in the nursing hierarchy were included in the study sample. An audit trail is provided through the data collection and analysis phases of the research. Although the generation of the audit trail can be time-consuming (Bryman, 2001), this was considered an appropriate way to demonstrate the generation of findings in the current research.

5.8.2 Reliability

From the traditional quantitative perspective reliability refers to the repeatability of the results of a study (Bryman, 2001). Mason (1996, p.24) adopts the traditional quantitative approach to reliability within qualitative research stating that “reliability involves the accuracy of your research methods and techniques. How reliably and accurately do they produce data?”. LeCompte and Goetz (1982) define reliability as “the extent to which studies can be replicated”, but state that this is an enormous task for researchers who study behaviour in natural settings, or one-off phenomena. Precise replication of natural settings is impossible, and human behaviour is prone to change (LeCompte & Goetz, 1982). Qualitative research often focuses on dynamic situations, making the stability dimension of reliability difficulty (Murphy et al.,
1998). By differentiating between internal reliability and external reliability LeCompte and Goetz (1982) make the task of examining reliability more manageable. Internal reliability refers to the extent to which multiple observers in one study agree, or the degree of agreement in coding between the researcher and another person that checks codes the same batch of data. External reliability is more problematic as it refers to the replicability of a study (LeCompte & Goetz, 1982) or the extent to which another researcher working in the same or similar situation would find similar concepts or identify the same phenomena (Murphy et al., 1998).

In contrast to the traditional view of reliability Lincoln and Guba (1985) and Guba and Lincoln (1994) from the constructivist perspective formulated the quality criteria of trustworthiness and authenticity. Dependability is one of the criteria within trustworthiness and it is described as a parallel concept to reliability. Basically the researcher auditing the research and publishing an audit trail lets others judge the quality of the research.

5.8.3 Generalisability or external validity

External validity refers to “the degree to which findings can be generalised across social settings” (Bryman, 2001,p. 272). Advocates of traditional criteria for qualitative research argue that more attention should be paid to external validity (LeCompte & Goetz, 1982).

In contrast, Lincoln and Guba (1985) operating from the assumption that reality is always constructed in the mind argue that external validity is problematic if many different versions of reality exist. Instead they present the less stringent goal of transferability where findings could be extended to other similar situations and the assessment of transferability is not the original researchers’ responsibility, but that of the readers’ of the research report (Lincoln & Guba, 1985). Within the original research enough detail should be provided to enable readers to assess how similar the research context is to any other setting to which the findings might be generalised (Lincoln & Guba, 1985).
Hammersley (1992) refers to two different forms of generalisation, \textit{empirical generalisation and theoretical inference}. Statistical sampling is used infrequently in qualitative research but arguably should be used more; however, the small number of settings that can be studied, compared to the total number of settings to which generalisations are sought, is usually too small for probability sampling (Hammersley, 1992; Murphy et al., 1998). Even quantitative researchers rarely use the strongest type of probability sampling, opting for techniques such as \textit{stratified random sampling} (Hammersley, 1992). \textit{Empirical generalisability} in qualitative research involves making judgements about how representative the findings from a particular setting are to a wider population (Hammersley, 1992). To make this judgement Hammersley (1992) advocates drawing on published statistical data to assess the similarity of the study setting and the site to which generalisation is sought. A second strategy to promote generalisation of findings could be to use survey data within the same project to collect data not available elsewhere. Thirdly a series of studies could investigate a particular phenomenon perhaps employing stratified random sampling of cases (Hammersley, 1992; Murphy et al., 1998).

The \textit{theoretical inference} approach to generalisation refers to the researcher’s application of theory to observations and descriptions of events (Hammersley, 1992). Bryman (1988) highlights the importance of qualitative research findings being linked to a theoretical context; thus generalisability is construed in terms of links to theory rather than to populations. Mason (1996) states that theoretical generalisations could be made on the basis of purposive and theoretical sampling.

The empirical study adopts Miles and Huberman’s (1994) approach to assessing quality based on a critical realist perspective and blends the traditional research criteria of validity, reliability and generalisability, with their approximations in \textit{naturalistic} research. Thus the following discussion centres on the five issues of \textit{internal validity/credibility/authenticity; objectivity/confirmability; reliability/dependability/auditability; external validity/transferability/fittingness, and}
utilization/appication/action orientation (Miles & Huberman, 1994, p. 277). Within each category Miles and Huberman (1994) pose questions to assist in the judgement of quality—how the current study approached the issues are then summarised.

5.9 Internal validity/credibility/authenticity
This refers to how believable the findings of a study are, and how truthful the research has been. Interviewing is viewed as a suitable method for obtaining respondents’ perspectives rather than a literal report of an external reality (Murphy et al., 1998). Interview data need to be interpreted with reference to the context in which they were obtained (Murphy et al., 1998). From a realist perspective interview data are used to develop and check out ideas about the essential qualities of the phenomenon, but the interview data are fallible and so the potential threats to validity need to be made explicit (Wengraf, 2001).

Interviewing was considered an appropriate method to use in the current study because the data could not be accessed in any other way (Mason, 1996), observation would be unlikely to reveal the cues clinicians considered important as these are more cognitive than directly observable cues. The completion of an extensive systematic review of predictor cues for critical illness or cardiac arrest (study 1) identified mainly objective and measurable cues, whereas the empirical study (study 2) reported the cues’ clinicians considered important contributing to the validity of the overall cue identification process. Participant observation could be used in a future prospective study to cross check clinicians accounts of cues with actual patient cases providing a check on the study’s internal validity. As critical illness and cardiac arrest events occur infrequently this approach was not considered feasible for the researcher in the current study as many hours of observation would be required to capture a small number of cases. The semi-structured qualitative interview approach enabled informants to participate actively and encouraged them to contribute without the constraints of a pre-structured set of questions. It was hoped this would lead to a more in-depth representation of their views (Mason, 1996).
Data collection commenced around the time the Medical Emergency Team (MET) score was introduced at the main research site. This could have made clinicians more likely to report the cues included in the MET criteria. However this did not seem to be a problem in the current study. Whilst many clinicians had been exposed to the MET criteria this did not prevent them from mentioning the range of cues they considered important in their judgements.

The potential for the researcher to induce alterations in behaviour was minimised by clearly explaining the purpose of the study, why interviews were being used, and how information would be analysed and communicated to informants (Miles & Huberman, 1994). Interviews were held in the most appropriate location available, usually the ward manager's office. Some interviews took place away from the clinical environment so that the informants could feel more relaxed at the end of a clinical shift. In all cases the researcher was alone with informants and both were generally free from other distractions. The research questions/ interview guide was referred to during the interviews to avoid excessive digression from the main topics. By purposively sampling on a range of characteristics such as location, position in the organisational hierarchy, gender, and nationality, a comprehensive range of informants was included. There was an active search to recruit to the more thinly sampled types of cases. It was not feasible to include random sampling at any stage in the study.

Maxwell (2002) documents different types of validity from the perspective of critical realism, as descriptive, interpretive, theoretical and evaluative validity. Descriptive validity refers to the requirement for accurate description of accounts as the basis for all other types of validity. For example in the current study this would refer to the accuracy of interview transcriptions, and the member checking process used whereby 25% (8) participants were given copies of the interview transcript and were asked to comment if this was an accurate record of the discussion. All participants reported that the account was accurate and some supplied additional information relating to the
cases such as a patient diagnosis or type of treatment. Any information received was catalogued and used in subsequent data analysis.

*Interpretive validity* focuses on the *meaning* of things to research participants and the researcher *constructs* participants' meanings from the evidence available including verbal accounts (Maxwell, 2002). Extracts of informants' accounts and the researcher's interpretations have been included in the current chapter and in the results chapter, so that readers can judge their validity. During interviews the researcher also checked the meaning of accounts by summarising comments and reflecting these back to participants asking if the interpretation was correct. Researchers have a major responsibility to present informants' perspectives without distorting the information to confirm their own position.

To add to the trustworthiness of conclusions the researcher actively pursued *confirming, negative, contrasting and typical cases* within the interviews (Miles & Huberman, 1994). Examples of these are reported in the methods chapter (chapter 6).

In the early stages of data collection the data were examined for any discernible patterns, and as data collection progressed, the search identified *confirming cases*. Ideas were *tested*; emerging patterns were closely scrutinised, and subjected to further testing in the subsequent interviews as described by Patton (2002).

*Negative or disconfirming cases* are extremely important as they may suggest alternative interpretations, or demarcate findings that are supported (Patton, 2002). In this research *negative cases* include those where the patient did not go on to critical illness, cardiac arrest, or acute illness and vulnerable to deterioration and cases where subjective or behavioural cues were not considered important in judgements of critical illness or cardiac arrest.

*Contrast cases* in the current study refers cases in non-general medical areas that were used to test whether the findings in general medical cases also apply elsewhere.
Critical cases were also actively sought (Miles & Huberman, 1994); these were the strongest exemplar cases where the clinicians reported subjective or behavioural cues to be important early predictors of critical illness or cardiac arrest.

Typical cases are those that add weight to the conclusions, the cases that indicate general trends in support of the conclusions (Miles & Huberman, 1994).

Theoretical validity refers to an account’s performance as a theoretical explanation of a phenomenon (Maxwell, 2002). The conceptual and theoretical frameworks for the current study drew on a broad conceptualisation of severity of illness, critical illness and the cue identification phase of judgement analysis, as outlined earlier (chapters 2 and 3). These were used to present and discuss the study findings in chapter 7. Attempts to falsify the research hypothesis are important tests of the research thesis. Negative evidence for the research thesis was actively sought and this evidence is presented in chapter 7. Finally, the results were circulated to as many of the original informants as possible - it was not possible to circulate results to all participants as some had moved - comments were invited, and these are reported in chapter 7.

Other tactics used to confirm findings and support the claims being made might include the use of multiple sources to triangulate on the findings (Miles & Huberman, 1994). Types of triangulation include the use of different methods, various types of data, different investigators, and or theoretical triangulation (Denzin, 1970). Debate surrounds whether triangulation is a way to check validity. Triangulation in surveying involves plotting one’s position by taking bearings from two landmarks and seeing where lines from the two intersect. Using this analogy a triangulated study would seek to converge on a single reality (Seale, 1999) but some argue that there are multiple realities, and convergence on one is inappropriate (Murphy et al., 1998). Seale (1999) also discusses a philosophical objection to triangulation wherein a range of methods may all lead to the same conclusion but there is no guarantee that they are all correct. Nevertheless if used within the context
of qualitative research being fallible, triangulation can assist in the development of plausible descriptions (Seale, 1999). The decision to use triangulation or not, may in the end be decided by the resources available in terms of time and expertise (Murphy et al., 1998); triangulated studies are likely to require much of both.

Other research approaches were considered during planning for the current study. An interview study rather than participant observation was undertaken for a variety of reasons as highlighted by Bryman (2001). Firstly, the topic studied was not fully accessible to observation. The focus was on the cues that clinicians considered important and these were accessed via verbal descriptions; for example an observer could miss subjective cues. Secondly, the informants were asked to reconstruct events and so interviews would still be required. Thirdly, the ethical considerations for participant observation were problematic as these would involve negotiation of informed consent from the critically ill patient and from the clinicians whose attention would quite rightly be on the delivery of appropriate care. Around the time of data collection there was considerable national publicity about deficits in the care of the critically ill (McGloin et al., 1999; McQuillan et al., 1998). It was thought that clinicians would be uneasy about an external person observing their practice using participant observation, this was deemed too intrusive for the clinicians (Bryman, 2001). Since then the developments in critical care practice and establishment of critical care outreach teams to support ward staff may make participant observation in practice less problematic. Fourthly, the events of critical illness and cardiac arrest tend to be infrequent; prolonged periods in the field would be required to sample sufficient instances within a participant observation study. The researcher had time constraints within data collection and clinicians similarly had limited time to engage in a prolonged participant observation study. Fortunately clinicians and examples of cases could readily be accessed via interviews. The current study sample comprised informants from a range of medical wards, and from different specialities both within the main hospital site and at the university. Written guidelines on Medical Emergency Calling Criteria were also collected from the research site.
Murphy et al., (1998) consider the use of respondent validation or member checking as a test of validity. The first problem is that the purposes of the researcher and respondent are likely to differ, resulting in contrasting but valid accounts. A further problem is that respondents may not have read the research critically enough to comment. Data collected in interviews may not represent the participants’ actual beliefs. There may be a desire to protect a relationship or avoid disagreement, and bias can occur as participants consider the positive or negative connotations of the research conclusions for the organisation (Murphy et al., 1998). However member checking or respondent validation can be used as a way of minimising error, and reassuring participants that they will be able to feedback on findings before their publication which could be important in sensitive situations (Murphy et al., 1998). The member validation method used in the current study involved the circulation of the results chapter to research participants and their responses were collated so that evidence for claims could be assessed (section 7.10, pp. 291-292). Seale (1999) argues that this represents a strong approach to member validation.

5.10 Objectivity/confirmability
This issue refers to conclusions being independent of the researcher, or the study’s external reliability, and that another researcher replicating the study would arrive at similar conclusions (Miles & Huberman, 1994).

These factors are addressed as follows: The methods employed in the research and stages leading up to the study findings and conclusions are documented. Indicators of the researcher’s impartiality are given in the audit trail where extracts of data are presented at each stage of the data collection and analysis processes. Conclusions are supported with summaries and displays of data (chapter 7). Alternative hypotheses were considered at an early stage in data analysis. For example the hypothesis that objective cues were early predictors of critical illness and cardiac arrest. Frequency counts of cues and the time sequence in which they were reported to occur
demonstrated that objective cues were sometimes considered more important than subjective cues.

The possibility of a rival conclusion was also considered – for example clinicians could have been using cues that they had not reported. If no pattern had emerged for the types of cues considered important this would have suggested that other cues were being used by clinicians.

The availability of raw data such as taped interviews can enhance claims to confirmability. Tape recordings were retained for the duration of the study. However, a condition of ethics approval was that tape recordings would be destroyed at the end of the study, defined as the period immediately after formal examination of the thesis.

Some participants at the main hospital site had met the researcher previously in the role of teacher on courses, clinical liaison visits or during clinical teaching sessions with student nurses; this could have had positive or negative effects on the research. Some participants may have chosen not to take part in the study if they felt a teacher was examining them. However others did volunteer, and the researcher’s teaching role did not dissuade them from participating. Participants who had met the researcher in a teaching capacity provided as detailed interview accounts as their counterparts who had not.

5.11 Reliability/Dependability/Auditability

This concerns consistency in the conduct of the study and how reliable the researcher and the methods have been. A clear statement of the research perspective, theoretical framework, research problem and the rationale for the choice of design was given so that a reader could judge the suitability of the approach. The researcher’s role within the current study was explained to potential participants in the letter of introduction and again as the interview commenced (Appendix 16). The rationale behind data collection was described with informants representing general medicine, surgery, and
critical care areas. This range of settings was considered appropriate to address the research questions, although a future study could also include accident and emergency areas.

Data collection quality checks were performed where possible. On two occasions two sets of informants were interviewed and referred to the same cases; their accounts were similar. Interviews 28 case 2 and 29 case 4 both referred to a male patient with chronic pleural effusions who eventually required a MET call and admission to ICU for acute respiratory distress. There was a time interval of two to three days between these reports during which the patient’s condition deteriorated but the account details were consistent. Interviews 27 case 1 and 30 case 2 reported on a post-gastrectomy patient who returned to the general ward following post-operative recovery in HDU. The two accounts of the patient receiving blood transfusions for anaemia, the subsequent fluid overload, referrals to the anaesthetist and eventual MET call leading to emergency ICU admission were consistent.

The researcher did not crosscheck the original case notes of patients against the information recounted in the interviews; many of the cases reported were former patients. Whilst clinicians’ remembered clinical details, patient identification information would have been more difficult to establish. A future study could follow up cases as they happen, in which case it may be possible to obtain patient consent to access medical and nursing notes to crosscheck the various sources of data.

A professional transcriber prepared 16 of the 32 interview transcripts using a checklist with the researcher’s requirements listed; the researcher transcribed the remainder. Both sets of transcriptions were checked for accuracy by the researcher listening to the interview tapes on at least two occasions and correcting where necessary.

To assess the amount of confidence that can be placed in the results obtained it is necessary to examine the reliability of the coding scheme. Intra-rater reliability
refers to how consistently the observer or rater measures the same behaviour or items on different occasions (Robson, 2002b). By coding the same interview transcripts on two occasions separated by a period of three months the amount of agreement was calculated at 90% over all cases. However this approach to checking reliability is open to bias if the coder remembers how data were coded initially. Due to this limitation a process of inter-rater reliability was also used.

*Inter-rater reliability* refers to the amount of agreement between two or more raters on the independent coding of the same behaviour or interview transcript (Robson, 2002b). *Coding checks* were performed on a selection of clinical cases by two independent coders who were nurse teachers, one specialising in acute adult nursing, and the other a specialist in intensive care nursing. To assess and correct for any departure from the initial application of the coding scheme Miles and Huberman (1994) recommend that *inter coder* reliability checks should include data from the last third of the study as well as earlier data. In the check coding exercise a total of thirteen cases from the early, middle and late interviews were identified; the independent coders each checked six different cases plus one case was administered to both.

Check coders were asked to code transcriptions of cases using the coding framework and afterwards to discuss any problems they encountered. Areas of disagreement could mean that the coding framework definitions required modification. To assess the amount of agreement the codes applied to data were compared to the researcher's codes for the same segments of data. Miles and Huberman (1994, p.64) report that 70% agreement is usual for the first attempts at check coding again using the formula:

\[
\text{Reliability} = \frac{\text{number of agreements}}{\text{Total number of agreements and disagreements}}
\]

According to Miles and Huberman (1994) *inter coder agreements* should reach the level of 90% agreement after discussion of differences in the application of codes.
The results of the check coding process for percentage agreements were 92% and 93% for the two independent coders, representing a high level of agreement. The data relating to these calculations are shown in Appendix 18. Disagreements occurred in the categorisation of medical conditions and clinical outcome states. For example cases of pulmonary embolism were categorised as respiratory by the researcher, and as cardiac/ cardiovascular by another. Cerebrovascular accidents were categorised as neurological by the researcher and as cardiac/ cardiovascular by another. The definition of medical condition was subsequently modified to specify the body system affected rather than the main pathophysiological process. The definitions of the clinical outcome states were modified to include a statement that the rating should be applied to the patient's most severe state for the period reported, rather than the patient outcome state, which implies the final outcome.

A limitation of the percentage agreement approach to check coding is that it does not take account of the number of agreements that could occur by chance. Cohen's Kappa statistic can be used to assess how much better the agreement is than that expected by chance (Altman, 1991). However the data must satisfy a number of conditions for Cohen's Kappa to be used; the units of measurement must be independent, judges are required to code data independently, and nominal categories should be independent, mutually exclusive and exhaustive (Cohen, 1960). Cohen's Kappa was not used because the coding scheme in the current study did not satisfy these conditions. Categories were not always mutually exclusive, a patient could be categorised as suffering from more than one medical condition/ body system disorder, and cues could be rated according to type and whether they were early, late, or where there was no pre-warning.

5.12 External validity/Transferability/Fittingness

The concern here is how generalisable the study conclusions are to other situations. Two types of generalisability were identified, empirical, and theoretical.
generalisability (Hammersley, 1992; Mason, 1996). Empirical generalisation from a sample to a population using a statistical approach is less common in qualitative research, and it was not feasible to use this approach here. However some statistical information on the main research site was available (section 5.6.2, p.165).

Theoretical or analytic generalisation was attempted using a range of strategies (Mason, 1996). Although the study sample makes no claim to be statistically representative of a wider population there is no evidence that the sample was atypical of the views of general ward nurses and critical care nurses with at least three years experience since qualification. The methods used in the selection of the study sample, their characteristics and limitations of the sample were discussed earlier in this chapter (sections 5.6.4 & 5.6.5, pp. 168-175). Details about the study sample and the research context provide the reader with a description of the “sending case” so that the potential generalisability or transferability of findings to another setting may be assessed (Murphy et al., 1998). Based on the apparent typicality of the sample, it is also suggested that the findings in the current study were not atypical.

Generalisation to other settings depends on the researcher presenting a clear and systematic account of the methods used in data collection, analysis and interpretation, as well as the theoretical framework supporting the study (Murphy et al., 1998). Also by identifying the important dimensions of the phenomenon in the research report readers can judge if this is relevant to them. Bryman (2002) argues that generalisation in qualitative research depends on the quality of the theoretical inferences made out of the data. By linking qualitative research findings to a theoretical context generalisability is construed in terms of links to theory rather than links to populations (Bryman, 1988). Generalisability of the findings from the qualitative interview study is considered at the theoretical rather than the empirical level. The extent to which findings correspond or connect to other theories (Miles and Huberman, 1994) is examined later (see chapter 6 and chapter 7).
5.13 Utilisation/Application/Action orientation

This criterion refers to the value of the study to the intended audience, and how it could affect future actions.

The major requirement is that the report should be accessible to readers, which means it should be physically available, and readable. It is anticipated that clinicians would find a more explicit framework to support their judgements both helpful and clinically applicable.

Qualitative research should be relevant, it may address issues identified by practitioners as important, other significant problems, and it should contribute to the existing body of knowledge (Murphy et al., 1998). Hammersley (1992) cautions that practitioners’ and researchers’ views of relevance might differ. The former may judge research according to its capacity to solve current problems, a more short-term view than that of researchers who may be interested in the methodological and theoretical dimensions, as well as the specific research problem.

5.14 Reflexivity

Reflexivity is concerned with how the researcher’s presence affects the data collected, and how the research process might affect the findings. Taking the first element, it is acknowledged that in a qualitative interview study the researcher is the research instrument and the relationship created with participants is crucial (Maxwell, 1996). At an early stage in the study design the researcher opted for qualitative semi-structured interviewing. It was believed that the researcher would need to establish a rapport and gain the trust of participants so that they would divulge the full range of cues they considered important in judgements of the state or condition of the patient. Another approach might not have yielded results on the more subtle cues.

It was important to be self-aware, to understand how the researcher came across to participants or potential participants, so that they would feel comfortable during the
interview, and be confident that data would be handled in accordance with ethical, professional and legal requirements after the interview.

The main purpose was to gain an insight into the cues clinicians considered important and the time sequence in which cues were reported. It was therefore important not to impose the researcher's organising framework for physical assessment which is based on a broad interpretation of severity of illness, a body systems approach and Hammond's (1996b) typology of cues, as this might not be the format used by nurses. The researcher also considered that semi-structured interviews would permit the clarification or expansion of key points. The inclusion of cases that did not support the research thesis suggests that the researcher did not unduly influence participants' responses.

The research process undertaken in the current study would have influenced the research findings. The use of qualitative interviewing meant that the clinicians' perspective on cues considered important could be explored. The choice of a conceptual framework based on a broad conceptualisation of severity of illness and the inference/correspondence model of diagnostic judgement (Hammond, 1996b) may also have influenced the findings as interview questions arose from the research questions that related to these frameworks. The choice of data analysis methods, including coding and contextualising approaches, enabled cues and their time sequence within judgements to be identified within and across cases.

Participants volunteered to take part in the study in response to a letter of introduction from the researcher. The surgical unit and medical unit managers both expressed their support for the study. In the medical unit of the clinical site the practice development sister was also very positive about the study and this may have contributed to the strong response received from the medical unit staff. Also the researcher had previously worked more with staff on the medical unit than on the surgical unit, and this may have influenced medical ward nurses' decision to volunteer in greater numbers than surgical staff.
The researcher's background as a senior experienced clinician influenced the initial choice of the research topic and may have contributed to the quality of data collected. The researcher could respond to the issues that came up within the semi-structured depth interviews and was able to pose questions that would lead to fuller descriptions of the clinical cases before returning to the original interview guide.

The significance of subjective clinical signs was emphasised during the empirical study because the researcher's husband experienced a critical illness. The clinical signs in this case were pleuritic chest pain, dyspnoea and pallor, in a person who was normally fit and well. The two possible diagnoses seemed to be pleurisy (but there was no history of chest infection), or pulmonary embolism. The on-call General Practitioner initially prescribed analgesics and anti-inflammatory drugs for the pleuritic chest pain. Two weeks later, after a series of medical appointments and two hospital visits my husband was admitted to hospital. He had started to cough up fresh blood. The diagnosis of pulmonary embolism and multiple emboli was confirmed 48 hours after admission based on the results of a series of lung scans. Anticoagulation, oxygen therapy, cardiac monitoring, respiratory monitoring and bedrest were prescribed, and a catastrophic event was thankfully avoided.

5.15 Strengths and limitations of the approach chosen
The use of two cue identification approaches for a Judgement Analysis study (Cooksey, 1996a) strengthen the current research design: a systematic review of research evidence and experienced clinicians' reports. The systematic review was used to identify the cues reported to be predictors of cardiac arrest and critical illness in the research literature and the use of an explicit search strategy with criteria for inclusion and exclusion minimises the threat of bias in the selection of papers. The interviews with clinicians would identify the cues they considered important in judgements of critical illness and cardiac arrest. The researcher hypothesised that the cues clinicians considered important might differ from the cues reported in the
literature. A Judgement Analysis study requires all the important cues to be included in cue profiles before they can be administered to judges. Hence the two separate studies were undertaken.

There are a number of limitations in the current research. Within the systematic review there were few randomised controlled trials relevant to the research topic and so lower levels of research evidence were examined and included in the review. The heterogeneity and the lower level of evidence available in published studies limited statistical analysis.

Reliance on interviewing methods and clinicians' self-report exposed the empirical study to memory effects and the potential for bias in the interviewer's questions. The use of retrospective recall means that the empirical study is limited to the cases that can be recalled; it is not possible to know if these are typical of the cases the participant has been exposed to but cannot recall, or if they reflect the more unusual cases. In some cases clinicians' were unable to recall specific details of cases that occurred in the more distant past, but in the majority of cases they were able to recount the main medical condition(s) or the body system affected and the cues they considered important. Interviewer bias was minimised by referring to the interview guide when framing questions and by using open rather than leading questions. The measures taken to ensure the validity of study findings and minimise the threat of bias have been highlighted in the current chapter and are illustrated further in the next chapter.

The time-consuming nature of the research methods used - a systematic review and qualitative interviews - were limitations in the current study. The search strategy in the systematic review required a period of development, and the methods used to synthesise evidence were selected according to the quantitative or qualitative nature of the research evidence. Data collection in the empirical study relied on clinicians volunteering to participate. Clinicians in the medical unit readily volunteered, whereas surgical unit clinicians did not come forward in the same numbers. Also the
time required for data collection in the clinical environment was prolonged due to the need for patient care to take precedence over research. A number of interviews were re-scheduled due to clinical demands.

The sample size of 32 clinicians in the qualitative interview study limits the generalisability of findings. As the focus is on medical nurses and medical cases, further research would be required to test the applicability of the findings to a wider population of medical nurses and medical cases, and to other specialities including surgery or critical care.

5.16 Conclusion
This chapter introduced various philosophical perspectives and the implications of these for research. A Critical Realist perspective was selected for the empirical study because this enabled exploration of the clinicians' subjective accounts of cues they considered important, the characteristics of the judgement task and the type of cognition, and any evidence of a mechanism contributing to the events reported. The process of negotiating access to the research sites and gaining ethics approval was outlined. A description of the main research site and the wider research context was included. Major elements in the research design were highlighted and the rationale for the approaches taken was discussed. The measures used to address the validity, reliability and generalisability of findings were also presented.

The following chapter reports on the methods used in the empirical study, examines the various stages in data collection and analysis and illustrates the processes used in an audit trail.
Chapter 6
Data analysis in the empirical study to identify cues considered important in the prediction of critical illness or cardiac arrest

6.1 Introduction

The systematic review focused on research evidence for the period 1990- November 2002 inclusive (chapter 4). The most frequently reported predictors of critical illness were blood pressure, respiratory rate, administrative factors and pulse, but only pulse was a statistically significant predictor of critical illness at the level of $p<0.05$ when compared to the other clinical states. For cardiac arrest, respiratory rate, pulse, level of consciousness, blood pressure and temporal factors were reported most frequently. The predictors of respiratory rate, level of consciousness, pulse, delayed response and dyspnoea reached statistical significance at the level of $p<0.05$ when compared to the other clinical states. Studies reported in the systematic review were predominantly quantitative and tended to be less focused on qualitative aspects of judgements.

A qualitative study of clinicians in general wards and coronary care in Australia reported that the Medical Emergency Team criterion "seriously worried about a patient" comprised a number of cues; including feeling not right, colour, agitation, and marginal changes in observations or no changes (Cioffi, 2000b). However Cioffi did not analyse the cue composition of clinical judgements according to the particular clinical specialities, or the time-sequence of cues in specific clinical cases.

An interview study was undertaken to identify cues experienced medical ward clinicians considered important in judgements of patient condition for patients in transition from acute illness to critical illness or cardiac arrest. The focus was on cues that were seen to be early predictors. This chapter examines the data collection and data analysis procedures used in the empirical study.
6.2 Main Components of Qualitative Data Analysis
The main issue that qualitative researchers face is how to derive valid meaning from qualitative data (Miles & Huberman, 1994). To this end Miles and Huberman (1994, p.12) present a framework for qualitative data analysis comprising data collection, data reduction, data display, conclusion drawing and verification. These overlapping activities are used as headings to discuss how the research to elicit cues considered important in judgements of patient condition and the prediction of critical illness and cardiac arrest in general medical ward patients was conducted.

6.3 Stage 1: Data collection
Qualitative studies often focus on small samples of individuals located in a particular context studied in detail, whereas quantitative studies seek larger sample sizes, with the context removed, for the purpose of examining statistical significance (Miles & Huberman, 1994).

6.3.1 Data collection using qualitative interviews
Qualitative interviewing was selected as the method of data collection to access the cues that clinicians considered important in judgements of patient condition in acute illness through to critical illness and cardiac arrest. A particular strength of the qualitative interview is that it can be used to uncover things that are hidden, it is a useful method when asking people about perceptual information, their feelings and their understanding of an issue or situation (Arksey & Knight, 1999). Mason (1996) suggests that interviews may be useful when the topic is complicated or not organised clearly in the informant's mind; in such cases it might not be possible to answer short questions in a highly structured interview situation. This was the case in the current study where a semi-structured interviewing approach was used with mainly open questions to encourage responses from informants (Wengraf, 2001). Interviewing is also useful when investigating possible connections between things (Arksey & Knight, 1999) such as the relationship between the type of cue and timing of when cues were important in judgements in the current study. Using interviews it was
possible to delve into the clinicians' understandings and the meanings they gave to particular cues and events, and thus achieve a greater depth of understanding than might have been possible with a questionnaire approach. Additionally any answers that required further clarification or expansion could be addressed at the time of data collection in the qualitative interview situation.

One of the main limitations of the qualitative research interview method is the indirect nature of the evidence. Maxwell (1996) describes interview data as fallible evidence of extra-interview realities. The informant's response may be inaccurate as it relies on how accurately the original event was interpreted and how well it was committed to memory. In the current study the informants often reported when they were unsure of precise details of a case but they seemed able to recall the cues that alerted them to major patient problems. These cues constituted the essential qualities of the phenomenon of deterioration to critical illness or cardiac arrest that the researcher was hoping to access.

Mason (1996) refers to the "epistemological" deficiencies of interviewing because experiences that are the focus of the interview are recounted and may differ from what the informant really thinks. The interviewer is accessing the interpretations and meanings the informant wishes to reveal (Mason, 1996). In the current study the informants reported cases where they identified problems early and other cases where they did not, so the researcher had no reason to believe that they were providing an unbalanced view. However the accounts need to be viewed within the context in which they were obtained as researcher or informant impression management could take place (Murphy et al., 1998). Extracts of interview data are provided during the course of this chapter so that the reader can judge if this was an issue here.

Interview studies are costly in terms of time setting up, conducting the interviews and transcribing data. Sometimes events on the ward meant that interviews were rescheduled because clinical care must be the priority in health care settings. Each hour of tape required approximately six hours for transcription by the researcher, but the
experienced transcriber would have required less time. Generally fewer participants are included in qualitative interview studies than in quantitative ones because the researcher seeks information in depth, and is more often guided by theory-based sampling or purposive sampling than statistical sampling, as in the current study. The use of interviews meant that informants were not anonymous to the researcher and this may have introduced bias, but transcripts were assigned a code to protect anonymity during data analysis, and in the final report. Fortunately the researcher experienced few technical difficulties when using the tape-recorder, with only one minor mishap encountered when the tape recorder was not switched on for the first five minutes of one interview. The problem was recognised quickly and the informant submitted the information again. Due to the semi-structured nature of the interviews, analysis was more challenging in this study than might be the case in a more structured interview situation but the conceptual framework and research questions guided analysis.

Arksey and Knight (1999) state that interviewing refers to a range of research approaches with the common feature being a conversation between individuals where one person is a researcher. Interviews can be classified as structured, semi-structured and unstructured (Arksey & Knight, 1999). Structured interviews identify all questions in advance, the interviewer must not deviate from what is written and all interviews should be administered in the same way so that responses are not contaminated by extraneous factors. Semi-structured interviews follow a set of main questions, but the researcher can use probing or additional questions to gain a deeper understanding and the informant can select how to respond. The unstructured interview normally starts with a list of topics or themes, but the informant influences the course of the interview (Arksey & Knight, 1999). Murphy et al., (1998) argue that the unstructured interview would still have some basic structure.

A semi-structured approach was adopted in this interview study. As in Kvale's (1996) semi-structured interviewing approach, an interview guide was used with topics and related questions identified in advance of data collection. Questions were
based on the conceptual framework and the main research questions. It was also important be able to achieve depth in the semi-structured interviews (Wengraf, 2001). Therefore follow-up questions were based on the initial replies to attempt to uncover informants' perspectives, and to explore the meanings they attached to particular cues or events. The semi-structured research interview is defined as

"...an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomenon" (Kvale, 1996, pp.5-6).

6.3.2 The interview guide

The items included in the interview guide (Appendix 19) were based on the conceptual framework of severity of illness and the states of critical illness and cardiac arrest (for conceptual framework see section 2.2, p.17), the clinical judgement process, the main research questions, and the findings from the systematic review. According to Kvale (1996) interview questions need to perform two functions; they should link in to the research theme and they should contribute to a positive interview process. Theoretical questions may require translation to be suitable interview questions as the language of the former can be abstract and difficult to interpret in the interview situation (Kvale, 1996; Wengraf, 2001). Therefore the interview guide identifies both the research questions and their translation into interview questions, with the informants being asked the latter. Wengraf (2001) states that research interviews may refer to a range of possible objects and gave examples of three categories: discourse, objective referents and subjectivity. In the current study the main focus was on the cues the clinicians considered important in the prediction of cardiac arrest and critical illness, these could be described as objective referents. Objective referents are the external objects that the informant has indicated (Wengraf, 2001). Subjectivity describes inferences the researcher makes about the characteristics of the informant (Wengraf, 2001). The focus was less on the unique characteristics of each informant but it was of interest to review how experienced clinicians reported their role in the judgement of clinical conditions. Discourse refers to the informant's
manner of talk and the researcher tries to uncover the deep structure below the surface, but this was not the primary focus here (Wengraf, 2001).

The interview guide was submitted to two research colleagues for review of the content, no changes were advised. It was then piloted with three nurses at the main research site. They were asked if the questions were clear, if the order was logical and if they could provide the information requested in the format it was being asked. The nurses reported that the questions were clear and that the order was appropriate, however they found it difficult to rate the importance of a cue from one to ten. The final interview guide asked nurses to identify cues that were most important in particular situations rather than rating importance on a scale (Appendix 19). The three pilot interviews were included in the final sample.

Kvale (1996) refers to the importance of providing the context of the interview or framing the interview for interviewees. Before the interview started interviewees were briefed on the topic of the interview by reviewing the information provided in the letter of introduction. Upon completion of the interview the researcher indicated to the interviewee that their views provided valuable material for the study. At this stage the researcher was also able to reveal more information about the purpose and design of the study if interviewees expressed an interested in this (Kvale, 1996).

Different types of questions were included in the interview guide and these are described using Patton’s (2002) typology. Background/demographic questions were asked at the beginning of the interview and informants noted their responses on the summary contact sheet for interviews (Appendix 20). Opinion and values questions focus on gaining an understanding of cognitive and interpretative dimensions (Patton, 2002). Informants were asked to draw on their experiences of patients’ conditions that changed along the continua from acute illness to critical illness or cardiac arrest as a way of gaining access to the cues considered important. Feeling questions aimed at uncovering how the informants felt about particular patients’ conditions, and whether they were anxious or concerned about them. Sensory questions enquire into
the informants senses of sight, hearing, touching, taste and smell (Patton, 2002). Sensory questions were used to elicit information about how particular patients looked to the informant, or what their skin felt like to touch, and these questions were frequently used as probes to achieve greater depth in the informants accounts. Knowledge questions were asked to elicit factual information about diagnostic procedures and treatments and local organisational issues that impacted on care such as criteria for calling the Medical Emergency Team.

Further to the above Kvale (1996, pp.133-135) refers to interview questions according to their form within the interview as introducing, follow-up, probing, specifying, direct, indirect, structuring, silence, and interpreting questions. The early questions in the current study were introducing questions in the form of “Can you recall...? Could you describe...?” Follow-up questions were used to elicit further information, and to explore unusual comments that could contribute something to the research questions. Probing questions were used to gain more information about cases without revealing the researcher’s position and biasing the responses. Specifying questions were used to direct the informants from more general discussions of cues to actual cases where particular cues were considered important. Direct questions were occasionally used when the researcher asked about an issue. Indirect questions refer to instances where the informant was asked to comment on the attitudes or actions of others in particular situations. Structuring questions were those where the researcher changed the course of the interview by asking about a new topic for example when all elements in a case had been presented and interviewees were asked about other cases. Silence was sometimes used to give informants time to think through answers. Finally, interpreting questions were used to check meaning, gain clarification, and to make comparisons between different situations. Kvale (1996) also suggests that the hazards of leading questions has been exaggerated arguing that in some cases they could be used to check how reliable the informant’s answers are or to check the interviewer’s interpretations. In the current study the researcher tried to avoid using direct or leading questions in the body of the interview.
When each interview was finished the researcher noted what had been learned from each session and commented on the interpersonal nature of the interview, for example how freely the interviewee had been able to engage in the process, and if they had appeared apprehensive or relaxed at various stages. These comments were useful when orientating the researcher to each interview during the process of data analysis.

6.3.3 Ethics of interviewing
Kvale (1996) states that “An interview is a moral enterprise” where the interviewee may be affected by the process, and the knowledge acquired can enhance understanding of a particular subject. Ethical dimensions must be considered at all stages in an interview enquiry.

Mason (1996) highlights particular ethical issues connected with interviewing which were considered in the current study. Firstly the interviewer did not ask questions that could distress interviewees and did not focus on omissions in care. Secondly, the interviewer asked questions in the style of a colleague interested in understanding more about a topic, and at all times tried to ensure that interviewees were comfortable with the questions. The interviewer did not ask the interviewees to reveal more than they felt comfortable sharing, and interviewees were asked if there was any material they had reported that they were unhappy for the interviewer to use. Clearly the interviewer needed to be sensitive enough to realise when ethical issues came up, and responsible enough to deal with them appropriately (Kvale, 1996). On a few occasions the tape-recorder was switched off when the interviewees wanted to discuss something confidential. In the presentation of results, interviewees’ names were not revealed, codes were used, and the researcher made efforts to ensure that specific information that could identify a participant was not revealed. There was no evidence that a power relation between the interviewer and interviewee had any effect on the data generated, but it may have been a factor in participants’ decision to take part in the study. The interviewer kept personal knowledge and experience of critical care out of the interview situation, as the purpose was to hear the views of the interviewees and develop a climate in which this could happen. The process of
eliciting informed consent was followed in all cases and this included receiving the interviewees written consent to use the data collected in the interview at the conclusion of the interview. Within data analysis the researcher was mindful of the sensitive nature of information on cues about patients and so all data were anonymised, there was no indication of the time period the cases referred to, and respondents were given a code number to protect their anonymity and confidentiality. All interviewees were informed of the plans to produce written reports on the interview data, and expressed their interest in reading the study findings.

6.3.4 The search for different types of cases
To add to the trustworthiness of conclusions the researcher actively pursued the search for confirming, negative, contrasting and typical cases within the interviews (Miles & Huberman, 1994). In the early stages of data collection the data were examined for any discernible patterns, and as data collection progressed the search progressed to identifying confirming cases. Ideas were tested; emerging patterns were closely scrutinised, and subjected to further testing in the subsequent interviews as described by Patton (2002).

Interview 11 case two
*No. 11 ++ Text units 32-33:
*No. 11 ++ Text units 212-230:

Em he was a very elderly gentleman I think he was in his nineties em fully compos mentis and a very charming man. Came in with a chest infection and was a known COPD. And em spent a couple of days pottering round his bed needing his oxygen if he did too much but he was managing. Speaking sentences eating his food and everything. And again during the morning shift he started to become quite really quite breathless cold and clammy not able to speak in sentences really struggling and his chest sounded dreadful as well. And em because of the MET scoring system that we’ve got as the morning went on we were able to score him and he came up with quite a high score. And we did a MET call on him and got the team down to see him and he went to HDU

*INTERVIEWER
Right O.K. aha er so if you’re thinking back then to him the most significant features in his condition were em?

*No. 11
Em he was becoming gradually more and more breathless until a point where he was unable to speak or eat.
A further confirmatory case is interview 12 case two

*No. 12 ++ Text units 173-277:
Yeah. Em trying to think. Yeah we had another lady with em asthma in fact did end up going to the Intensive Care Unit. Em but was put down here because she was on Aminophylline so we could essentially monitor her but was just becoming more and more tired. Having to make more and more respiratory effort to get any oxygen really and was on high oxygen was on nebulisers almost continuously via the oxygen. Em and just looks very poorly and tired and worn out and couldn’t speak anymore

*INTERVIEWER
What was it about how she looked?

*No. 12. She looked tired she looked withdrawn she couldn’t speak she could only sort of nod her head. Her eyes just didn’t look quite with it she just didn’t look with it anymore and I’d known her or I’d seen her earlier in the day when she’d looked better. And she couldn’t move around she couldn’t get comfortable she was agitated again. Em kept sitting up in bed kept trying to lean over the table just couldn’t do anything to get comfortable

*INTERVIEWER So her previous medical history had she anything?

*No. 12. Long history of asthma that had required being ventilated.

**Negative or disconfirming cases** are extremely important as they may suggest alternative interpretations, or demarcate findings that are supported (Patton, 2002). In this research negative cases include those where the patient did not go on to critical illness, cardiac arrest, or acute illness and vulnerable to deterioration to critical illness and cases where subjective or behavioural cues were not considered important in judgements of critical illness or cardiac arrest.

For example, Interview 9 case two was a surgical patient with sudden onset of atrial fibrillation post operatively;

*No 9 ++ Text units 152-224:
Yeah I mean the only thing is I don't know the outcome of this one because it's more recent it was only last week.

*INTERVIEWER That’s fair enough if you could even sort of take me through the background and em the sorts of issues that came up when you thought the condition was changing.

*No 9 I mean I wasn't too involved in this because I, I became involved because I was Blue Star for this particular night and there's a lady over on er [ward name] who'd been unwell apparently all day. ICU had been informed but did not plan to admit this patient... Well anyway I went up to [ward name] to see you know what was going on because you know I like to see for myself if they're telling me there's problem. I thought it's only fair. Well there was a lady who had surgery two days beforehand for reversal of a Hartmann's procedure I think if I remember rightly. And em she hadn't been well since about ten o'clock that morning because she'd gone into atrial fibrillation. Her SATS were sort of like eighty-five and that was on sixty per cent oxygen. Em she wasn't passing any urine the maximum was sort of like twenty mls an hour and her BP was like eighty over fifty and it had been like that all day.
And the staff had done their best to sort of like get the surgeons to sort her out or whatever and they hadn’t done anything about it. Well that was how the situation was when I came on. Then ITU said no we won’t take her so I said well there’s nothing we can do really you know if ITU aren’t going to take her. All I can do is you know we can help you with the drugs and things and get her stabilised. And then ITU said well I will send somebody along as well which I thought was fair of them if they weren’t going to take the patient at least they offered to give some help. So anyway they eventually got her heart rate down because it was going at about a hundred and fifty so we then got it down to about a hundred with various other drugs that she was given. But the staff still weren’t happy. So by this time it was one o’clock in the morning so I’ve known this lady for about three hours by this time and things weren’t picking up apart from the fact just her heart rate had reduced. So they said to me should we do a MET score well they should have done that off their own bat they didn’t really need to ask me. But anyway we decided to do a MET score and between us and their were three trained and one Care Assistant from ITU and we got the MET score at eleven so she decided to put out a call. Well the medics were very good. They responded and got her all sorted but the em the chap who was in charge of ITU from the medical point of view he felt really it was inappropriate putting out a MET call and he didn’t feel it was justified. That was before he actually went and reviewed the patient. He said you know shouldn’t be doing this at sort of one o’clock in the morning blah blah blah. But anyway eventually he decided yes she should go to HDU. And I think she was still because this happened on Thursday night she was still there on Sunday night so obviously she was very unwell because they wouldn’t have kept her in that environment for that amount of time if she didn’t warrant it. So em I haven’t heard how she’s doing at the moment.

Interview 15 case three refers to a patient admitted with chest pain. Acute changes in his ECG were found after a routine ECG when he was not in pain;

++ Text units 254-282:
*No. 15 I had a patient who had no pain, he looked quite well but I just did an ECG because I can’t say why, and he had acute changes and there was this series of ECGs and they were just constantly changing and the doctor there said he’s got LAD (left axis deviation).
*INTERVIEWER So what primarily got you to do the first ECG?
*No. 15 I don’t know. He’d come in in the morning, and I’d thought, okay, it’s about time to do an ECG, 6 hours post coming in. And I just did one.
*INTERVIEWER Were you surprised when you saw the acute changes?
*No. 15 Yes.
*INTERVIEWER How did he look?
*No. 15 He looked fine. We wasn’t in pain, he looked fine. He was lying reading a book.
*INTERVIEWER Had he been admitted with chest pain?
*No. 15 Yes.
*INTERVIEWER Is that a contrast to other cases you’ve mentioned?
*No. 15 Yes.
Interview 2 case three refers to a patient with chest pain, query pulmonary embolism, who developed shortness of breath and severe chest pain. The pain settled and she was discharged from hospital, as the v/Q scan was negative for pulmonary embolism.

*No. 2 ++ Text units 281-344:
There was a lady that I did call the MET team out about a few weeks a few months ago actually, just after Christmas. She was a lady in her 40s, mid- forties. She’d come in with, um, chest pain, I think query PE. I think the scans were proved to be, no no. She came in with chest pain query, um angina, query PE. And she was waiting for her scans, she was waiting for her V/Q scans. So when I went along to meet her she’d been pain free for a day or two. I remember that she became, suddenly became very short of breath, extremely short of breath, and she hadn’t been like this. Even when she came in she wasn’t short of breath. And she’d had this severe chest pain. So all these- new short of breath, new severe chest pain, and nurse concern, I was concerned about her. She’d come in with query PE- maybe she’s throwing off a PE now. Her oxygen saturation levels were quite poor. You know, again she was sweaty, clammy, obviously very anxious, um, we gave her oxygen, and we called the MET Team to come out and see her. And they eventually came out, I don’t think a lot was done- I think they did blood gases etc, etc. And she eventually calmed down. But to me that looked like it could have been potentially life-threatening, but it settled down within an hour or so of it happening. We seemed to settle her down with oxygen and doctor coming to examine her, taking blood gases etc. We gave her analgesia and she settled...

*No. 2 Yes. I must admit when I actually called the MET team, I said to the SHO- I think it also depends on how you communicate with people as well- I remember saying to the SHO, the whole MET team doesn’t need to come, just one of you get here ASAP. And they did. They were here. One doctor came up, and sorted it, and dealt with it.

INTERVIEWER Could it perhaps have been something more sinister averted in that way?
*No. 2 Yes. Yes I think the lady actually went home after a day or two- because her lung scans came back as negative. You know, she was fine, um.

Cases where the earliest cues to deterioration included subjective cues and objective data were also reported. An example is interview 8 case three:

*No 8 ++ Text units 225-288:
...She was a lady who came in she’d been found half in and half out of a garden pond em in at home by the neighbour I think and was hypothermic. Had no temperature to report at all when she came into A&E perked up here and was actually, became conscious again em actually we had a catheter in her she was quite oedematous she had cardiac monitoring. Em she didn’t have a CVP done this lady’s output dropped during the daytime. Her temperature was being maintained her obs were not too bad at all her blood pressure was relatively stable it was low but relatively stable. We’d whisked her a few lots of fluid with her.

*INTERVIEWER When you say it was low what sort of
*No 8 It was it was sort of hundred and four-ish over sixty.

*INTERVIEWER Yes
*No 8 It wasn’t below the hundred. Her pulse had been about ninety five em as I say temperature was coming up and up and I can remember one of them it was thirty six
one which we thought was amazing cause I think it had been twenty seven. Em and gradually her urine output tailed off to some it got to be that there'd been twenty mls in two hours. Doctors were aware and then I couldn't get anything else out of the catheter I was priming it. I did a wash out didn't get anything back. Em blood pressure shot down she looked dreadful she became confused more confused. She was when I say she was conscious she wasn't completely lucid she wasn't she could say she was in hospital but no she couldn't repeat (name of hospital) to me that sort of level of confusion. Em she became confused and slightly agitated more tachycardic and her resps. went up they were over thirty I think. Did the obs again in fifteen minutes whilst I was doing that she had a respiratory arrest called the crash team. We actually worked and got her round and she went to ITU but unfortunately died in ITU. Em I think with her it had seemed to have been thought that because she became slightly more conscious and things were on the up. Obviously they weren't.

_Counter cases_ in the current study refers to the search for cases in non-general medical areas to test whether the findings in general medical cases also apply elsewhere. Examples of cases from critical care and surgical areas are reported in chapter 7.

_Critical cases_ were also actively sought (Miles & Huberman, 1994). These were the strongest exemplar cases where the clinicians reported subjective or behavioural cues to be important early predictors of critical illness or cardiac arrest. Examples include interview 1 case one and interview 18 case three.

Int 1 case 1++ Text units 87-110:
*No. 1. Aah well... I remember... (pause). Yes we had a chap I don't know how many months ago now, can't remember his name, do you need to know? [Interviewer, no that's fine], who actually did come in with chest pain who sort of became more withdrawn as the evening went on, and he said he felt alright but his level of consciousness seemed to be... he wasn't as alert... he was becoming more withdrawn, we actually called the team up to see him, he then began to have slight changes in his blood pressure, and then as they were actually here he did actually arrest, and he was an aneurysm when we got him back he went off to theatre, but the team were actually here when it all happened because we'd called them several times during the evening. So that's aah, we've had a few aneurysms like that actually...

*INTERVIEWER What sort of age range was that person in?
*No. 1. 60s or 70s. One chap didn't make it, but he actually made it, that chap did.

A further example is as follows:
Int 18 case 3 ++ Text units 362-539:
*No. 18. She's a lady she's a [name of foreign country] lady em in her early fifties I'm just trying to think what her why she actually came into hospital. I think she'd been having night sweats and I don't believe you know anybody ever found out why she was referred to all manner of people you know the Rheumatologist, the
Haematologist while she was here. And em but she was virtually a self caring admission anyway she did have again her breathing she did like to have the odd bit of oxygen because you know she felt her breathing was a problem. I can't remember it that well about the whys and the wherefores. But she was an extremely pleasant person and then em just her demeanour changed it was one lunchtime. You know she was you know she smiled a lot and all the rest of it and then one day you know I went in there and there was a slight change in her colour she looked sort of greyish really and she was quite a tanned person anyway. Em and she was stuck to her oxygen and it was that look again

INTERVIEWER Emm

*No. 18. You know and em and because I'd known her so well I knew she was sort of sort of pretty vivacious person suddenly she wasn't anymore you know and she was sitting in her chair. And I said let's you know let's go and lie down on your bed and we'll have a bit of a look at you and that was a struggle I had a struggle getting her there on my own.

*INTERVIEWER Uhhuh

*No. 18. So em I did some obs and again her now what were her obs. I know her resps were sky high don't ask me what they were I've got forty one in my head. Em and I have to be honest I can't remember anything else. And so I called the MET team and but it was actually her Registrar who came down as well and he em. And it turned out she had and if you ask me how they diagnose this and I don't know but they brought this big machine down from the cardiac department and she had a ....(This was debated and cardiac tamponade, pericardial effusion was confirmed later) there's lots of fluid round the heart. And within you know you sort of took one look at her and they had the machine and some sort of tubing.

Typical cases are those that add weight to the conclusions, the cases that indicate general trends in support of the conclusions (Miles & Huberman, 1994). Examples of typical cases are as follows:

Int 7 case 1 + + Text units 28-202:

*No 7 One particular patient that I was handed over this morning who I had never met before. Em she's about a seventy two female. I was handed over that she's in fast AF OK she's on digoxin for that and she's here for observation she actually came from an observational ward yesterday. When I got to the patient after hand over today classic signs she looked clammy she looked you know greyish. She just I don't know I just felt there was just something not right about her. I asked if she was OK she said no I've got a bit of chest pain, not pain, but tightness. Em so then I automatically did some observations which were about actually quite elevated at two hundred and twenty or something

*INTERVIEWER Was that high blood pressure?

*No 7 Over a hundred and eighty. So blood pressure was slight indication because it had only gone up about forty but it was still quite a bit. Her SATS were ninety five per cent because I actually thought that maybe her saturations were low at first so I did her saturations ninety five per cent on twenty four per cent oxygen so I wasn't so concerned about that because they had been lower than that previously. Em I then did an ECG straight away and also at the same time I gave her some GTN to see if she em which obviously I wasn't written up but I just gave it because it thought OK I had a gut instinct I just thought I'd give it. She was obviously quite what's this tablet
and I explained it and everything so I gave her this sub-lingual tablet which took ages to dissolve and her blood pressure actually came down she had less chest discomfort. I bleeped the SHO, the SHO came to the ward she was very good very good SHO. And she said she just gave her some Enoxaparin sub cut which I gave her straight away and some 40mgs of IV Frusemide which I gave her straight away. And she said please get the team to review her ASAP and at the same time we gave her another GTN tablet and the pain generally subsided. Em

*INTERVIEWER She hadn't previously been on GTN, this lady?
*No 7 No not previously on GTN her main problem was just fast AF. ECG showed I think that she was flipping in and out of rhythm she was more like sinus tachycardia, then she was in AF again. So we did another ECG to confirm that, and she actually showed ischaemic changes. I've told... She was seen by a team now and she's actually quite poorly she's em actually come back as Trop T positive on her cardiac enzymes so she's actually going to [cardiac ward] now.

Int 32 case two ++ Text units 225-315:

*INTERVIEWER Can you think of one of those patients at the minute that you've been called to when you've been in charge?
*No 32 I probably can. Do you want surgical or medical patients?
*INTERVIEWER Either.
*No 32 We have had again an elderly gentleman, but not that old, maybe in his 60s, 50s or 60s. He was a COPD guy, because we do get quite a few COPD chaps that come in. Who again, I mean it's common ground in the mornings that you're always faced with someone who's not quite right, doesn't quite feel as well as what we did do yesterday, and emm he'd emm the girls had called me into his room, you know evidently things aren't right. I'd asked for a full set of observations and had a bit of a chat with him, you know what's the problem, etcetera, etcetera. And he felt that his chest was much tighter that day than any other day. We listened to his chest, but it's a chronic chest and it's always difficult to decipher any sort of... are you coughing anything up, is there anything new today, are they hot, are they on any new medication etcetera, etcetera? So you're judging all that and it turned out we had to get the consultant out in the end because this guy didn't feel well. He wasn't scoring high on his METs, his observations were quite stable. He was scoring low in his SATS which is again interesting, but he had done all the way through. And emm we ended with the consultant coming out, doing a v/Q scan and he actually had multiple clots. So I mean that's kind of the nature of the beast of having a COPD if you like as well isn't it. Because the common ground with that is that you're more likely to have reduced mobility so therefore the impact is that you have a PE.

*INTERVIEWER Was that a patient who had recently been admitted to this ward?
*No 32 No he'd probably been in for about a week actually.

*INTERVIEWER So he'd been in for approx. 7 days, was he a planned admission?
*No 32 No he'd been an emergency admission for treatment with IV antibiotics.

*INTERVIEWER For a chest infection with COPD?
*No 32 Yes.

*INTERVIEWER So his background was COPD with a chest infection on top of that, and he'd been on a period of more like bed-rest because of that...?
*No 32 Restricted definitely.

*INTERVIEWER Would he have been on any anticoagulants during that period?
*No 32 No.
*INTERVIEWER And his observations, apart from the SATS, was there any change there?
*No 32 Not really. His respiration rate was always high because of the fact of his COPD, so if you were looking for distinct changes, no there wasn't a distinct change, nothing that we could definitely put our hand on, but things were definitely not right.
*INTERVIEWER When you say that things were definitely not right, what was the main thing that was significant that was telling you that?
*No 32 I think the patient feedback was my big indicator, it was "I don't feel right" and you know again I'm a true believer in the patient knows how he feels, you know how you feel. And where they're saying I don't know why I don't feel well but I know there's something wrong. You know there's something wrong. You know, and it's not always on an observation that you get that impression. Sometimes that can mask the real problem doesn't it. If they don't feel well then you should always, I mean I would always get someone to check them out definitely.

6.4 Stage 2: Data reduction

Data reduction is a component of analysis (Miles & Huberman, 1994). It begins at a very early stage in a qualitative research project because choices are made about the conceptual framework, the types of cases, research questions and method of data collection (Miles & Huberman, 1994). Data reduction continues with writing summaries (in the current study brief summaries of interviews were written in the interview summary contact sheet -Appendix 20, and as memos in QSR NUD*IST N4), coding, identifying themes, clustering data, dividing the data up in various ways such as cases according to case outcomes, and writing memos (Miles & Huberman, 1994). Tesch (1990) refers to the same ideas as data condensation.

To facilitate the coding of data a computerised data management package of the code and retrieve type was used (QSR NUD*IST version 4 for Macintosh, 1997). Later versions of QSR NUD*IST do not work on Macintosh systems, the main computers used for this study. Interview transcripts were prepared according to the instructions in the QSR NUD*IST 4 user manual (1997) and saved as ‘text only with line breaks’ before being imported into QSR NUD*IST v4.

A preliminary coding framework or start list (Miles & Huberman, 1994) was developed for the coding and analysis of interview data. This was based on the conceptual framework presented in chapter 2, the findings of the systematic review in
chapter 4, and the theoretical framework discussed in chapter 5. It was used as a guide when reviewing and beginning to code the interview transcripts and applying descriptive codes (these are codes that describe rather than interpret data according to Miles & Huberman, 1994).

The coding framework was modified to capture aspects of judgements and categories of cues that had not been evident earlier. This was achieved by going back and forth between the research hypothesis and questions, the conceptual framework, the interview questions, and the interview data. Descriptive codes and interpretive codes (where an additional explanation or meaning becomes possible), were identified (Miles & Huberman, 1994). Interpretive codes in the current study included cues described as early or late, and the change in condition described as acute/ sudden, or chronic/ gradual. The computerised qualitative data analysis software meant that modification of the coding framework was a straightforward procedure.

The final version of the coding framework and definitions for category membership for this study are shown in Appendix 21. The eight main categories used in the coding framework included the following (also see Figure 6, p.216):

1. Interviewee data- biographical data
2. case data- biographical and medical condition data
3. change in condition as acute/ sudden, or chronic/ gradual
4. cues considered important as early, late and no pre-warning
5. cues by type as clinical signs and symptoms, objective measures, paraclinical, laboratory, investigative data, subjective clinician data, behavioural data, patient history, patient self- report and response to treatment
6. interventions required, type of support needed- emergency intervention, medical review, specialist clinician input, monitoring of physiological state, physical interventions adjusted, psychological interventions, and quality of interventions- delayed reactive or earlier pro-active

214
7. consequences or patient outcome as critical illness, cardiac or respiratory arrest, acute illness and vulnerable to deterioration, acute illness, chronic illness and palliative care/ terminal illness (including Do Not Resuscitate Orders)

8. factors that change in judgements, such as the context or cues.

In addition *free nodes* were used to record whole cases, references to physiological reserve, organisation of care and a diary node with the investigator’s progress notes on the study. Earlier versions of the coding scheme had itemised the different cues such as blood pressure and pulse, but this level of description was too unwieldy for analysis and so higher order categories of cues were used as shown above.

Appendix 22 shows extracts from two interviews as text before coding and Appendix 23 shows the same extracts with codes attached. Interview 6 was conducted within the earliest phase of data collection, and interview 28 was conducted in the later phase of data collection.
Figure 6. The coding framework
6.5 Stage 3 Data display

A data display is defined as

"...an organized, compressed assembly of information that permits conclusion drawing and action" (Miles & Huberman, 1994, p.11). Data displays were used to condense coded interview data so that trends in the data could be more readily seen, something which is difficult to do with large amounts of text (Miles & Huberman, 1994).

The definitions of terms used for data entry into the matrices or the decision rules for data entry were the same as those identified for the final coding framework (Appendix 21) with the addition of further categories for cues according to their function and the different types of judgements. These were interpretive codes according to Miles and Huberman's (1994) coding types.

The interpretive codes focused on the following aspects. Cues used to assign a patient to a particular class or diagnostic group are termed diagnostic. There are very few single diagnostic cues that indicate a particular disease with certainty and so clinicians rely on a number of uncertain cues when making diagnostic judgements (Hammond, 1996b). Cues can be used to establish changes in condition over time as their severity can be estimated at a given point and compared with later values such as respiratory rate and SpO\textsubscript{2} in patients with respiratory problems (Wulff & Gotzsche, 2000) and the term evaluative judgements is used. When the cues are used to predict a future patient condition they are termed prognostic. Prognostic cues include the patient's diagnosis, the pathophysiological and clinical manifestations of the illness in the patient, the clinician's knowledge of the likely course of the disease or illness, the patient's response to therapy, and the patient's physiological reserve inferred from factors such as age, medical history, and functional status.

A range of tables, matrices, charts and graphs were used to access the data and prepare for conclusion drawing and verification. Initially matrices were created to display within case analyses of judgements, where a case refers to the separate patient
accounts from one research participant (Appendix 24: Within-case matrices). At a later stage cross case analyses were created with cases compared across the patient outcome conditions of critical illness, cardiac arrest, acute and vulnerable to deterioration, acute illness, chronic illness and palliative and terminal care (Appendix 25: Cross-case matrices). The main aim in the construction of the various data displays was that they would be useful for the purposes of analysing the data and drawing conclusions. Miles and Huberman (1994) caution that any conclusions based on a display are only as good as the data entered into it, and that this depends on the quality of the data collected in the first place.

6.6 Stage 4. Conclusion drawing and verification

A number of techniques were used to draw meanings and conclusions from the data displays ranging from descriptive through to explanatory (Miles & Huberman, 1994). The main approaches used in the current study included the descriptive techniques of noting patterns, plausibility, counting, making contrasts and comparisons in the early stages and gradually more abstract approaches were applied, partitioning variables, noting the relations between variables, building a logical chain of evidence and making conceptual/theoretical coherence.

At the early stage of analysis the focus was on noting patterns or themes (Miles & Huberman, 1994). It became apparent that subjective and behavioural data were frequently the initial cues that stimulated the clinician to record physical measures/objective measures. Acute deterioration in the patient’s condition was frequently the precursor to critical illness and cardiac arrest (section 7.7, pp.283-285).

Miles and Huberman (1994) advocate considering the plausibility of ideas. This refers to the intuitive hunches that the researcher may later be able to substantiate or refute. For example examination of interview data revealed that subjective data were frequently used as a trigger to measure patients’ objective physical signs.
Clustering according to Miles and Huberman (1994) involves the search for things that fit together. The various cues reported by clinicians were categorised according to the main types of cues identified by Hammond (1996b) with the addition of temporal factors and responses to treatment, as these were important in the current study.

Metaphors can be used to stimulate theoretical thinking (Miles & Huberman, 1994). The metaphors cited by informants in the current study included the following references to patient conditions, 

"...not right", "going off", "I knew he was going to do something", "I wouldn't have been surprised if he'd arrested", and he was just "not himself".

When clinicians used metaphors the researcher probed further to try to uncover what these might refer to. In some cases clinicians were able to expand with more detail. For example:

No 31 "I particularly remember one gentleman when I was working on (name of previous medical ward), who I believe his initial diagnosis was one of CA Lung but it was very early stages. Emm and I remember one day just having a feeling about this man that things weren't quite right. With hindsight and since the MET scoring has come in I would say that I noticed an increased respiratory rate and he just wasn't himself really. His observations were unremarkable except for the increased respiratory rate. And he just didn't seem to be emm as happy really that day. That night he actually had a cardiac arrest and died... INTERVIEWER. When you said that he wasn't himself what were you referring to there? No 31. Just his general demeanour really...but when I did my MET training I thought yeah, I just thought of him straight away. And I thought yes definitely ....he had a raised respiratory rate." Int 31 case 1 lines 27-85.

The above extract refers to a problem that has been reported in recent literature (Kenward, 2002). The significance of raised respiratory rates did not seem to be universally appreciated by ward staff even though it is one of the vital signs-
including temperature, pulse, respiratory rate, and blood pressure. The next example refers to an elderly lady transferred from coronary care to the cardiac ward.

No 2 ...We had a lady just last week....she'd had a heart attack but it was too late to thrombolyse her...she'd have a chat with you and then I remember I came back after a couple of days off and she'd had another heart attack and she wasn't the same lady. She wasn't the chirpy lady that we knew, she wasn't talkative, She'd become very depressed within the period of a week to 10 days, I think realizing that she'd never get better again. Initially she'd be the sort of person who'd have a chat with you, want to chat to you, and then after the second heart attack she came out, [transferred out of Coronary Care] and I thought...there's something about her, there's something about this lady that's not right. Okay we know that she's low in mood, and it could be that she's had two heart attacks. But there's something else. And then we noticed that her husband would come in, she was the main carer for him, and he'd chat away to her, and she wouldn't even bother to, she probably wasn't able to because she was so tired after having two heart attacks. We did notice that her abdomen became quite swollen over the weekend...Int 2 case 2 lines 127-146. [Treated for massive dilated bowel. Patient died a few days later in her sleep].

Because metaphors are at a different level of abstraction from the primary observation they can be used to move from the facts to identifying the processes and this can help when examining a particular phenomenon (Miles & Huberman, 1994). The metaphors used by nurse clinicians seemed to refer to physiological instability and potential for deterioration.

Miles and Huberman (1994) explain that counting is a background activity in qualitative research but it informs the development of themes and patterns because how often something happens is important, and judgements of consistency are also based on counting. Counting can be used for three different purposes:

1. To quickly check what is in a large amount of data
2. To check an idea or hypothesis
3. To maintain an accurate account of the data minimising the risk of bias (Miles & Huberman, 1994).
Kvale (1996) also refers to the use of numbers as a method of confirmation or disconfirmation of a hypothesis within the analytical step of *meaning categorization*. Mason (1996) recommends a cautious approach to quantification; informants’ accounts and experiences require qualifying and putting into context. Counting needs to be placed in the context of the research strategy, the purpose of the research, and how it was carried out (Mason, 1996).

In this study counting was used for all of the above reasons. It was useful for gaining a picture of the different cues reported by clinicians across cases. Frequency counts of cues were used to identify trends in the data and this was helpful when verifying the hypothesis that clinicians frequently used subjective data in early predictions of critical illness and cardiac arrest. The graphs of results were checked against potential conclusions to ensure that the evidence and conclusions were consistent. A bias that threatens all research is the tendency to place too much weight on evidence that supports personal beliefs and failure to see evidence to the contrary (Miles & Huberman, 1994). As a result researchers are inclined to find confirmation rather than refutation of instances and look at only part of the evidence; by examining a complete batch of data using numbers it was possible to check for biases that could otherwise have remained hidden (Miles & Huberman, 1994).

Based on frequency counts it could be seen that subjective and behavioural cues were important in the *initial stages* in the judgement situations reported, but a more in-depth qualitative examination was required to establish the conditions under which these cues were considered important.

Miles and Huberman (1994) advocate *making contrasts/comparisons*. This involved comparing and contrasting the cues considered important within and across each of the patient outcome conditions. The purpose here was to assess practical or clinical significance rather than statistical significance. Comparisons were made using graphs of frequencies in each of the patient outcome conditions and these are reported in chapter 7.
The technique of partitioning variables (Miles & Huberman, 1994) was used within the cross-case matrices to differentiate between initial and early cues. Up to this point the coding framework had identified early and late cues. However it became clear that the further differentiation of initial and early would capture important information about the function of initial cues that were important when drawing conclusions. Three time periods were attributed to the data as analytical devices rather than representing real time periods. Initial cues represent the cues clinicians reported noticing first in the particular case. Early cues refer to all cues considered important in the time period leading up to making a referral to medical staff, specialist nurses, and/or the nurse’s intervention. Late cues refer to all cues considered important that were available in the period after the initial referral to medical staff and/or the nurse intervention (see Appendix 25: Cross-case matrices).

Pattern codes refer to the level of abstraction in coding following on from descriptive and interpretive codes (Miles & Huberman, 1994). Pattern codes in the current study refer to patterns that link across cases; these codes were attached within the final stages of data analysis. Three pattern codes were evident. The first referred to cases where subjective cues were used as initial cues to trigger the clinician to undertake a set of patient observations. In the second, subjective and objective cues were viewed as complementary initial cues in some cases, and the third pattern code referred to a small number of cases objective cues alone were the initial cues to deterioration or prediction of critical illness or cardiac arrest.

The technique of subsuming particulars into the general is similar to pattern coding as the analyst is looking for ways of classifying instances into a more general class (Miles & Huberman, 1994). The relationship between the class or general category and the study’s conceptual framework need to be clear. In the current study this approach was used early in the analysis to note patterns such as deterioration or improvement, and late in the analysis to suggest possible links between changes in
cues and physiological instability. The results of this activity are reported in the
discussion in chapter 8.

Noting the relations between variables occurs after the researcher has identified
which variables are important in a situation and when it becomes possible to
investigate the nature of the relationship between them (Miles & Huberman, 1994).
Within the current study the relationship between subjective cues, objective cues and
the timing of when they were considered important in judgements of patient condition
was investigated. The study investigated if clinicians considered that subjective cues
preceded objective cues in judgements of patient condition, and the circumstances
under which subjective cues reportedly preceded objective cues. It was possible in the
current study to review the time sequence (initial, early and late) in which variables
were considered important for each outcome condition using the cross case matrices.
A version of the cross case matrices with the actual case codes noted was retained so
that it was possible to track back through the data to investigate relationships in
detail.

Finding intervening variables may be important when initial results demonstrate a
weaker relationship between variables than the study’s conceptual framework
suggested (Miles & Huberman, 1994). In other cases it may not be obvious why two
variables are related (Miles & Huberman, 1994). In the current study subjective cues
were important in the early recognition of deterioration and prediction of critical
illness and cardiac arrest in many cases, either as the initial cues or because they
complemented quantitative data, but in some cases they were not considered
important. In examining possible reasons for these observations the researcher
speculated that some cases were picked up late, earlier subjective evidence could
have been missed, and in other cases particularly catastrophic deterioration to cardiac
arrest, events occurred so fast that there was no opportunity to identify early warning
signs.
Building a logical chain of evidence, refers to seeking out a number of instances that have a similar direction and testing the claims being made in the research hypothesis or conceptual framework (Miles & Huberman, 1994). The chain of evidence is developed gradually through the life of the research project, with early hypotheses being checked in the next round of data collection, explanations are then refined, and these are tested in subsequent data collection (Miles & Huberman, 1994). According to Miles and Huberman (1994, p.260) the logical chain of evidence must be complete; it should be possible to move from antecedents right through to outcomes without any breaks in the chain. In the current study data were scrutinized to check if subjective cues were considered early and accurate predictors of patient outcome and the circumstances in which clinicians’ considered subjective cues important. Alternative hypotheses must also be examined; for example the hypothesis that objective cues were early and accurate predictors of patient outcome and the circumstances in which clinicians’ considered objective cues important.

There were cases where subjective cues were not considered important and so the researcher had to decide whether these were deviant cases and the hypothesis should be re-written to exclude them, or if the hypothesis required modification to accommodate all the cases (Bryman, 2001).

The final procedure for generating meaning is termed making conceptual/theoretical coherence (Miles & Huberman, 1994). At this stage the study findings were linked to broader constructs and more abstract theories which could make them applicable across a wider range of situations (Miles & Huberman, 1994). In turn these abstract ideas may help to explain some of the findings that were previously unclear (Miles & Huberman, 1994). A discussion of these aspects takes place in chapter 8.
6.7 Conclusion

This chapter presented the methods used in an empirical study designed to identify the cues considered important in transition from acute illness to critical illness or cardiac arrest clinical states. Strengths and limitations of interviewing as a method of data collection were reviewed. The main phases in data analysis followed the stages described by Miles and Huberman (1994) and data from the current study were presented as evidence in an audit trail to illustrate these processes. The next chapter reports the findings from the qualitative interview study in detail.
Chapter 7: Results

Cues considered important in clinicians' judgements of patients' condition in transition states from acute to critical illness or cardiac arrest

7.1 Introduction

This chapter reports the results from the empirical study. The research questions that arose from the systematic review findings (section 4.19, p.150) were used to develop qualitative research hypotheses that were examined in the empirical study. The hypotheses are listed below:

Hypothesis 1. Subjective clinician, behavioural and/or patient self-report data are frequently the earliest cues that a patient's clinical condition is deteriorating.

Hypothesis 2. Diagnoses and predictions of patient condition are often reported to be accurate in critical illness, cardiac arrest and acute and vulnerable to deterioration outcome conditions.

Hypothesis 3. Diagnostic, evaluative and prognostic judgements characterise nurses' assessments of patient conditions in transition from acute to critical illness or cardiac arrest states.

Hypothesis 4. General medical ward clinicians draw on cues from various dimensions of severity of illness when judging patient condition in transition states from acute to critical illness or cardiac arrest.

7.2 Case data

The case data on gender, age ranges, categories of medical conditions, and references to patients' physiological reserve were entered into graphs for each of the clinical outcome states of critical illness, cardiac arrest, acute illness and vulnerable to deterioration, acute, chronic and palliative/terminal illnesses. This information provided contextual information for the judgements of patient condition. Graph 17 shows patient history according to clinical outcome categories. Across the categories of outcome states patient history and medical conditions were reported.
Graph 17.  
Patient history according to clinical outcome categories 

Total = 109 cases

Graph 17(a)  
Critical illness cases  
n = 46

Graph 17(b)  
Cardiac arrest cases  
n = 23

Graph 17(c)  
Acute illness & vulnerable to deterioration cases  
n = 25
Graph 17 (continued)

Graph 17(d)
Acute illness cases
n = 3

Graph 17(e)
Chronic cases
n = 7

Graph 17(f)
Palliative care / terminal illness cases
n = 5
In some cases more than one medical condition was reported as a causal factor leading to the outcome condition, and these were all included in the results. The most frequently reported conditions leading to the outcome categories of critical illness, cardiac arrest and acute illness and vulnerable to deterioration to cardiac arrest or critical illness were cardiac/cardiovascular conditions, followed by respiratory conditions. The number of cases included in the remaining categories of outcome states was seven or less and the medical conditions were distributed across a range of conditions including respiratory, malignancy and post-operative cases. Due to the small sample sizes the current results are not generalisable. A similar number of males and females were reported across all outcome states with the exception of cardiac arrest cases that included more males than females. References to indicators of physiological reserve were reported across all the outcome states.

7.3 Research Question One- results

What cues do clinicians consider important in judgements of patient condition?

- How frequently are the various cues reported in judgements of patient condition?
- What are the sources of cues considered important in judgements of patient condition? (Using the typology of objective measures, paraclinical, laboratory or investigative data, subjective clinician/behavioural data, patient self-report, treatment response or patient history – see appendix 21: Coding framework and definitions for category membership)

A range of cues was considered important in judgements of patient condition. The content analysis of case reports and frequency counts of cues revealed that nurses reported more cues than are currently included in patient at risk scores. For example the Modified Early Warning Score (Stenhouse et al., 2000) specifies six physiological criteria. The original Medical Emergency Team calling criteria (Lee et al., 1995) identifies acute changes in cues relating to airway, breathing, circulation, neurology, and another category for patients who did not fit these categories but where there was still clinician concern.
Initial, early and late cues were identified to facilitate further data analysis (see definitions in section 6.6, p.222).

7.3.1 Critical Illness
The results for critical illness are summarised in Graph 18. In the initial time period subjective clinician and behavioural cues were more frequently reported as important in judgements of patient condition than any of the other categories of cues apart from the category patient history and medical condition(s) which may have informed all judgements. Breathing difficulties (13 cases) included breathlessness, abnormal chest sounds, and use of accessory muscles of respiration. Level of consciousness or Glasgow Coma Score (LOC/GCS) (9 cases) included patients labelled drowsy, unrousable, or with decreased level of consciousness. Behavioural signs (8 cases) covered changes in behavioural and functional ability, and specific references to tiredness, weakness, demeanour and abnormal position. Skin colour (6 cases) included references to ashen, grey, cyanosed, mottled, flushed, and pale looking. Within the objective measures heart rate (6 cases), blood pressure (5 cases) and urine output (4 cases) were most frequently reported.

Within the early time period the objective measure, blood pressure, was the most frequently reported cue (23 cases). The next most frequently reported cue was the subjective cue of behavioural signs (16 cases) which included references to behavioural and functional changes, and specific references to the patient appearing tired, lethargic, restless or uncomfortable, abnormal position and demeanour. Oxygen saturation levels were reported in 12 cases. Medical Emergency Team/Early-Warning Scores was the next most frequently reported cue (10 cases). The remaining cues reported in at least five or more cases were distributed across objective measures, paraclinical, laboratory and investigation data, and subjective cues with subjective clinician and behavioural data, patient self-report of symptoms and not responding to treatment. Within the objective measures it was noted that in eight cases objective measures were within normal ranges.
For the *late* time period the most frequently reported cues were the subjective cues of LOC/ GCS (10 cases), MET/EWS (10 cases) and not responding to treatment (10 cases). The objective measures of blood pressure, heart rate, oxygen saturation levels, respiratory rate, and urine output/ fluid balance were each reported in at least five cases. Electrocardiograph (ECG) was the most frequently reported paraclinical/ laboratory/ investigative data cue (9 cases). Breathing difficulties (9 cases) which included breathlessness, and changes to breathing, respiratory rate (7 cases) and behavioural signs (6 cases) were the next most frequently reported cues.

### 7.3.2 Cardiac Arrest

Graph 19 shows the cardiac arrest results. In the *initial* time period the most frequently reported cues were the subjective cues of behavioural signs (6 cases) which included more withdrawn, lacking in motivation, delayed mobility, quieter, demeanour, and tired. The next most frequently reported cues were the subjective cues of breathing difficulties (4 cases) which included respiratory function worse and gasping for breath. Looked unwell (4 cases) covered statements that the patient looked different, not very well or physically looked awful. The objective cue blood pressure was also reported (4 cases) as either hypotension or changes in blood pressure.

Within the *early* time period the objective cue ECG was the most frequently reported (7 cases) and included no ECG changes, atrial fibrillation, cardiac ischaemia, ectopics, and patients on cardiac monitoring. Also reported was blood pressure (6 cases), which included slight changes in blood pressure, blood pressure within normal ranges, and hypotension, subjective cues or behavioural signs (6 cases), skin colour (6 cases) which included colour change, poor or grey colour, and patient self- report of pain (6 cases). Types of pain reported were chest, back, and abdominal pain and discomfort.
Graph 19. Cardiac arrest cases  n = 23

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Number of cases: 23
For the late time period the most frequently reported cues were respiratory or cardiac arrest (19 cases). The remaining 4/23 cases included one patient who died in her sleep, one case where the elderly patient had requested not to be resuscitated, and two coronary care cases where cardiac arrest was the final stage in advanced cardiogenic shock. The next most frequently reported cue was the objective measure blood pressure (8 cases) as normal, hypotension, blood pressure unrecordable, no cardiac output, or increase in blood pressure. The next most frequently reported cues were the subjective cues of LOC/GCS (5 cases) which included references to patient collapse, and behavioural signs (5 cases) which included lethargy and looked exhausted.

7.3.3 Acute illness and vulnerable to deterioration to critical illness or cardiac arrest
Within this outcome category the patients did not have a major acute event and so cues tended to be reported more broadly as early rather than initial and early when the distinctions between these time periods were less obvious than in the above outcome states. The results are reported in Graph 20.

The most frequently reported cue in the initial time period was the subjective cue looked unwell (4 cases) and this was linked to the patient’s colour in two cases. Although objective measures and other subjective data were reported as initial cues they occurred in three or less cases.

In the early time period the most frequently reported cue was behavioural signs (11 cases) and included quieter, withdrawn, clasping the oxygen mask, delayed mobilisation, treated for constipation, still talking in sentences, unable to cooperate during washing, untalkative, tolerating lying flat, reduced mobility, mobilising with assistance. The next most frequently reported cue was skin colour (6 cases) which included pale, ashen, grey, or very red, and ECG (6 cases) atrial fibrillation and ischaemia, no acute changes, ECG should have been performed but was not according to the clinician, ectopic beats, and ECG abnormal. Oxygen saturation levels were also reported (6 cases).
Graph 20. Acute illness & vulnerable to deterioration cases

n = 25

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<td>Peri-arrest</td>
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<td>Treatment omission</td>
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<td>Abd. Dist/ fluid</td>
</tr>
<tr>
<td>Skin colour</td>
</tr>
<tr>
<td>Breathing imp</td>
</tr>
<tr>
<td>Irregular pulse</td>
</tr>
<tr>
<td>Pain</td>
</tr>
<tr>
<td>LOC/ GCS</td>
</tr>
<tr>
<td>Behavioural change</td>
</tr>
<tr>
<td>Psych. State</td>
</tr>
<tr>
<td>Confusion</td>
</tr>
<tr>
<td>Breathing diff</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
</tr>
<tr>
<td>Haematology</td>
</tr>
<tr>
<td>Coag. studies</td>
</tr>
<tr>
<td>MRSA positive</td>
</tr>
<tr>
<td>Scans</td>
</tr>
<tr>
<td>Chest/abd xray</td>
</tr>
<tr>
<td>ABGs</td>
</tr>
<tr>
<td>Serum K+</td>
</tr>
<tr>
<td>Blood Sugars</td>
</tr>
<tr>
<td>Cardiac enzyme</td>
</tr>
<tr>
<td>ECG</td>
</tr>
<tr>
<td>Fracture</td>
</tr>
<tr>
<td>Diarrhoea</td>
</tr>
<tr>
<td>Hypovol. shock</td>
</tr>
<tr>
<td>Wound Drainage</td>
</tr>
<tr>
<td>Temp</td>
</tr>
<tr>
<td>Signs satisfactory</td>
</tr>
<tr>
<td>Bleed</td>
</tr>
<tr>
<td>No event/changes</td>
</tr>
<tr>
<td>Vomit</td>
</tr>
<tr>
<td>CVP</td>
</tr>
<tr>
<td>Urine out/balancing</td>
</tr>
<tr>
<td>MET/EWS</td>
</tr>
<tr>
<td>RR</td>
</tr>
<tr>
<td>02 SATS</td>
</tr>
<tr>
<td>HR</td>
</tr>
<tr>
<td>BP</td>
</tr>
</tbody>
</table>

235 number of cases
Psychological state was considered important in some early cases (5 cases) and included patients who were considered anxious looking or distressed, and finally cues relating to patient self-report of pain (5 cases) specifically chest or abdominal pain were reported.

For the late time period the most frequently reported cue was responding to treatment/ tolerating treatment (9 cases) with treatments such as analgesia, GTN, oxygen, bed-rest, nil orally and intravenous fluids. This was followed by the objective sign of no major changes/ no event (7 cases).

7.3.4 Acute Illness
There were three cases in this outcome category and of the few cues reported subjective cues were the most frequently reported, see Graph 21. The initial cues were the patient history cues of chest infection and very elderly (case 8.5), high-risk surgery for adrenal tumour (case 30.3), and laparoscopic bowel surgery (case 32.5).

The early cues were MET score satisfactory (case 30.3), the subjective clinician cue of pain control good (case 30.3), weak tiny and emaciated (case 8.5), and tired (case 30.5). The behavioural/functional cues were reduced mobility (case 8.5) and eating post operatively without problem (case 32.5). Patient self-report was of no pain (case 30.3), and no complaints of feeling unwell (case 30.3, case 32.5). Response to treatment was reported as rapid post-operative recovery in case 30.3.

The late cues were reported as subjective clinician and behavioural/ functional cues of reduced mobility, required Zimmer frame (both in case 8.5), and bowel function normal (case 32.5). Response to treatment was reported as chest infection improved and responded to antibiotic therapy (case 8.5), and uneventful post-operative recovery (case 30.3, case 32.5).
Graph 21. Acute illness cases  n = 3

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
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<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>too late</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not responding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bravado'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>refused treatm.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dizziness'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>speech coherent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alright/ no pain'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nausea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refusing food</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short of breath</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bruise abdomen'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felt unwell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resp/card arrest</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| frail/emaciated  |         |       |      |
| Med diag wrong   |         |       |      |
| NRF              |         |       |      |
| Dark stools      |         |       |      |
| oedematous       |         |       |      |
| Pedal pulses'    |         |       |      |
| Spots/ bruises   |         |       |      |
| Fitting          |         |       |      |
| Swallow reflex   |         |       |      |
| Looked unwell    |         |       |      |
| Looked well      |         |       |      |
| Periph/ cold     |         |       |      |
| Sweaty           |         |       |      |
| Abd. Dist/ fluid |         |       |      |
| Skin colour      |         |       |      |
| Breathing imp    |         |       |      |
| Thready pulse    |         |       |      |
| Pain             |         |       |      |
| LOC/ GCS         |         |       |      |
| Behavioural      |         |       |      |
| Psych. State     |         |       |      |
| Confusion        |         |       |      |
| Breathing dif'   |         |       |      |

| Coag             |         |       |      |
| MRSA positive    |         |       |      |
| Scans            |         |       |      |
| Hb               |         |       |      |
| Chest/abd xray   |         |       |      |
| ABGs             |         |       |      |
| Serum K+         |         |       |      |
| Blood Sugars     |         |       |      |
| Cardiac enzym    |         |       |      |
| ECG              |         |       |      |

| diarrhoea'       |         |       |      |
| hypovol. shock   |         |       |      |
| Wound Drainage   |         |       |      |
| Temp             |         |       |      |
| Signs unchanged  |         |       |      |
| Bleed            |         |       |      |
| objective norm   |         |       |      |
| Not vomiting     |         |       |      |
| CVP             |         |       |      |
| Urine out/balance|         |       |      |
| MET/EWS          |         |       |      |
| RR              |         |       |      |
| O2 SATS          |         |       |      |
| HR              |         |       |      |
| BP              |         |       |      |

|0|5|0|5|0|5|

number of cases
7.3.5 Chronic Illness

There were seven cases in this outcome category, shown in Graph 22. Within the *initial* category the subjective cue of behavioural signs was the most frequently reported (3 cases) and included withdrawn, not eating or drinking, and unable to self-care. For the *early* category the subjective cue of behavioural/functional signs was again reported most frequently (5 cases) and covered reduced mobility/taken to bed, unable to self care, unable to eat or drink, and one anorexia/bulimia case with improved behaviour. The subjective clinician cue *looked unwell* was reported (3 cases). In the *late* time period oxygen saturation level, treatment response, non-response, and behavioural signs were each reported in two cases. Treatment response referred to oxygen saturation improved with physiotherapy and nebuliser therapy (case 19.4). Treatment non-response was a case where frusemide was administered for low urine output (case 29.2). The behavioural signs were able to eat and drink (case 31.3), and very sensitive to touch (case 29.2).

7.3.6 Palliative care/terminal illness

Graph 23 shows the palliative/terminal illness cases. There were five cases in this outcome category. Within the *initial* time period category behavioural signs was reported in two cases specifically self-removal of a nasogastric tube, and sleepier. Skin colour was reported as pale in one case, and blood pressure was reported in one case of a patient who required Inotrope support. For the *early* time period behavioural signs (unable to verbalise treatment preferences, reading and writing less, tingling motion in lips) and not responding to treatment (not recovering from surgery, breathing deteriorating whilst on oxygen therapy, urine output not responding to fluid challenge) were each reported in three cases. In the *late* time period category the subjective cue of breathing difficulties was reported most frequently (3 cases). Breathing difficulties included chest sounds and requiring suctioning, being on pressure support ventilation but oxygen saturation levels dropping, and *puffing* respirations.
Graph 22. Chronic illness cases  n = 7

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too late</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responding/tolerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not responding</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                  |         |       |      |
| bravado          |         |       |      |
| refused treatm.   |         |       |      |
| dizziness        |         |       |      |
| speech coherent  |         |       |      |
| tired            |         |       |      |
| alright/ no pain |         |       |      |
| nausea           |         |       |      |
| Refusing food    |         |       |      |
| Short of breath  |         |       |      |
| Bruise abdomen   |         |       |      |
| dizziness        |         |       |      |
| Felt unwell      |         |       |      |
| Pain             |         |       |      |
| resp/card arrest |         |       |      |

|                  |         |       |      |
| peri-arrest      |         |       |      |
| Med diag wrong   |         |       |      |
| NFR             |         |       |      |
| Dark stools      |         |       |      |
| oedematous       |         |       |      |
| Pedal pulses     |         |       |      |
| Spots/ bruises   |         |       |      |
| Fitting          |         |       |      |
| Swallow reflex   |         |       |      |
| Looked unwell    |         |       |      |
| Looked well      |         |       |      |
| Periph/ cold     |         |       |      |
| Sweaty           |         |       |      |
| Abd. Dist/ fluid |         |       |      |
| Skin colour      |         |       |      |
| Breathing imp    |         |       |      |
| Thready pulse    |         |       |      |
| Pain             |         |       |      |
| LOC/ GCS         |         |       |      |
| Behavioural      |         |       |      |
| Psych. State     |         |       |      |
| Confusion        |         |       |      |
| Breathing dif    |         |       |      |

Subjective

|                  |         |       |      |
| Coag. studies    |         |       |      |
| MRSA positive    |         |       |      |
| Scans           |         |       |      |
| Hr              |         |       |      |
| Chest/abd xray   |         |       |      |
| ABGs            |         |       |      |
| Serum K+        |         |       |      |
| Blood Sugars    |         |       |      |
| Cardiac enzym   |         |       |      |
| ECG             |         |       |      |

Para. Lab. data

|                  |         |       |      |
| diarrhoea        |         |       |      |
| hypovol. shock   |         |       |      |
| Wound Drainage   |         |       |      |
| Temp            |         |       |      |
| Signs unchanged  |         |       |      |
| Bleed           |         |       |      |
| objective norm   |         |       |      |
| Not vomiting     |         |       |      |
| CVP            |         |       |      |
| Urine out/balance |         |       |      |
| MET/EWS         |         |       |      |
| RR             |         |       |      |
| O2 SATS         |         |       |      |
| HR             |         |       |      |
| BP             |         |       |      |

Objective Measures

|                  |         |       |      |
| number of cases | 239     |       |      |
Graph 23. Palliative care / terminal illness cases  n = 5

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<td>Responding/tolérating</td>
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<td>Response</td>
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<tr>
<td>Ca not talk</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>bravado</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>refused treatm.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>diziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>speech coherent</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>tired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alright/ no pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nausea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refusing food</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short of breath</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bruise abdomen</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felt unwell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not responding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dying no obs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypovol. shock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound Drainage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signs unchanged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>objective norm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not vomiting</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CVP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine out/balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MET/EWS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O2 SATS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td></td>
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<td></td>
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<tr>
<td>BP</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Subjective

Para. Lab. data

Objective Measures

number of cases
7.4 Research Question Two

Are subjective clinician, behavioural signs or patient self report signs considered important in judgements of patients' conditions in the clinical outcome states of critical illness, cardiac arrest or acute illness and vulnerable to physiological instability and deterioration to critical illness or cardiac arrest?

- When are subjective clinician, behavioural signs or patient self report signs considered important in judgements of patient condition?
- Which subjective clinician, behavioural signs or patient self report signs are considered important in judgements of patients' conditions?

Graphs 18, 19, 20 above demonstrate that subjective cues including subjective clinician/behavioural signs, and patient self-report were considered important in judgements of patient condition in critical illness, cardiac arrest and acute illness and vulnerable to deterioration to critical illness or cardiac arrest. The conditions under which various types of cues were considered initial predictors was reviewed and tables constructed for each outcome state. Pattern codes were attached as follows:
- Subjective cues reported as initial cues in judgements
- Subjective and objective cues together reported as initial cues, and
- Objective cues reported as initial cues.

Clinicians were asked to recount cases where patients went on to critical illness. The questions were then modified to ask about patients with cardiac arrest, and contrasting cases where the patients did not go on to critical illness or cardiac arrest (see Appendix 19: Interview guide). The responses elicited from clinicians were narrative descriptions. The extracts reported below were selected to provide the full range of cues elicited.

7.4.1 Critical illness

Clinician subjective, behavioural or patient self-report data were considered important initial cues in predictions of critical illness in 54% (25/46) cases and may have been present before changes in objective signs had occurred or were the main...
triggers to objectively measure the patient’s physiological status. Clinician subjective, 
behavioural or patient self-report data were complementary to objective data in 35% 
(16/46) of cases, and in only 11% (5/46) of cases were objective measures noted as 
the most important initial or early signs. In 13% (6/46) of critical illness cases 
clinician subjective, behavioural or patient self-report data alone were reported as 
cues to indicate that the patient’s condition was deteriorating; there was no objective 
evidence of deterioration available.

In the 54% (25/46) of cases where subjective data were considered the most 
important, initial cues were found across the categories of chest pain, abdominal pain, 
respiratory function, change in colour, altered level of consciousness and urinary 
incontinence, see Table 23. The medical conditions within this category included post 
myocardial infarction (5 cases), pulmonary embolus/ deep venous thrombosis (4 
cases), respiratory failure (5 cases), neurological – cerebral vascular accident, 
epilepsy (4 cases), carcinoma (3 cases), internal haemorrhage (2 cases), cardiac 
tamponade (1 case), diabetes mellitus (1 case), and intestinal obstruction (1 case). Of 
the 25 cases in this category 21/25 were general medical cases, 3/25 were surgical 
and 1/25 was a coronary care patient.

Table 23: Critical illness cases where subjective data were considered the earliest 
cues in judgements of patient condition, n=25 cases

<table>
<thead>
<tr>
<th>T.23 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
</table>
| **Chest pain**                   | Interviewer* How do some of these patient’s problems present?  
Persistent chest pain  
Patient description of knife-like pain moving up to shoulder blades area  
Patient complaint of chest tightness  
1nt 1 case 2 Persistent “chest pain” [new chest pain admission to cardiac medicine ward] Lines 199-201 |
| **Abdominal pain or abdominal discomfort** | Interviewer* How did this lady’s condition present?  
Int 22 case 2 “...looked bad, ...looked grey, ...was very short of breath, em and with pain in the back and chest.” [post orthopaedic surgery patient developed pulmonary embolism] Lines 125-127 |
| **Distended abdomen**            | Int 17 case 2 “Em the most recent incident of somebody becoming acutely ill and she did in fact as soon as I came on the shift...The lady one of my colleagues had been concerned that she’d had a distended abdomen...they did a bladder scan which recorded four hundred mis...inserted a catheter which only drained a small” |

242
<table>
<thead>
<tr>
<th>T.23 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
</table>
| abdominal pain    | amount which seemed a bit odd...tried everything thinking maybe there was a blockage or whatever and did all the little tricks with a catheter and it still wasn't draining very much and the scan showed 700 mls...actually she had a rectus sheath bleed there was about 1 litre in there”.

[Medical patient, cardiac patient had been making slow but steady progress, developed internal haemorrhage –on anticoagulant therapy] Lines 81-84, 104-105 |
| Projectile vomiting | Interviewer* If you have some cases in mind you could start off with perhaps summarising the main details relating to one person's personal, medical, and nursing history and reasons for coming in to hospital?

Int 30 case 1 “Right the most recent one that's come in is a lady in her late 70s, she'd come in for a total hip replacement. And she'd actually recovered from that and was just about mobile again when she dislocated and had to have a relocation of her hip, and after that she became acutely unwell, initially we thought it was constipation but it was a twisted bowel... projectile vomiting.” [in post-operative patient] Lines 20-30 |

Breathing difficulties
| Short of breath | Interviewer* Em perhaps at this stage we could go back to the other patient’s case that you mentioned earlier. And if you could give me details on that person, their past medical history, their reason for admission and any significant medical and nursing details?

Int 11 case 2 “Em he was a very elderly gentleman I think he was in his 90s em fully comosmentis and a very charming man. Came in with a chest infection and was a known COPD. And em spent a couple of days pottering around his bed needing his oxygen if he did too much but he was managing. Speaking in sentences, eating his food, everything. And again during the morning shift he started becoming quite really quite breathless, cold and clammy not able to speak in sentences really struggling and chest sounded dreadful”.

[Medical patient with Chronic Obstructive Airways Disease] Lines 212-222 |
| Sudden onset of breathlessness | Interviewer* So at what stage would you estimate that her condition was becoming seriously ill or becoming more life-threatening?

Int 12 case 2 “Em I think she was one of those ladies that I just got concerned about really quite early on in the shift. Because although.initally she was ok, she seemed to change quite quickly, she seemed to get tired quite quickly she was asking for nebulisers much more frequently. Em the Aminophylline that was going through didn’t seem to be helping. Em she was sort of holding the mask to her face so she could breathe so quite early on in the shift I became concerned as the rate of nebulisers increased and she started to gasp a bit more really. Em then quite a lot. And I usually phone the Registrar ....So they probably, they usually come fairly quickly for me...”

[Medical ward patient with acute asthma attack transferred to ICU] lines 243 -257 |
<p>| Sudden onset of shortness of breath | |
| Unable to speak in sentences | |
| Unable to speak | |
| Struggling to breathe | |
| Abnormal chest sounds | |
| Patient self-report of being unable to get air into lungs | |
| Increasing tiredness | |
| Increasing respiratory effort | |
| On oxygen and nebuliser therapy | |
| almost continuously | |
| Poor sitting posture, slumped and not breathing effectively. | |
| Laboured breathing | |
| Ineffective breathing – not breathing deeply into bases of lungs. | |
| Behavioural | |</p>
<table>
<thead>
<tr>
<th>T.23 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>changes- clasping the oxygen mask tightly, looking fearful.</td>
<td>Int 1 case 4 “We’ve had cystics [Cystic Fibrosis patients] in the past who have had respiratory problems, and they’re sort of different again in case really. Because they’re often very far down the line. They’re often very anxious when they are short of breath. We had a chap, a lad actually, who actually kept getting pneumothoraces, and we knew him really well, [different tone, sounds sad] we knew his personality. And I would say he was always quite anxious anyway, and um, I remember we had quite a lot of bother insisting that the doctors came up to see him...His actual physical signs you couldn’t say there was a lot different. He never had good SATS anyway, always short of breath, always used his accessory muscles...that was a lot to do with knowing his personality, and he knew that something wasn’t right. ...wasn’t getting any air into lungs”. [Cystic Fibrosis patient with 3 pneumothoraces, had cardiac arrest later in treatment unit, resuscitation unsuccessful, and patient died] Int 1 case 4 Lines 274-275</td>
</tr>
</tbody>
</table>

Interviewer* I am interested in situations where the patients’ conditions change from acute illness to becoming more seriously ill and I was wondering if you could recall some examples of patients that you would put in that kind of category?

Int 27 case 1 “Yes. I mean the first one that springs to mind is the lady that I looked after ....who’d had a gastrectomy. So she’d been in high dependency area for a couple of days and had come back to us and I felt she was quite high risk, she was fairly elderly. And when I went into the room she was you know, her position wasn’t great. She was quite slumped and that kind of thing, and to me the breathing, and the just general respiratory rate, and the way [the patient] was breathing sort of caused me concern”. [Elderly post operative major surgery patient] Lines 17-20

Interviewer* And your third patient, you mentioned you may have another case?

Int 18 case 3 “Well this one she did very well...” Colour change-“...a slight change in colour, looked sort of greyish really in a ...tanned person. Behaviour changes- clasping the oxygen and it was that look (of fear) again”.[Medical patient with cardiac tamponade] Lines 359-378

Interviewer* If you could recall a few patients whose condition deteriorated?

Int 21 case 1 “I can remember one of the patients...So she came down from ICU and with a left ventricular failure and everything like that and she was not for resusc she’s not for everything.” “Interviewer Not for resus? [Not for resuscitation does not mean not for care]

Int 21 case 1 “Not for resus not for everything and suddenly she developed some shortness of breath. So even she’s not for MET or for you know resusc. I will not let her deteriorate as quickly as I can. So I did this I just bleeped one of the doctors and then we did some ECG and there were some ECG changes and also some em what do you call this one, when you did some blood gas which had some abnormalities.” [Medical ward patient transferred from
**T.23 Cues reported**

| **Examples** | **ICU with left ventricular failure and myocardial infarction, acute episode treated with medication, patient recovered, and was discharged home.** Lines 11-23 |
| **Interviewer** | Having talked through this case are there any other cases that you can recall? |
| **Int 4 case 2** | "...The last MET call I put out was quite similar in that it was the respiratory function that alerted us more. The patient was short of breath, he was cold and clammy, his ST segments were going up following thrombolysis." [CCU patient admitted with chest pain, transferred from A&E after thrombolysis] Lines 178-180 |
| **Interviewer** | I am particularly interested in situations where patients conditions changed from being acutely ill to being either at high risk of critical illness or actual critical illness. And I was wondering if you'd be able to recall a few of those types of cases? |
| **Int 8 case 1** | "...Yes I can especially working on here...There's a patient on the ward at the moment who came in with em been, found to be in fast AF. And after being on the ward for a couple of days with the AF being treated and in a monitor bed umm she had digoxin. She was actually becoming more and more unwell and medical team decided that she was septic from something they don't still don't quite know what, query diverticulitis. Em and on one particular morning she became very breathless. She's a very very nice lady who is very uncomplaining and she was quite blue peripherally as I say very breathless didn't look well at all. We did one set of obs immediately it was very early on the shift." [Medical ward patient admitted with Atrial Fibrillation, developed sepsis] Lines 37-46 |

<p>| <strong>Change in colour</strong> | <strong>Grey colour</strong> |
| <strong>Clamminess</strong> | <strong>Sudden change in colour to grey</strong> |
| <strong>A more yellow colour</strong> | <strong>Interviewer</strong> And the man that you called Outreach team for in that bay a few days ago, I think you were around whenever his condition was changing? |
| <strong>Int 29 case 4</strong> | &quot;Oh yes Mr...yes we'd um, we'd been referring him all week, every time the doctors came round they said he's fine. But he's not fine...didn't look well... was grey in colour. Observations were satisfactory, but then nearer lunchtime couldn't breathe. Difficulty breathing... respiratory rate was high.&quot; [Medical patient with multiple medical problems and pleural effusions] Lines 208-211 |
| <strong>Interviewer</strong> | If you could take that first example and summarise some of the points or the main details relating to that person's personal, medical and nursing history, and that could also include their reasons for admission to hospital? |
| <strong>Int 7 case 1</strong> | Clamminess and grey colour &quot;...when I got to the patient after handover today, classic signs she looked clammy, she looked you know greyish. She just... there was just something not right about [this patient]&quot;.[Medical patient admitted with atrial fibrillation, developed acute myocardial infarction] Lines 33-35 |
| <strong>Interviewer</strong> | And at what stage did you think that her condition was becoming serious? |</p>
<table>
<thead>
<tr>
<th>T.23 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int 11 case 1 “...Em we did a set of obs. on her in the morning that were all slightly abnormal but just so you say we'll keep an eye on her and do it again later. After she'd had her lunch she started going a horrible grey colour and saying she really didn't feel very well and then we started rechecking everything and there was definitely a downward slide”. [Medical ward patient with chronic obstructive pulmonary disease, developed abdominal pain with gastrointestinal bleed related to anticoagulant therapy. Admitted to HDU] Lines 51-57</td>
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<tr>
<td>Level of consciousness</td>
<td>Interviewer* Would it be possible to move on to another example and give me the background for that person and their personal, medical and nursing history? Int 10 case 2 Sudden onset of &quot;...coughing into porridge. Palpated swallow reflex- possible swallow deficit.&quot; [Medical patient - Cerebral vascular accident patient] Lines 296-299</td>
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<tr>
<td>Gradual increase in confusion</td>
<td>Interviewer* I was wondering if you would be able to recall examples of patients whose condition changed from acute to critical illness or to being at high risk of critical illness? Int 17 case 1 Sudden deterioration in level of consciousness, started &quot;to go off&quot;.[Medical patient with multiple medical problems including diabetes mellitus] Lines 33-34</td>
</tr>
<tr>
<td>Sudden onset of vagueness, not making sense</td>
<td>Interviewer* So if you have a few cases in mind perhaps you would like to talk through the first one? Int 28 case 1 Gradual deterioration in level of consciousness over period of days &quot;...became agitated, GCS dropped and you can see visibly in front of us the patient is getting worse&quot;. [Medical patient undergoing investigation for sudden deterioration- possible brain tumour] Lines 11-14</td>
</tr>
<tr>
<td>Sudden onset of coughing on food</td>
<td>Interviewer* Can you think of any other cases that you have nursed recently? Int 9 case 3 “This one was a long time ago. I mean I'd not been qualified that long and I was doing some nights and a gentleman who the night before although he had chronic breathing problems you know he was alert, was able to walk out to the toilet could take all his medication. And the next night for some reason he wouldn't, couldn't take his tablets, couldn't sort of like wake him and nobody had handed over to us that there was a problem.... And of course I was trying to give him his medications and there was no response so I did his blood pressure and everything like you do and his BP was down in his boots so we got the doctors down to review him and he was up in ITU in [name of tertiary referral hospital] within about four hours so I...mean...” [Medical ward patient, diagnosis not reported] Lines 229-241</td>
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</table>
| Swallow deficit Poor swallowing reflex Sudden onset of patient distress, agitation or confusion Sudden change in level of consciousness Sudden deterioration in level of consciousness, "going off". Glasgow Coma Score (GCS) dropped No response to painful stimuli | Interviewer* [Interviewee refers generally to confusion and distress as signs of deterioration] Have you any cases in mind where the patient was confused or distressed? Int 6 case 4 “Em we had an incident again on the team next door where a patient newly admitted and they were querying that she had carcinoma of some sort but they didn't know where. Quite a
<table>
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<tr>
<th>T.23 Cues reported</th>
<th>Examples</th>
</tr>
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<td>young lady and she went off very quickly very quickly. And that was a MET call but that was the situation where doctors were at an arrest on orthopaedics and so was blue star [the senior nurse in charge of the hospital] and orthopaedics aren't used to arrest situations and it was obviously that they were the priority. We had a patient with no line in no venous access getting very distressed and very agitated very confused em and we did...</td>
<td>[Medical ward patient admitted with carcinoma location not confirmed, developed hypoglycaemia] Lines 482-490</td>
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<td>Interviewer* And can you think of any other cases where the patient was acutely ill and you then became more concerned? Int 7 case 2 &quot;...It was on nights em one night and I had a lady in she was about forty eight years old and I think she came in with query a malignancy I can't pronounce that word. Em and one morning she was absolutely fine and she as she walked out to the toilet and she was going really vague on me. She was not making sense I mean I talk quite well to my patients and I just thought again my feeling was this isn't right just wasn't making sense. She again she looked she was complaining of a bit of pain in her chest and she was em complaining of I think she was complaining of shortness of breath at the time.</td>
<td>[Medical ward patient with carcinoma, hypoglycaemia, later developed sepsis] Lines 208-216</td>
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<tr>
<td>Interviewer* Have you any other cases just at the moment that you can remember? Int 12 case 3. &quot;Em yeap. That was em last weekend or the weekend before we had a lady that had come in with chest pain query cardiac pain query PE. Em was a bit confused that she had dementia so it was a little bit difficult to tell how much of it was sort of hypoxia or that she was unwell or her dementia anyway as she was in different surroundings. Em needed oxygen when she first came in but became over the weekend became increasing confused. Em and the doctors were asked to see her twice and refused twice because they were in Accident and Emergency and in the end she ended up going to A&amp;E and having some TPA. Em because they decided she had a large PE so she was very poorly over the weekend. Em and again I think somebody probably rang the Registrar to come and see her em and she’s O.K. she’s further down the ward now. But again she became increasingly short of breath hypotensive agitated trying to climb out of bed de-saturating very quickly. I don't know whether they managed to get gases because she was very restless em and again it was when one of the senior medical staff saw her often the junior ones...&quot;</td>
<td>[Medical ward patient with chest pain, query pulmonary embolus] Lines 281-299</td>
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<tr>
<th>Behavioural/Functional changes</th>
<th>Sudden onset of urinary incontinence</th>
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<td>Interviewer* I was wondering first of all if you could tell me about some of the patients you have nursed who went on to have life-threatening events or a serious clinical deterioration? [Interviewee nods in agreement] If you could take these examples one at a time and summarise their details and some of the things that led...</td>
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In the 35% (16/46) of cases where subjective data were complementary to objective data are shown in Table 24. The conditions present in these cases were examined further. In the majority of cases patients appeared to be further along the trajectory towards critical illness than the 54% (25/46) of cases identified in the category where subjective signs were reported as the initial cues. A range of subjective cues such as decreased level of consciousness, chest pain, colour changes, breathlessness, behavioural signs (patient removing oxygen mask, refusing food, weakness and lethargy) complemented the measurable indicators of cardiac, respiratory, cardiovascular, renal/ fluid balance, multiple states, and gastrointestinal bleed clinical states. The medical conditions within this category were respiratory failure (including one aspiration pneumonia and one possible pulmonary embolus) (6 cases), myocardial infarction or cardiac arrhythmias (3 cases), gastrointestinal bleed (3 cases), congestive cardiac failure (1 case), and sepsis including one case of meningococcal
septicaemia and one case secondary to psychiatric condition (refusing food) (2 cases). In this category 8/15 cases were medical, 5/15 were surgical, and 2/15 were intensive care cases.

Table 24: Critical illness cases where subjective data were seen as complementary to objective measures as earliest cues in judgements of the patient condition, n=16 cases

<table>
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<tr>
<th>T.24 Cues reported</th>
<th>Examples</th>
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<tr>
<td><strong>Cardiac cues</strong></td>
<td>Interviewer* Could you refer to one or two cases that went on to life-threatening events?</td>
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<tr>
<td>Decreased level of consciousness</td>
<td>Int 5 case 1 “Em there was a man who came in in complete heart block and he was quite moribund when we were actually pacing him. Em and obviously on the assessment initially he was still slightly responsive but he was losing consciousness and he was his blood pressure was low and his heart rate was 20-30 beats per min (complete heart block)” [Cardiac patient admitted to coronary care with a life-threatening condition] Lines 186-189</td>
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<tr>
<td>Chest pain</td>
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<td>Abdominal pains (pain later experienced in chest and between should blades)</td>
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<td>Sweating</td>
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<td>Collapse</td>
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<td>Low blood pressure</td>
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<tr>
<td>High blood pressure</td>
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<td>Bradycardia</td>
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<td>Heart block</td>
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<td>Tachycardia</td>
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Interviewer* If you could think of the first case and if you could recount the medical and nursing history and then we could move on to the situation you found yourself in? Int 32 case 1 ”...Post-operative tachycardia of 100 dropped to 45 beats per minute, at which point the patient actually passed out.” [Post operative patient with cardiac history, transferred to CCU for cardiac monitoring and review of medication] Lines 48-51.

Interviewer* Have you been around when patients have deteriorated on this ward (CCU)? Int 21c3 “There’s one very good example also we got a patient I mean one of the patients a gentlemen he is a very young fifty years old and then he came in due to er chest pain OK All enzymes are increased, Trop T is positive. Only chest pain and hypertension and everything and then always complaining of abdominal pains sweating everything like that. And then the doctor we don’t know where the hypertension came from. We did some ultrasound abdominal ultrasound and everything and they found some em mass on the adrenal gland. That’s the one that’s causing er hypertension so they give some Alpha- something blocker and just to and he had some operation also and also he’s had a history of Crohn’s disease also...” [Admitted to CCU with chest pain, investigated for hypertension, required adrenalectomy, recovered and was discharged home]. Lines 212-224

Interviewer* That’s not a problem, I’ll give you a few moments to think if you have any examples of patients (who changed from acute to critical illness or to high risk of critical illness) Int 19 c1 “...We had a patient I think he is only forty five a forty five year patient who came to us with abdominal pain, upper quadrant upper abdominal pain. Then he was taken by a surgical with a surgical team and he was, he had x-rays and such like that but all came back negative. Then after two days he became like so tachycardic and sweaty and then the pain moved up.” [Surgical ward admission with abdominal pain- upper quadrant. Developed
<table>
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<tr>
<th>T.24 Cues reported</th>
<th>Examples</th>
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<tbody>
<tr>
<td><strong>Respiratory cues</strong></td>
<td>Interviewer* Could I ask you to recall a few patients that you have nursed whose condition changed from being acutely ill to being more at high risk of critical illness or critically ill?</td>
</tr>
<tr>
<td>Increased respiratory rate</td>
<td>Int 9 case 1 &quot;The first one was probably about four months ago. A gentleman in his 60s, normally fit and independent but had come to us as a result of a stroke. ...He was doing quite well and then one day we noticed an increase in respiratory rate, looked flushed in the face and patient stated he felt unwell which was unusual for this patient to complain.&quot; [Medical patient following cerebral vascular accident developed aspiration pneumonia] Lines 44-48</td>
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<tr>
<td>Flushed in the face</td>
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<td>Patient self report of feeling unwell</td>
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<tr>
<td>Exhaustion</td>
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<td>Acutely short of breath</td>
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<tr>
<td>Receiving oxygen and almost continuous nebuliser therapy and condition not responding to treatment</td>
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<td>Observations within acceptable range (apart from respiratory observations)</td>
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<tr>
<td>Systolic blood pressure low or below pulse rate 'Portsmouth sign'.</td>
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<td><strong>Urine output/ fluid imbalance or overload</strong></td>
<td>Interviewer* Have you got any other patients that you can recall at the moment em that you noticed a change in their condition over a period of hours or days?</td>
</tr>
<tr>
<td>Sudden decrease in urine output</td>
<td>Int 6 case 3 &quot;When I was on night duty there was a patient on the team next door...Sudden decrease in urine output We knew this patient wasn't right but we didn't know what was wrong. Score was outside the MET score criteria initially.&quot; [Medical ward patient with chronic respiratory disease having continuous positive pressure via a face mask- transferred to HDU] Lines 260-263, 274-275.</td>
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<tr>
<td>Clinician non-specific concern about patient condition</td>
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<td>Pale looking</td>
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<tr>
<td>Medical Emergency Team Score- outside criteria initially, deteriorating to within the MET criteria.</td>
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<tr>
<td>Patient self report of</td>
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250
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<tr>
<th>T.24 Cues reported</th>
<th>Examples</th>
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<tr>
<td>shortness of breath, feeling unwell</td>
<td>and looked pale&quot; [Medical patient admitted with congestive cardiac failure and developed renal failure - transferred to coronary care] Lines 41-44, 54-55</td>
</tr>
<tr>
<td>Not making expected progress after surgery</td>
<td>Interviewer* Do you have another case in mind? Int 30 case 2 &quot;Fluid overload in elderly post operative patient, condition deteriorated rapidly...confused at times, wasn't breathing very well...wasn't picking up after surgery&quot; [Gastrectomy patient developed fluid overload in early post-operative days] Lines 247-248, 260-263</td>
</tr>
<tr>
<td>Confusion</td>
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<thead>
<tr>
<th>Multiple clinical cues</th>
<th>Interviewer* Taking the first example could you summarise the main details about the patient's medical, nursing history and reasons for admission?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low or nil urine output</td>
<td>Int 12 case 1 Sudden deterioration before admission, &quot;...ill since admission, no urine output, confusion. Removing oxygen regardless of the type of oxygen mask or the nasal cannulae or whether family sat and held it on, ... de-saturating very quickly&quot; [Medical ward admission with abdominal pain, developed renal failure, and acute myocardial infarction]. Lines 66-80</td>
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<tr>
<td>Confusion</td>
<td></td>
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<tr>
<td>Removing oxygen mask</td>
<td>Interviewer* So what did you particularly note in that girl's condition? Int 14 case 1 Rapid onset critical illness &quot;...with very low blood pressure, rapidly became drowsy, respiratory rate was high initially, within 45-50 minutes level of consciousness decreased and became unrousable&quot; [ICU admission with meningococcal septicaemia] Lines 49-51</td>
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<td>Oxygen saturation levels low</td>
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<td>High blood pressure</td>
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<td>Crepitations on lungs</td>
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<td>High central venous pressure (CVP)</td>
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<td>Shortness of breath</td>
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<td>Decreased level of consciousness</td>
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<td>Raised respiratory rate</td>
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<th>T.24 Cues reported</th>
<th>Examples</th>
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<tr>
<td>&quot;... the first one is a man in his early [age range] who came to us em from the [name of psychiatric hospital] because he'd stopped eating for religious reasons so he obviously had a a sort of psychiatric history. Em and he refused everything really. Em and then as time went on he obviously became weaker and weaker and was unable to sort of mobilise. And on one occasion he collapsed in the night and they put in a central line but he was still able to say because we thought while he's got a central line in we might as well start feeding him. You know, but he'd even though he had he was mentally ill he was very adamant that he didn't want to be fed. And er he was just a very quiet man and then he never did spike a temperature but he actually became septic and it was quite difficult to spot because he was non communicative. And on that occasion he it was his respirations that went up and his saturations just dropped. His blood pressure which had been low just went lower. But you weren't getting anything from him you know he was quite sort of flat really. ...you know and you knew then that there was something very odd going on because it had changed from you know the morning to the afternoon well it had been within the hour really</td>
<td>Interviewer* Yes so I was going to ask you at what stage you realised he was becoming more ill? Int 18 case 1. Right we did usual obs... I think we just did usual obs in the middle of the day. And we'd put oxygen on him because his SATS had dropped to sort of ninety from their usual.</td>
</tr>
<tr>
<td>T.24 Cues reported</td>
<td>Examples</td>
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| And then           | *Interviewer What were they normally can you remember?  
Int 18 case 1 Yeah they were normally sort of ninety six something like that. Trying to think what his pulse rate was, a normal pulse rate. Em then he was kind of very sleepy and everything so we went back and we did his SATS again and even with the oxygen on they'd dropped to sort of the mid eighties. His resps were now sort of thirty something and em his BP never really changed that much and you know that's when we called you know because his resps had gone up to within MET level. "*[Medical ward patient with psychiatric history, refusing food, developed sepsis and deteriorated, seen by MET and transferred to ICU where he died a few weeks later]*. |
|                   | Int 23 case 1 *I had a patient, a 70 years old female, who was admitted originally to the medical ward and she actually came to the surgical unit because of PR bleeding. But since admission she hadn't any episodes of melaena, but in view of her past medical history included ischaemic heart disease so they wanted to keep an eye on her. ...She was a very big lady and had a huge abdomen. And since admission she hadn't any episode of melaena. She was an ex smoker and then she was admitted. ...On admission her blood pressure was high with a poor urine output, on auscultation um she had bilateral crepitations on both lungs and her CVP was really very high. So they took bloods as well. And checked vital signs. They initially managed her, they took ABGs and her blood gases weren't very good, low PO2. She was actually diagnosed as having a type 1 respiratory failure but in view of her very high CVP reading, shortness of breath and chest x ray as well revealed like she had pulmonary congestion or pulmonary oedema. So umm the registrar was there. And they got the anaesthetist down and so they suggested BiPapping her. And she was started initially on 5 of PEEP. They gave her frusemide, and then she's also diabetic and she was on a sliding scale...one of their concerns, when they gave her frusemide they weren't able to really check how was her potassium now. So they gave frusemide...a diuretic...and so ...watched the ECG, took bloods and gave potassium supplements. ECG tracing. After that she's still short of breath and she went into AF as well*. |
Interviewer* So were you the nurse with her at this stage?  
Int 23 case 1 *Yes. The nurse, I did an admission ECG and then she was on continuous respiratory assessment and cardiovascular umm. They actually were worried at that point because umm she was high risk for surgery.... The nurse played a very important role in a way because really she is the one who monitors and refers most of the time to the anaesthetist and the registrar... we work closely together. So yes she went into AF and then they came to see her. And at the same time she had shortness of breath...they also started her on amiodorone, a loading dose of amiodorone, so continuous monitoring was done, however despite the frusemide um injections and the diuretic her CVP wasn't accurate. ...UUUmm after 5-6 days actually the patient's condition was very, not stable, but very temperamental. At times she was stable and then after a couple of days she tends |
### T.24 Cues reported

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
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<td>to deteriorate. ...So in the end the patient was on ...humidified oxygen and nebulisers, she was in fact managed very well, but still in view of her past medical history and the quality of life she had after that issues she was placed not for resusc., but she lived, and after a week or ten days she was actually discharged from the unit.“ [Medical admission with abdominal pain and gastrointestinal bleeding, transferred to surgical HDU] Lines 19-79</td>
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### Gastrointestinal bleed

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<th>Interviewer* You’ve mentioned two cases, do you have any other examples?</th>
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<td>Int 22 case 3 “Very recently one where an elderly lady came I don't know if this is relevant. She had a haemorrhoidectomy and went home and she phoned back to say she was bleeding. She came back in that morning... and there was a call to her room where there was already a nurse and she was sitting on the commode and she looked to all intents and purposes as if she had collapsed. A sudden collapse, pale looking, not conscious, bleeding per rectum post haemorrhoidectomy. I couldn't get her peripheral pulse and she looked like she was dead or dying” [Surgical patient], Lines 213-217</td>
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The category in which objective measures were reported as the most important initial or early cues (11% or 5/46 cases) are shown in Table 25 and they constitute examples of negative cases for the research thesis. The conditions present in these cases were examined further. One case with atrial fibrillation was identified in the immediate post-operative period (case 9.2), and the second case was readmitted to
ICU with low serum potassium (case 15.2) that may have been picked up late, missing possible early signs. Two cases were referred due to problems in the post operative and recovery periods (case 25.1, case 30.4). The remaining case was a patient recently admitted with chest pain and no other acute signs or symptoms (case 15.3), however a routine ECG was abnormal. The objective data or measures reported as cues within this category included atrial fibrillation, tachycardia, acute changes on ECG, large decrease in blood pressure, decrease in urine output, and low serum potassium. In this category 3/5 cases were surgical, 1/5 was coronary care, and 1/5 was intensive care.

Table 25: Critical illness cases where objective measures were considered the earliest cues in judgements of patient condition, n=5 cases

<table>
<thead>
<tr>
<th>T.25 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac cues</strong></td>
<td>Interviewer* If you could take me through the background and the sorts of things you noticed when you thought the patient’s condition was changing? Int 9 case 2 &quot;...Sudden onset of atrial fibrillation post operatively.&quot; [Surgical patient] Lines 177-180.</td>
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<tr>
<td>Sudden onset of atrial fibrillation</td>
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<td>Acute changes on ECGs</td>
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<td>Irregular pulse</td>
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<td>Tachycardia</td>
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Interviewer* How does deterioration present in coronary care patients?
Int 15 case 3 "I had a patient who had no pain, he looked quite well but I just did an ECG because I can’t say why. And he had acute changes and there was this series of ECGs and they were just constantly changing and the doctor there said this patient’s got LAD (left axis deviation)." [Coronary care patient] Lines 255-259

Interviewer* Have you any other cases in mind...perhaps a patient who deteriorated?
Int 30 case 4 "We’ve had patients that have had surgery. I remember one man in his 50s following a bowel operation he developed AF...Sudden onset of fast Atrial Fibrillation first day post-op, irregular pulse palpated and a tachycardia over 120/min." [Surgical patient] Line 486-495, 516.

<table>
<thead>
<tr>
<th>Cardiovascular cues</th>
<th>Interviewer* Do you have a case in mind? Int 25 case 1 Patient history &quot;This gentleman came into A&amp;E originally, he was about 70 years old. He came in with abdominal discomfort and nausea, a two-day history. He was diagnosed as acute pancreatitis, ...he had a CT scan which showed a very enlarged pancreatic cyst, they attempted to drain it without success and they thought he would need surgery the next day. He spiked a temperature and became very uncomfortable and nauseous. He was rushed to theatre Post-operative event Initially post-operatively blood pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop in blood pressure</td>
<td></td>
</tr>
<tr>
<td>Increase in pulse</td>
<td></td>
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<tr>
<td>Drop in urine output</td>
<td></td>
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<tr>
<td>Not answering questions as clearly</td>
<td></td>
</tr>
</tbody>
</table>
T.25 Cues reported | Examples
---|---
dropped very slightly, pulse went up... Then the blood pressure fell quite quickly, quite dramatically. The drain sites had drained 200 ml in about an hour, urine output had dropped right off. Stomach was bloated anyway. Quite a big person so that was hard to tell. Became a bit incoherent and wasn’t quite answering my questions straight." [Post operative recovery ward patient] Lines 220-233
Abnormal biochemistry Low serum potassium | Interviewer* Have you had to re-admit patients who’d gone out to the ward?
Int 15 case 2 "We have. ...They said she’d obstructed and needed to go to theatre, but it turned out her potassium was low which should have been sorted on the ward" in a patient readmitted to ICU from the general ward. [Medical ward patient- admitted to ICU]

7.4.2 Cardiac arrest
Clinician subjective, behavioural or patient self-report data were considered important initial cues in predictions of cardiac arrest in 61% (14/23) cases. Clinician subjective, behavioural or patient self-report data were considered complementary to objective data as early predictors in 26% (6/23) cases. In only 13% (3/23) cases were objective measures considered to be the most important initial or early predictors of cardiac arrest. In 9% (2/23) cases subjective clinician or behavioural signs alone were considered important cues (case 11.3, case 24.1).

The 61% (14/23) of cases where subjective signs were considered the initial predictors of cardiac arrest, are shown in Table 26. Clinicians may have identified subjective signs before changes in objective measures occurred, or they may have been using the subjective cues as triggers to investigate objective physiological measures. These cases included the following; undiagnosed abdominal aortic aneurysms (2 cases), possible pulmonary embolism in addition to cardiac or respiratory disease (3 cases), cardiac failure (1 case), myocardial infarction (2 cases), pneumonia (1 case), lung cancer (1 case), cardiac tamponade secondary to systemic lupus erythematosis (1 case), Parkinson’s disease (1 case), cancer and angina (1 case), and in one case the medical diagnosis was not reported. The cues considered
important were in the categories of level of consciousness, cardiac failure, chest pain, back-pain, abdominal pain and discomfort, behavioural changes, and nausea and vomiting. Respiratory problems were also reported in association with cardiac failure, chest pain and back-pain. In this category the 14 cases were medical patients.

Table 26: Cardiac arrest cases where subjective data were seen as earliest cues in judgements of patient condition or trigger to measure objective signs, n= 14 cases

<table>
<thead>
<tr>
<th>Cues reported</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td><strong>Level of consciousness</strong></td>
<td>Interviewer* Can you recall any patients where you intercepted what seemed to be a deterioration?</td>
</tr>
<tr>
<td>More withdrawn</td>
<td>Int 1 case 1 “Yes we had a chap a few months ago who actually came in with chest pain who sort of became more withdrawn as the evening went on. He said he felt alright but his level of consciousness seemed to be wasn’t as alert he was becoming more withdrawn…called the team up. He then began to have slight changes in blood pressure and arrested with the doctors present.” [Medical patient admitted with chest pain, cardiac arrest, abdominal aortic aneurysm] Lines 90-94</td>
</tr>
<tr>
<td>Less alert</td>
<td></td>
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<tr>
<td>Decreased level of consciousness</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiac and respiratory difficulties</strong></td>
<td>Interviewer* Can you recall another case?</td>
</tr>
<tr>
<td>Gasping for breath even with oxygen therapy</td>
<td>Int 8 case 2 “Yes, sure. This is a gentleman who came in with late stage heart failure…a typical cardiac failure patient who was gasping for breath given the oxygen he had.” [Medical ward patient just admitted] Lines 142-143</td>
</tr>
<tr>
<td><strong>Chest pain</strong></td>
<td>Interviewer* What about any more of the male patients?</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Int 1 case 3 “We had a patient, a huge man, he did actually arrest with a PE but we got him back very quickly. He’d had an MI. He had some chest pain…we’d done ECGs and there was nothing specific,…was found in a bay collapsed” [Cardiac ward patient with acute myocardial infarction, developed pulmonary embolus] Lines 246-248</td>
</tr>
<tr>
<td>ECGs nothing significant</td>
<td></td>
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<tr>
<td>Found collapsed</td>
<td></td>
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<tr>
<td>More lethargic</td>
<td></td>
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<tr>
<td>Slightly short of breath</td>
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<tr>
<td>Chest pain</td>
<td>Interviewer* Do you have a case you’d like to describe?</td>
</tr>
<tr>
<td></td>
<td>Int 24 case 1 “Yes, I have one but it’s not very detailed. Basically an 80 year old man admitted with shortness of breath query PE. He’d got a history of COPD. He was doing okay and then over a period of two days he became more lethargic. He was slightly short of breath, but nothing dramatic. But then…started to complain of chest pain…nothing else specific in his vital signs” [Medical ward patient with chronic obstructive pulmonary disease, possible pulmonary embolus] Lines 136-137,</td>
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<td></td>
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<tr>
<td>T.26 Cues reported</td>
<td>Examples</td>
</tr>
<tr>
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<tr>
<td><strong>Back pain</strong></td>
<td>Int 1 case 5 “I’ve thought of another case now, a really awful experience actually, and this was terrible. ...She complained of a persistent pain in her back, ...echocardiograms were negative, physical signs were unchanged, patient complained of persistent back pain and couldn’t breath.” [Cardiac ward patient – later found to have pericardial effusion secondary to Systemic Lupus Erythematosi] Lines 311-314, 316-317</td>
</tr>
<tr>
<td>Persistent back pain</td>
<td></td>
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<tr>
<td>Feeling unwell</td>
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<tr>
<td>Severe breathing difficulties</td>
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<tr>
<td><strong>Abdominal pain/discomfort</strong></td>
<td>Int 3 case 5 “There was another man we had...he came in with an MI and he was just at the beginning of his mobilisation regime. Patient complained of “a discomfort in the abdomen, but there was nothing really specific...agitated and unwell.” [Admitted with myocardial infarction, then had ruptured aortic aneurysm] lines 365-367</td>
</tr>
<tr>
<td>Agitation</td>
<td></td>
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<tr>
<td>Unwell</td>
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<tr>
<td><strong>Behavioural changes</strong></td>
<td>Int 2 case 2 “Another example... We had a lady last week. She was in her 80s, she’d come in on [date] and she’d had a heart attack.... She had another heart attack. Became untalkative, had previously been talkative...became very depressed within the period of a week to 10 days.” [Medical patient after 2 heart attacks developed abdominal distension] Line 134</td>
</tr>
<tr>
<td>Less talkative</td>
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<tr>
<td>Low in mood</td>
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<tr>
<td>Frail</td>
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<tr>
<td>Tired</td>
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<tr>
<td>Less active</td>
<td></td>
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<tr>
<td>Lacking motivation</td>
<td></td>
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<tr>
<td>Poor colour</td>
<td></td>
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<tr>
<td>Using oxygen more</td>
<td></td>
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<tr>
<td>Change in general condition of patient noted by clinician</td>
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<tr>
<td>Int 18 case 2 “My next patient was a youngish man in his 40s...And he came in with a pneumonia and you think, fine, you know a bit of oxygen don’t you...”. Noticed a change in behaviour. “he was using oxygen a lot and whereas initially he was getting up and having a shower and then going back to bed and using it. Em the next day was stuck to it all the time...” [Medical ward patient admitted with chest infection/ pneumonia]</td>
<td>Lines 205-207</td>
</tr>
<tr>
<td><strong>Interviewer</strong>* Perhaps we could move in to the other case you had in mind?</td>
<td></td>
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<tr>
<td>Int 13 case 2 “This was quite a while ago. It was a gentleman in is 70s and he’d come in with query PE. They hadn’t been able to scan him because he had a multitude of other problems...had been complaining of back pain em and generally feeling unwell. And the doctors had been and reviewed [the patient] a couple times in the morning [Medical ward patient with multiple medical conditions including heart failure, possible pulmonary embolus] Lines 237-239.</td>
<td></td>
</tr>
<tr>
<td><strong>T.26 Cues reported</strong></td>
<td><strong>Examples</strong></td>
</tr>
<tr>
<td>------------------------</td>
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</tr>
</tbody>
</table>
| Interviewer* When the doctor was with him?  
Int 3 case 3* “Yes. The doctor was here for a good few hours trying to work out what was the cause... I think they decided in the end that he'd had a big infarct, but at the time it was quite difficult to work out what was causing the problem, why he was feeling unwell. And it must have been why he was hypotensive.”  
Interviewer* Tiredness was something you picked up on?  
Int 3 case 3* “Yes. Um.” [Medical ward patient with multiple medical diagnoses] Lines 137-159 |
| Int 10 case 1 “...Em this particular man although he's, his rehabilitation was more or less going according to how we'd planned his care, em and he was responding well to all of the therapists input. There was always something not quite, you just couldn't quite put your finger on and we did feel there was something else going on though there was nothing specific. His observations were quite stable, his ECGs were fine. There was really nothing. He just seemed very de-motivated. Em he would have good days and bad days. Some days he would pick up a bit more and other days he would be down quite low. And then one Sunday morning em we had actually been planning his discharge for about a week and we had a date in mind and everything was focused on that date. Em he'd slept well the night before an uninterrupted sleep he'd got up in the morning we'd walked him out to the bathroom helped him with his hygiene needs. Em but he just seemed very tired so we asked him you know do you want to go back to bed and he said no I'll sit in a chair for a little while longer. But his colour wasn't good. Em his observations were unremarkable there was no real changes in them at all his temperature was a little bit low but only by a degree or so. Then mid morning I suppose the best way I could describe it was that he was really lack lustre his em body language had changed instead of sitting back in the chair he was sitting forward in the chair. So I said to him you really should get back into bed if you're feeling this unwell then get back into the bed. And we just ran a cursory set of obs. Em his SATs were fine but his respirations had dropped.” [Medical/elderly care ward patient with acute exacerbation of Parkinson's disease undergoing rehabilitation] Lines 53-76 |
| Int 31 case 1 “...I particularly remember one gentleman when I was working on (name of previous medical ward), who I believe his initial diagnosis was one of Ca Lung but it was very early stages. Emm and I remember one day just having a feeling about this man that things weren't quite right. With hindsight and since MET scoring has come in I would say that the thing that I noticed most probably was an increased respiratory rate and he just wasn't his-self really. His observations were a bit unremarkable except for this increased respiratory rate. And he just didn't seem to be emm as happy really that day. That night he actually had a cardiac arrest and died. And I remember thinking when I did my MET training how they pushed home the respiratory rate thinking that definitely was significant because at that time we weren't really measuring respiratory rate as much as we are now.” |
**T.26 Cues reported**

<table>
<thead>
<tr>
<th></th>
<th>Examples</th>
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</table>
| Interviewer* | Uhuh and respiratory rate being an early indicator of a respiratory problem.  
Int 31 case 1* “Early indicator, but at that time to be honest we weren’t really at (name of hospital) we weren’t recording respiratory rates at all until really MET training came about.”  
Interviewer* When you said he wasn’t himself what was that referring to?  
Int 31 case 1* “Just his general demeanour really he, if you asked if ‘are you okay?’ he would say ‘Oh yeah I’m fine, I’m fine’. And as I say his blood pressure, pulse, everything was unremarkable, just this increased respiratory rate.” [Medical patient with recent diagnosis of carcinoma of lung- clinician recognised change in behaviour but did not realise significance of raised respiratory rate until later] lines 27-48,  60-72 |
| Nausea and vomiting | Nausea and/or vomiting without an obvious explanation  
Interviewer* If you could recall patients that you’ve nursed whose condition changed from an acute illness state to one that you were more concerned about?  
Int 6 case 1 “...a gentleman a couple of months ago who was feeling quite nauseated overnight and he had unexplained vomiting, it was completely unexplained. Em and when [the patient] vomited...became vague and the query with the PE I was concerned that you know [the patient] might be throwing off clots” [Medical ward patient admitted with possible pulmonary embolus developed respiratory arrest] Lines 92-98  
Interviewer* What factors assist or make it difficult to achieve an accurate assessment of a patient’s condition?  
Int 11 case 3 “It’s difficult when you’ve only got nurse concern...It’s so hard to get a doctor down and say I’m not happy with this patient and I can’t really tell you why but it’s a feeling I’ve got”  
Interviewer* Aha aha have you encountered that recently  
Int 11 case 3* “Yeah yeah”  
Interviewer* Could you maybe enlarge on expand on that situation?  
Int 11 case 3* “I think it’s to do with knowing your patient and knowing that they look different and their demeanour is different and everything. But em we had a lady that died last night that fitted that category very very well. She just said she felt a bit dizzy and nauseous so we gave her some cyclizine and em she didn’t want her tea which she was nauseous I didn’t think anything of it really. And the night nurses came on and she’s not right she doesn’t look right at all and she actually died a few hours later”  
Interviewer* Right aha and there were no obvious signs of change in her?  
Int 11 case 31* “They had the doctor down to look at her and he found nothing but she’d gone this ghastly colour and she just wasn’t herself at all”. [Medical ward patient] Lines 351-374 |
In the 26% (6/23) of cases where subjective data were considered complementary to objective data in the prediction of cardiac arrest, as shown in Table 27, the underlying conditions and features of the cases were examined. The cases included: a readmission to the coronary care unit following a second cardiac event; a case of gradual deterioration in patient condition with underlying congestive cardiac failure and history of pneumonectomy; an angina case with delayed presentation to hospital following chest pain; and a case with hypothermia and loss of consciousness/collapse thought to be responding to treatment. The remaining two cases included patients with chest pain developing into cardiogenic shock and admission to ICU, and chronic obstructive airways disease with abdominal pain. The cues considered important in this category referred to multiple clinical states and to cardiac clinical states. In this category 3/6 cases were medical, 2/6 cases were coronary care, and 1/6 cases was intensive care.

Table 27: Cardiac arrest cases where subjective data were seen as complementary to objective measures and were the earliest cues in judgements of patient condition, n=6

<table>
<thead>
<tr>
<th>T.27 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiple clinical signs</strong></td>
<td>Interviewer* If you could start to explore the kinds of signs and symptoms that you noticed that led you to suspect this person was deteriorating?</td>
</tr>
<tr>
<td>Low or no urine output</td>
<td>Int 3 case 1 *&quot;The one that is mostly in my mind ...was a case of congestive heart failure and he'd had minimal urine output, just about no urine output for probably more than 24 hours, He was very hypotensive, and um, just clinically he didn't appear very well. His respiratory rate was quite fast and his colour wasn't very good, and [the patient] looked a bit clammy, and um, complaining...of shortness of breath&quot; [Congestive cardiac failure patient on cardiac ward] Lines 16-25.</td>
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<tr>
<td>Low blood pressure</td>
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<tr>
<td>Raised respiratory rate</td>
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<tr>
<td>Looked unwell</td>
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<tr>
<td>Colour poor</td>
<td></td>
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<tr>
<td>Clammy</td>
<td></td>
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<tr>
<td>Complaining of shortness of breath</td>
<td></td>
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<tr>
<td>Abdominal distension worsening</td>
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<tr>
<td>Abdominal pain</td>
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<tr>
<td>Oxygen saturation levels decreased</td>
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<tr>
<td>Raised pulse rate</td>
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<tr>
<td>Atrial Fibrillation</td>
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<tr>
<td>Cardiac ischaemia on ECG</td>
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<tr>
<td>Onset of confusion</td>
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<tr>
<td>Grey, pale colour</td>
<td>Interviewer* Could you summarise the details of that case?</td>
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</tbody>
</table>
| Sweaty/clammy/sweating profusely | Int 4 case 1 *"A patient came into coronary care about a week ago having had an anterior myocardial infarction. He progressed okay apart from some abdominal distension that was treated with laxatives...He went to the cardiac step-down unit and developed some left ventricular failure. He then had a second cardiac episode and the abdominal distension was getting worse ...respiratory function had deteriorated and ...respiratory rate was up into the 30s and...saturations were down ...blood pressure had dropped, and pulse rate had gone up, ...more tachycardic, ...had gone into an AF... Ischaemia on his ECG"[Myocardial infarction patient with abdominal distension, had second cardiac event and}
<table>
<thead>
<tr>
<th>T27 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not passed urine</td>
<td>was readmitted to coronary care from cardiac ward [Lines 21-23]</td>
</tr>
<tr>
<td>Low blood pressure</td>
<td>[Interviewer* Have you got any more cases that you can recall? Int 17 case 4 &quot;We had a gentleman with COPD... he presented with an abdominal pain, elevated respiratory rate, blood pressure was abnormal, he was tachycardic, clammy, short of breath.&quot; [Medical ward patient with chronic obstructive airways disease and abdominal pain] Lines 435-439</td>
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<tr>
<td>Severe cardiac ischaemia on ECG</td>
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<tr>
<td>Looked awful</td>
<td>[Interviewer* And another example? Int 8 case 3 &quot;She was a lady who came in she'd been found half in and half out of her garden pond at home by her neighbour and was hypothermic. She had no temperature to report at all when she came into A&amp;E. She perked up here, became conscious, she had a catheter in, she was quite oedematous and she had cardiac monitoring. She didn't have a CVP done. Gradually her urine output tailed off and she became confused...respiratory rate increased&quot; [Medical ward admission with hypothermia] Lines 231-246</td>
</tr>
<tr>
<td>Gasping for breath</td>
<td></td>
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<tr>
<td>Raised heart rate</td>
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<tr>
<td>Low blood pressure</td>
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The 13% (3/23) of cases where objective data were considered important in cardiac arrest cases are shown in Table 28. These cases constitute *negative cases* for the
research thesis in the current study, and the underlying conditions were examined. There were no early data available in the case of a patient with haematemesis and cardiac arrest (case 4.3); the research participant reporting the case was a member of the cardiac arrest team in attendance. One patient with fitting and cardiac arrest was subsequently designated not for resuscitation due to severity of illnesses and poor prognosis (case 7.3), and another patient with a prior history of shortness of breath and insulin dependent diabetes collapsed without pre-warning signs being evident (case 21.2), but was successfully resuscitated. All three cases were categorised as medical.

Table 28: Cardiac arrest cases where objective measures were considered the earliest cues in judgements of patient condition, n=3

<table>
<thead>
<tr>
<th>T.28 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac arrest</td>
<td>Int 4 case 3 &quot;...The last crash call that I went to was put out by somebody else for a patient with haematemesis who'd gone into hypovolaemic shock. Because of the hypovolaemia he became ischaemic, and in the end was actually EMD (electromechanical dissociation)&quot;. [Haematemesis patient not for surgery] Lines 322-323</td>
</tr>
<tr>
<td>Severe haematemesis leading to hypovolaemic shock</td>
<td>Interviewer* Can you think of any other patients whose condition caused concern? Int 7 case 3 “There was one, a man who was fitting and went straight into a cardiac arrest” [Medical ward patient with severe illness- brain carcinoma] Line 299.</td>
</tr>
<tr>
<td>Little pre-warning of cardiac arrest</td>
<td>Int 21 case 2 “A second patient, I'm about to give her medication when I found her collapsed on the floor&quot; rang the emergency bell and started cardiopulmonary resuscitation.&quot; [Medical ward patient admitted with shortness of breath and history of diabetes mellitus] Lines 113-114</td>
</tr>
<tr>
<td>Fitting</td>
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<tr>
<td>Found collapsed (unwitnessed arrest)</td>
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</tbody>
</table>

7.4.3 Acute and vulnerable to physiological instability or deterioration

Clinician subjective, behavioural and patient self-report cues were considered important in the initial judgements of patient condition in 44% (11/25) of cases. Clinician subjective, behavioural or patient self-report data were considered complementary to objective data as early indicators or predictors of the patient’s
condition in 48% (12/25) of cases. Objective cues alone were considered important in
judgements of patient condition in 8% (2/25) of cases.

In the 11 cases where subjective cues were the *initial* cues, as shown in Table 29, a
range of medical and surgical conditions was present. These included medical
patients admitted with chest pain, angina or myocardial infarction (cases 2.3, 2.4, 3.2,
8.6), chronic obstructive airways disease, acute respiratory infections or asthma
(cases 8.4, 17.3) carcinoma of lung and acute physical distress (case 29.3), and
chronic pleural effusions and multiple medical problems (case 28.2). Surgical patients
comprised cases of pulmonary embolus post orthopaedic surgery (case 26.1), one
patient with abdominal pain admitted for cholecystectomy whose surgery was
postponed due to irregular cardiac rhythm (case 22.1), and a patient following
reversal of stoma for Crohn’s disease who developed paralytic ileus (case 32.3). This
category comprised 8/11 medical cases and 3/11 surgical cases.

**Table 29:** Subjective data as earliest cues or trigger to measure objective signs in
acute illness and vulnerable to deterioration cases, n=11 cases

<table>
<thead>
<tr>
<th>T.29 Cues reported</th>
<th>Examples</th>
</tr>
</thead>
</table>
| **Chest pain**     | Interviewer* Was there a difference over time from how you’d known her previously?  
Complained of severe chest pain  
Complained of some chest pain | Int 2 case 3 “...Had been pain free for 2 days then suddenly became short of breath, a new symptom, and complained of severe chest pain .... Sweaty, clammy and very anxious looking.”  
[Admitted to cardiac ward with chest pain, possible pulmonary embolus] Lines 287-295 |

  Interviewer* You’ve worked on the ward today, are there any patients that you would describe as stable or unstable?  
Int 2 case 4 “There was one patient that had severe chest pain ...and he was also short of breath. The chest pain and shortness of breath was what alerted me to there’s something not quite right here” [Chest pain patient in cardiac ward] Lines 513-515 |

  Interviewer* Would you like to describe another case?  
Int 26 case 1 “Our setting isn’t particularly acute, it’s all elective surgery. People have no big medical problems or they’d be somewhere else. So the things we get are usually post-surgical. So you’re handed a patient over and you go in and you think I’m not too sure about that diagnosis, but there was nothing specifically showing in the obs. But there was just something you would keep an eye on. And then going in he sort of became a little anxious had some chest pain and was being a bit canny, his pulse |
<table>
<thead>
<tr>
<th>T.29 Cues reported</th>
<th>Examples</th>
</tr>
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<tbody>
<tr>
<td>had gone up a bit but he wasn't showing any specific changes in the observations&quot; [Post operative elective orthopaedic surgery, developed pulmonary embolus] Lines 291-292</td>
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<thead>
<tr>
<th>Abdominal pain or distension</th>
<th>Interviewer* What other factors do you feel may be early signs of deterioration?</th>
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<td></td>
<td>Int .8 case 6 &quot;...There's a lady at the moment who doesn't look very well, doesn't look quite right. Complaining of abdominal pain, should be mobilising but isn't yet. She's a lady who every time you're near her she wants her pillows changing, she wants to be made comfortable, can you pass a drink because she can't manage it and she should really be mobilising a little bit and getting up. So you think what's happening there and somebody said shall we get her out of bed and I said no hang on I'll get the doctors to have a look at her first because you just don't know.&quot; [Medical ward patient with delayed recovery from acute myocardial infarction] lines 746-751</td>
</tr>
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<thead>
<tr>
<th>Respiratory function</th>
<th>Interviewer* Can you think of any of your cardiac patients who have deteriorated?</th>
</tr>
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<tbody>
<tr>
<td>Complaining of shortness of breath</td>
<td>Int 3 case 2 &quot;We have a gentleman with angina and some heart failure, and peripheral vascular disease. He was complaining of shortness of breath since [admission], not desperately and he was not distressed with it. But states can't get a breath when takes oxygen off. &quot;I've still got this shortness of breath, and I feel quite uncomfortable. I've got no chest pain but I want to take my GTN&quot;. The patient actually looked quite grey, and he was clasp[ing the oxygen]&quot; [Multiple medical conditions- angina, heart failure] Lines 73-81</td>
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<tr>
<th>Acutely short of breath</th>
<th>Interviewer* I think you were going to talk about a respiratory oriented case, could you tell me about that?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute severe breathing difficulty</td>
<td>Int 17 case 3 &quot;Yes, yeah. That was a gentleman when I was working down on one of the other teams for a shift. He wasn't a patient that I knew very well but he was an asthmatic patient, I think with an element of COPD. He'd been in for a while and had been improving steadily. Em but at the handover one of the other nurses had pointed out that she'd felt his breathing wasn't as good as it had been. Although he wasn't as well as I would have liked him to be he was still talking in sentences. So I had rung the doctor and asked her to see him. I went back to him and gave him nebulisers...and it didn't improve. And I phonod her and asked her to come immediately- I had scored him and I told her the score, it was a call the SHO score&quot; [Medical patient with chronic...</td>
</tr>
</tbody>
</table>
Within the 12 cases where subjective cues were complementary to objective data, there were cardiac patients who had failed to respond to treatment or had delayed recovery (case 1.6, case 1.7, case 1.8), one patient who was recovering from myocardial infarction (case 1.9), and a patient with pericardial effusion query Systemic Lupus Erythematosis (case 3.4). The results are shown in Table 30. Problems in the post operative period occurred in three cases (case 20.1, 25.2, 27.4) and one patient bled post arteriogram (case 27.3). The remaining two medical cases were a patient with a history of cerebral vascular accident who became acutely
distressed (case 6.5), and a respiratory patient who was allergic to Salbutamol nebulisers (case 7.4). In this category 8/12 of cases were medical and 4/12 cases were surgical.

Table 30: Acute illness and vulnerable to deterioration to critical illness or cardiac arrest cases where subjective data were viewed as complementary to objective measures in early judgements of patient condition, n= 12 cases

<table>
<thead>
<tr>
<th><strong>T.30 Cues reported</strong></th>
<th><strong>Examples</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest pain</td>
<td>Interviewer* What sort of things are you using when you make the judgement that a patient’s at greater risk than others? (\text{Int 1 case 6} ) “Ah, today, uum, there’s one patient who’s going to [name of hospital] in a minute, who came in with unstable angina 5 days ago now, and has had chest pain almost constantly. He is on maximal anti-anginal therapy. He is on a Nitrocin infusion, and continues to be in chest pain but hasn’t actually infarcted. It’s difficult to know how ischaemic the patient is... in atrial flutter all the time”. [Cardiac ward patient] lines 445-448</td>
</tr>
<tr>
<td>Reduced level of consciousness</td>
<td>Interviewer* Would you be able to recall examples of patients with conditions that changed from acute to being at risk of critical illness or actual critical illness? (\text{Int 20 case 1} ) “We did have a lady, obviously most of ours are elderly patients so they come in with their usual illnesses anyway. This lady had fallen and fractured her neck of femur. She was on her first day post op. and I washed [the patient] and she was conversing...was talking about family a little bit sleepy but seemed to really know where she was. And about two days later I was on the same shift and washing [the patient] again and was really worried because...didn’t respond to me... didn’t seem to be awake I also noticed that the urinary output had gone down” [Orthopaedic patient in the first 3 days immediately post surgery] Lines 17-24</td>
</tr>
</tbody>
</table>

| Reduced level of consciousness | Interviewer* Would you be able to recall examples of patients with conditions that changed from acute to being at risk of critical illness or actual critical illness? \(\text{Int 25 case 2} \) “Last week I had a patient who had a total knee replacement, very talkative, very comfortable. Then his blood pressure started to drop slightly and the anaesthetist had said that’s to be expected. Speed the fluids up a bit. And then I noticed he had gone quiet, a bit pale quickly, and I thought the patient was fainting... felt and looked a bit nauseous, so I turned [the patient] on his side... did pass out momentarily and... vomited clear fluids. So I suctioned him out and asked “are you alright?” And he came to...” [Recovery ward patient post total knee replacement surgery] Lines 415-420 |

<p>| Reduced level of consciousness | Interviewer* Would you be able to recall examples of patients with conditions that changed from acute to being at risk of critical illness or actual critical illness? (\text{Int 1 case 7} ) “…a very recent history of confusion and came in in fast AF... rate hasn’t really dropped yet. Has a chest infection, a raised white cell count, a UTI and... Ureas and Electrolytes are up, and...AST is high” [Medical admission to cardiac ward] Lines 457-460 |</p>
<table>
<thead>
<tr>
<th><strong>T.30 Cues reported</strong></th>
<th><strong>Examples</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical/behavioural signs</strong></td>
<td>Interviewer* Of the patients that you've nursed today are there any that you would classify as more at risk than others? Int 1 case 8 *&quot;A lady came in with a sub-endo MI (subendocardial myocardial infarction). She infarcted, re-infarcted about three days later and was &quot;strepped&quot; (given streptokinase). She hasn’t looked well ever since she came out of CCU... listened to lungs... chest x-ray [used to diagnose a pneumonia] ...sort of grey... started off quite bright and quite an extrovert type of personality, and now is sleeping a lot. Oxygen saturation levels were within acceptable limits, but even so you know, I wouldn’t be surprised- I would be keeping a close eye on this patient&quot; [Patient with two myocardial infarctions recently transferred from CCU to cardiac medical ward] Lines 473-489</td>
</tr>
<tr>
<td>Looks unwell</td>
<td></td>
</tr>
<tr>
<td>Chest auscultation-lung secretions</td>
<td></td>
</tr>
<tr>
<td>Chest x ray- consistent with pneumonia</td>
<td></td>
</tr>
<tr>
<td>Change in personality from extrovert to sleeping a lot</td>
<td></td>
</tr>
<tr>
<td>Oxygen saturation levels within normal limits</td>
<td></td>
</tr>
<tr>
<td><strong>Patient self report/patient history</strong></td>
<td>Interviewer* What about thinking maybe about handover today, and some of the patients that you’ve been looking after? Int 3 case 4 *&quot;We’ve got a girl in her 20s who’s been admitted yesterday...She’s a possible Lupus...she’s got a pericardial effusion, pericarditis but that could be secondary to Lupus. She felt very unwell with pain in... body and tingling in her arms... can’t sleep at night because of the spasms of pain, query SLE Hb’s only 8.9 and she’s only in her 20s and she’s on the Pill, ... she’s very pale and she hasn’t slept and I think has been really unwell [for months]&quot; [Recent admission to cardiac ward] Lines 229-238</td>
</tr>
<tr>
<td>Feeling unwell</td>
<td></td>
</tr>
<tr>
<td>General body pains</td>
<td></td>
</tr>
<tr>
<td>Tingling in arms</td>
<td></td>
</tr>
<tr>
<td>Unable to sleep due to pain spasms</td>
<td></td>
</tr>
<tr>
<td>Unwell for prolonged period</td>
<td></td>
</tr>
<tr>
<td>On oral contraception (higher risk of thromboembolism)</td>
<td></td>
</tr>
<tr>
<td>Possible SLE</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical signs</strong></td>
<td>Interviewer* Are there any other cases that come to mind? Int 1 case 9 *&quot;We had one patient recently who infarcted prior to admission. Had the patient complained of a headache I would have been straight in there getting the girls to do ECGs&quot; [Patient on cardiac ward after acute myocardial infarction with history of headache as presenting symptom] Lines 143-144</td>
</tr>
<tr>
<td>Anaemia</td>
<td></td>
</tr>
<tr>
<td>Pale looking</td>
<td></td>
</tr>
<tr>
<td><strong>Cardiac signs</strong></td>
<td>Interviewer* Are there any other cases that come to mind? Int 27 case 2 *&quot;Yeah there was a chap on the ward not long ago who again was another transfer from ICU and he’d got a long neurological history and I was asked to go and see him...they weren’t happy with the blood pressure and um...I walked into this darkened room um...Uum so you know one of the first things...[the patient] was obviously reasonable OK. So one of the first things I wanted to get obviously was [the patient’s] neurological status. And again I mean I think you can assess people um just by saying “How do you feel?”. And you can get a lot of information just from that. Obviously if they’re answering appropriately and um answer your questions...he obviously understood his condition and was obviously neurologically in the land of the living as it were...&quot; [Post operative patient following facial surgery- later noted an irregular pulse and a cardiac problem] Lines 258-267, 280-281</td>
</tr>
<tr>
<td>Earlier infarction accompanied by headache- headache a potential cue to re-infarction.</td>
<td></td>
</tr>
<tr>
<td>Sudden change in blood pressure</td>
<td></td>
</tr>
<tr>
<td>Patient conscious and orientated</td>
<td></td>
</tr>
<tr>
<td>T.30 Cues reported</td>
<td>Examples</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Colour/ appearance</td>
<td>Colour abnormal</td>
</tr>
<tr>
<td>Clinical index score</td>
<td>Medical Emergency Team score=16</td>
</tr>
<tr>
<td>Interviewer* Have you been involved with any cases where you’ve had to put out a MET call?</td>
<td></td>
</tr>
<tr>
<td>Int 7 case 4 “Yes. This one was a while ago. A gentleman wasn’t looking the right colour I did all the classical observations... Em and with a MET score of 16 I called the MET team out because I was quite concerned about this...[patient...was found to have an] allergy to Salbutamol nebulisers [Medical ward patient with allergic reaction to salbutamol nebuliser therapy]” Lines 368-370.</td>
<td></td>
</tr>
<tr>
<td>Psychological cues and objective data</td>
<td>Agitated Frightened Observations of pulse and blood pressure within acceptable ranges Oxygen saturation levels low</td>
</tr>
<tr>
<td>Interviewer* Could you recall a case where you thought this patient’s going off as you mentioned previously?</td>
<td></td>
</tr>
<tr>
<td>Int 6 case 5 A gentleman on the ward at the moment who’d been treated for constipation the previous day became very “...agitated and just looked at me and said I’ve had another stroke I’ve had another stroke... had a stroke many years ago but the patient’s obviously scared of that. So I reassured [the patient] and got the blood pressure machine and did observations and they were absolutely fine so I got the saturations machine and blood saturations were quite low. So we turned the oxygen up and I was really quite concerned [Medical ward patient] Lines 610-620.</td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>Acute haemorrhage Patient conscious and alert Responding to questions Not collapsed</td>
</tr>
<tr>
<td>Interviewer* Do you have any other cases in mind?</td>
<td></td>
</tr>
<tr>
<td>Int 27 case 3 “The only other case I can think of is...somebody that bled post arteriogram. I was called in to see this man and the nurse was applying pressure to a patient’s groin - bleeding arteriogram site. On first sight the man was you know sitting up and taking notice. He hadn’t lost so much blood that he’d collapsed. And umm, I said to him something like “how are you feeling?” and he said, “oh I’m fine, it’s just it was making a big mess” or words to that effect. So you immediately sort of know, ok, so we’re doing ok here... I said to her “have you done a set of obs.?“ and she said “yes” and I said “have you recorded them because you know it’s important to get that down.?”... Have we got intravenous access?” [Post arteriogram haemorrhage from arteriogram entry site] Lines 401-408</td>
<td></td>
</tr>
<tr>
<td>Pain (not chest pain)</td>
<td>A range of signs: Respiratory rate slightly elevated Oxygen saturation levels lower Pain control inadequate Patient position in bed poor Other staff were focused on washing patient rather than patient’s condition-in pain, poor respiratory function.</td>
</tr>
<tr>
<td>Interviewer* On another occasion the nurse entered a patient’s room and “...could see just little bits, but all those little bits to me add up to a whole. [The patient’s] respiratory rate was a little bit high and the SATS (oxygen saturation levels) were a little bit low, and um the pain control wasn’t very good... A lot of nurses are focused on who’s had a wash, whose bed needs made. My priorities then were to sort the pain relief, and change [the patient’s] position so that [the patient] was sat up” [Day 1 after surgery for diverticular disease patient] lines 772-777.</td>
<td></td>
</tr>
</tbody>
</table>

In the two cases where objective cues alone were considered important in judgements of patient condition, as shown in Table 31, one case was a patient referred to ICU.

268
who was found to have raised blood sugars which should have been treated with insulin at ward level (case 16.3). The other case was a patient recovering from a cerebral vascular accident who fell during the night and sustained a fractured neck of femur (case 32.4). This category therefore comprised one intensive care and one surgical case.

**Table 31:** Acute illness and vulnerable to deterioration to critical illness or cardiac arrest where objective measures were the earliest cues in judgements of patient condition, subjective data not reported as important, n=2

<table>
<thead>
<tr>
<th>T.31 Cues reported</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elevated blood sugars</strong></td>
<td>Interviewer* Have you had to readmit patients who had gone out to the ward?</td>
</tr>
<tr>
<td>High blood sugars untreated on general ward.</td>
<td>Int 16 case 3 We had a lady on the coronary care side of the unit...And her &quot;...blood sugars in the morning were 28, couldn't get a venflon in and they continued to be 28, 29, 30 all day&quot;. [Patient required a venflon to be re-sited, should have received sub-cutaneous insulin but did not, and patient was readmitted to ICU]. [Coronary care patient post cardiogenic shock and renal failure transferred to general medical ward and readmitted to ICU with high blood sugars] Lines 134-143.</td>
</tr>
<tr>
<td><strong>Fall</strong></td>
<td>Interviewer* Have you had any of the older age group of patients who come in with a number of other medical problems as well as what they've come in with?</td>
</tr>
<tr>
<td>Sustained fractured neck of femur</td>
<td>Int 32 case 4 &quot;We had a lady that was a medical admission initially ... a stroke...and she was really going well. And then ...early in the morning, instead of ringing the bell to go to the toilet, [the patient] evidently thought I'm well enough ...but over-balanced and actually sustained a fractured neck of femur, post surgery recovered very well...[but then] ...did dip a little bit, ... definitely dipped, didn't want to eat anything, didn't feel overly well, it took a long time.&quot; Lines 543-570</td>
</tr>
</tbody>
</table>
7.5 Research Question Three

Which cues do clinicians consider to be important in the prediction of deterioration in condition in the clinical outcome states of critical illness or cardiac arrest?

- Which cues are initial or early predictors of the clinical states of critical illness and cardiac arrest?

Graph 24 is a combination of critical illness and cardiac arrest cases, with n=69. Within the initial time period category subjective cues were reported most frequently and comprised breathing difficulty (17 cases), behavioural signs (15 cases), and LOC/GCS (12 cases). Objective measures were less frequently reported than subjective cues, for example blood pressure (9 cases), heart rate (8 cases).

For the early time period the most frequently reported cue was the objective measure blood pressure (29 cases), followed by the subjective cue of behavioural signs (22 cases), and then the objective sign ECG (16 cases).

In the late cues category the objective cue respiratory or cardiac arrest (19 cases) was most frequently reported. The subjective cue of LOC/GCS was the next most frequently reported (15 cases), followed by the objective measure blood pressure (14 cases) and the subjective cue, not responding to treatment (13 cases).

For the initial time period clinicians reported more subjective and behavioural cues and in the early time period there was increased reporting of objective measures such as blood pressure and ECG as well as subjective cues. It may be that subjective/behavioural cues actually precede changes in physiological measures such as in the cardiac arrest case 1.1 where the nurse noticed deterioration in a patient’s level of consciousness and behavioural changes before the blood pressure began to change slightly.

"We had a patient who actually did come in with chest pain who sort of became more withdrawn as the evening went on, and he said he felt alright but his level of consciousness seemed to be... he wasn't as alert... he was becoming more withdrawn. We actually called the team up to see
him, he then began to have slight changes in his blood pressure, and then as they were actually here he did actually arrest, and he was an aneurysm. When we got him back he went off to theatre, but the team were actually here when it all happened because we'd called them several times during the evening". Interview 1 case 1 lines 90-98.

Alternatively clinicians may use subjective cues in the initial time period as trigger cues to perform objective measures, and so they become aware of changes to physiological measures that may or may not have been present earlier. An example is the critical illness case 8.1 where sudden onset of breathlessness prompted the nurse to perform observations of blood pressure, pulse, respiratory rate, urine output, and as these were abnormal an urgent referral was made to the doctor.

“There’s a patient ...who came in with em been, found to be in fast AF (atrial fibrillation). And after being on the ward for a couple of days with the AF being treated and in a monitored bed umm she had digoxin. She was actually becoming more and more unwell and the medical team decided that she was septic from something they don’t still don’t quite know what, query diverticulitis. Em and on one particular morning she became very breathless. She’s a ...lady who is very uncomplaining and she was quite blue peripherally, as I say very breathless didn’t look well at all. We did one set of observations immediately, it was very early on the shift. Did one set of observations immediately did another set 10 minutes later her blood pressure was relatively low, her pulse was rapid, her respirations were up and her saturations were quite low even though she had 100 per cent oxygen. Em so we were discussing it fortunately there was another trained with me it's lovely on here when there's another trained nurse because you can say “hey look what do you think?” Her urine output also was very very poor. So we ...the doctor of the team came on the ward we would have put out a MET call but we didn’t because he was there." Interview 8 case 1 lines 38-55

The next section examines the accuracy of clinicians’ judgements of current condition and predictions of patient condition based on self-report of clinicians.
Graph 24. Critical illness and cardiac arrest cases combined

<table>
<thead>
<tr>
<th>Initial</th>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
</table>

**Objective Measures**
- BP
- HR
- Respiration/cardiac arrest
- SPO2
- CVP
-卡带
- Urine output
- Balance
- Wound drainage
- Signs unchanged
- Temperature

**Subjective Data**
- LOC/Pain
- Behavioural state
- Confusion
- Breathing imp
- Thready pulse
- Abdominal distention
- Fluid
- Skin colour
- Breathing
- Periph/cold
- Periph/cold

**Cardiac state**
- ECG
- Chest/ab x-ray
- Cardiac MR

**Coagulation**
- Studies

**Psych. State**
- Confusion
- Breathing dif
- Coag. studies
- MRSA positive

**Scans**
- Chest x-ray
- ABGs

**Blood markers**
- Serum K
- Blood sugars
- Cardiac enzym
- Hypovol. shock

**Other**
- Diarrhoea
- Swallow reflex
- Looked well
- Looked unwell
- Facts
7.6 Research Question Four

How accurate are clinicians' diagnoses of clinical condition and predictions of deterioration as reported by clinicians themselves?

- Under what conditions are clinicians' predictions reported to be inaccurate?

Clinicians reported if the patient's condition was causing them concern, and if they thought it likely that the patient's condition would deteriorate further. The referral of the patient to medical staff generally indicated concern about a patient's condition and potential to deteriorate. In some cases clinicians reported specific predictions of critical illness or cardiac/respiratory arrest. All of the cases were entered into tables for each clinical outcome state and the clinician's prediction of the patient's condition was compared with the patient's actual outcome, as reported by the clinician. For example, if the clinician reported they had predicted that the patient's condition would deteriorate, and the patient's condition actually deteriorated then the prediction was recorded as accurate. If the clinician predicted deterioration and the patient's condition did not deteriorate then the prediction was recorded as inaccurate. These results are summarised for each clinical outcome state (see Tables 32-36 inclusive). However a significant limitation in the current study is the absence of external verification of clinicians' reports. Clinicians did not tend to use the term diagnosis to describe the patient's clinical state as this was more frequently used for references to medical diagnosis. Similarly the term prognosis was not used by clinicians, they generally referred to the patient's likelihood of further deterioration. One clinician referred to patients' potential for recovery as a likelihood ratio, stating that the patient's chance of recovery was 50:50, or 60:40.
7.6.1 Critical Illness

Table 32: Accuracy of clinicians’ self-report of patients’ current condition and predictions of deterioration in clinical condition compared to reported outcome-summary table, n=46

<table>
<thead>
<tr>
<th>Number of cases (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate prediction of patient deterioration</td>
<td>87</td>
</tr>
<tr>
<td>Inaccurate prediction of patient deterioration</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

Within the critical illness cases nurses reported accurate predictions of deterioration in the patient condition in 87% (40/46) cases. Reasons for inaccurate predictions were investigated. Case 6.4 represented a delay in diagnosing the cause of deterioration as hypoglycaemia. Case 7.2 was a recent admission with liver carcinoma where the nurse recognised the patient’s deterioration but missed the cause, hypoglycaemia. Case 15.2 was a patient with low serum potassium missed by medical and nursing staff at general ward level. Case 17.2 was a patient with a rectus sheath bleed related to anticoagulant therapy initially miss-diagnosed as urinary retention. Case 27.1 was a patient with fluid overload whose fluid replacement therapy had been questioned by nursing staff, but they had not followed their concerns through. They had continued with fluid replacement as instructed rather than re-iterating their concerns and achieving a review of therapy. In case 2.1 the nurse’s initial diagnosis of deep venous thrombosis was correct, but the doctor mis-diagnosed this patient’s pain as musculo-skeletal. The nurse did not persist with her initial judgement when the doctor diagnosed musculo-skeletal pain; the latter two cases may indicate a difficulty in doctor- nurse relations where nurses may lack confidence in their own intuitive
judgements and feel unable to question medical judgements or persist with their concerns.

7.6.2 Cardiac Arrest

Table 33: Accuracy of clinicians’ self-report of patient’s condition and prediction of deterioration in cardiac arrest cases compared to reported outcome, n=23

<table>
<thead>
<tr>
<th>Number of cases (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accurate prediction of patient deterioration</strong></td>
<td>48</td>
</tr>
<tr>
<td><strong>Inaccurate prediction of patient deterioration</strong></td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>High rate of inaccurate predictions in cardiac arrest cases – included unwitnessed cardiac arrests, a coronary care nurse on a cardiac arrest call to a ward patient with haematemesis, and patients who were thought to be improving.</td>
</tr>
</tbody>
</table>

In the cardiac arrest outcome state nurses reported accurate predictions in 48% (11/23) cases. Possible reasons for inaccurate predictions were investigated. In case 1.3 the nurse had earlier found no evidence of acute cardiac changes in a patient with chest pain admitted with myocardial infarction, but the patient went on to have an unwitnessed cardiac arrest, was successfully resuscitated and subsequently treated with thrombolytic drugs for pulmonary embolism. In case 2.2 a patient with multiple medical problems died in her sleep. In case 4.3 a patient with haematemesis had a cardiac arrest and died. In case 7.3 the nurse initially had not recognised that the patient had a cardiac arrest because fitting preceded it. In some cases the patients’ condition had been judged to be improving but they then had a respiratory or cardiac arrest (cases 8.3, 13.2, 18.2). Case 11.3 was not judged to be vulnerable to cardiac arrest. Cases 17.4, 21.2 and 31.1 were not judged to be in imminent danger of cardiac arrest.
7.6.3 Acute illness and vulnerable to physiological instability and deterioration to cardiac arrest or critical illness

Table 34: Accuracy of clinicians’ judgement of patient condition and prediction of deterioration in acute illness and vulnerable to deterioration compared to reported outcome, n=25

<table>
<thead>
<tr>
<th>Number of cases (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate prediction of patient outcome condition</td>
<td>64</td>
</tr>
<tr>
<td>Inaccurate prediction of patient outcome condition</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Over-estimated severity of patient’s condition (2 cases)</td>
</tr>
<tr>
<td></td>
<td>Mis-diagnosed angina and shortness of breath as psychological problem (1 case)</td>
</tr>
<tr>
<td></td>
<td>Allergy to salbutamol rather than a true MET call (1 case)</td>
</tr>
<tr>
<td></td>
<td>Raised blood sugars untreated (1 case)</td>
</tr>
<tr>
<td></td>
<td>Undiagnosed post-operative pain (1 case)</td>
</tr>
</tbody>
</table>

In the acute illness and vulnerable to deterioration category nurses reported accurate predictions in 72% (18/25) cases. Reasons for inaccurate predictions were investigated. In case 2.3 the nurse over-estimated the severity of the patient’s condition.

"She was a lady in her 40s... She came in with chest pain query, um angina, query PE (Pulmonary Embolus). And she was waiting for her scans, she was waiting for her V/Q (ventilation-perfusion) scans. So when I went along to meet her she’d been pain free for a day or two. I remember that she became, suddenly became very short of breath, extremely short of breath, and she hadn’t been like this. Even when she came in she wasn’t short of breath. And she’d had this severe chest pain. So all these- new short of breath, new severe chest pain, and nurse concern, I was concerned about her. She’d come in with query PE- maybe she’s throwing off a PE now? Her oxygen saturation levels were quite poor. You know, again she was sweaty, clammy, obviously very anxious, um, we gave her oxygen, and we called the MET Team to come out and see her. And they eventually came out, I don’t think a lot was done- I think they did blood gases etc, etc. And she eventually calmed down. But to me that looked like it could have been potentially life-threatening, but it settled down within an hour or so of it happening. We seemed to settle her down with oxygen and doctor coming to examine her, taking blood gases etc. We gave her analgesia and she settled. The lady actually went home after a day or two because her lung scans came back as negative. You know, she was fine."

Int 2 case 3 Lines 283-343
In case 3.2 the nurse and doctor initially mis-diagnosed the patient’s breathing difficulties and worsening angina as psychological dependence on oxygen. The patient’s condition improved after GTN medication was administered and oxygen therapy was reviewed. In case 7.4 the nurse called the MET but the MET doctor stated that this was not a true MET call and the patient was allergic to salbutamol. In case 16.3 a patient was readmitted to intensive care because ward staff had not treated elevated blood sugars. In case 27.4 a patient on the first post operative day was diagnosed with acute post operative pain but the staff in attendance had not recognised the patient’s clinical state. In case 32.4 an elderly patient recovering from a cerebrovascular accident fell during the night and fractured a femur, an event that had not been predicted. Finally in case 29.3 the nurse predicted that a patient recently diagnosed with carcinoma of the lung who was in severe pain and developed acute respiratory distress would die, but the patient responded to analgesia and sedation, and survived the event.

7.6.4 Chronic illness

Table 35: Accuracy of clinicians’ self report of current condition and prediction of chronic illness compared to reported outcome, n=7

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate prediction of patient deterioration</td>
<td>6 cases (86%)</td>
<td></td>
</tr>
<tr>
<td>Inaccurate prediction of patient deterioration</td>
<td>1 case (14%)</td>
<td>Liver failure patient was treated medically and recovered, nurse had predicted terminal condition.</td>
</tr>
</tbody>
</table>

In the chronic illness category nurses reported accurate predictions in 86% (6/7) cases. The small sample size means that findings could not be generalised beyond the current sample. Reasons for the inaccurate prediction were investigated. Case 31.3 was a patient with alcohol related liver failure considered unsuitable for liver transplantation. The nurse predicted that this patient would die but he responded to medication as recommended by the liver specialists together with anti-emetics, and was discharged home after 12 days in hospital.
7.6.5 Palliative care/terminal illness

In the palliative care/terminal illness category nurses reported accurate predictions in all five cases but the small sample size means that findings are not generalisable.

7.6.6 Acute illness

Table 36: Accuracy of clinicians’ self-report of current condition and prediction of acute illness compared to reported patient outcome, \( n=3 \)

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate prediction of</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>patient deterioration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unable to test accuracy</td>
<td>1</td>
<td>One prediction could not be tested. Clinician predicted an elderly patient</td>
</tr>
<tr>
<td>of prediction</td>
<td></td>
<td>would not cope at home, no further data available.</td>
</tr>
<tr>
<td>Inaccurate prediction of</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>patient deterioration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Within the acute illness category nurses reported accurate predictions in two post operative cases and in the third case the nurse predicted that the patient might not cope at home but the long term outcome was unknown. Findings are not generalisable due to the small sample size.

7.7 Research Question Five

*What are the psychological characteristics/properties of cues considered important in judgements of patient condition?*

The reports of cases were examined for the psychological structure of judgements of patient condition. Patient history/medical conditions provided the context within which judgements were made. There were some reports of diagnostic cues and prognostic cues, and there were many references to clinical indicators, and clinical indicators used to evaluate a change in condition. These cues were reported to contribute to the diagnosis of current patient condition, to the evaluation of change in patient condition, and to prognostic judgements, including the prediction of deterioration in condition, critical illness or cardiac arrest. Combinations of cues were
reported more frequently than single cues when judging the patient's clinical condition.

- **How information about patient history and medical diagnosis is used by clinicians in judgements of patient condition**

Clinicians frequently reported using information about patient history and medical diagnosis in judgements of patient condition. The following examples illustrate how this knowledge was used. When a patient complained of being unable to get air into his lungs (case 1.4) the clinician used knowledge of the patient's history, his diagnosis of cystic fibrosis, history of pneumothoraces, and the knowledge that the patient's clinical signs were usually deranged. In this case the clinician referred the patient to the doctor, three pneumothoraces were confirmed on x-ray, and three chest drains were inserted on the ward. Subsequently the patient arrested and died during the insertion of an intravenous line in another investigations unit.

In another example, a post cerebrovascular accident patient developed a raised respiratory rate and appeared flushed. In this case the nurse diagnosed aspiration pneumonia on the basis of history and presenting signs and predicted further deterioration (case 9.1). When the clinician was asked to recall a recent example where the patient's condition changed from acute to critical illness the following account was given:

No 9**"...Em a gentleman of about [mid 60s] I think he was if I remember rightly. Em normally fit and independent but had naturally come to us as a result of a stroke. Lived with his wife normally ...Em he'd had various problems while he'd been with us you know in the fact that his swallow wasn't good and he was at high risk of aspiration etc. And he had other problems in fact he was diabetic and he did have some heart problems. And he was doing quite well but em one day we noticed that his respiratory rate had gone up and he'd become really flushed in the face and we knew that this wasn't right for him and the fact that he actually said that he himself didn't feel well. Because he was a chap who really didn't ever complain and for him to actually say that he felt ill. .."**

Interviewer* Yes
No 9* "Em we knew there must be something wrong. So naturally we did a full set of observations tried to get hold of his doctor just to let them know that he didn't feel well. Em they said like they always do we'll come and review whenever that might be, who knows. So anyway over the course of the next sort of like quarter of an hour or so he was really starting to complain and his breathing was becoming really laboured and this then his saturations started to drop so that's when we decided that we would do a MET score. And we thought yeah we'll implement it you know. We'd never done it before so we were all a bit apprehensive about putting out this MET call but we did it cause his score em was twelve and you know the base you know the minimum is eight to put out a MET call...So em we had the team come up and the I found it quite disconcerting because the Registrar that attended just sort of like said don't you know how busy we are in A&E you've called us away from these patients and all he's got is aspiration pneumonia. Well the thing is we sort of like felt vindicated really because that afternoon he ended up going to the high dependency unit because he'd also gone into renal failure and all sorts. And he had to sort of like em go on CPAP I think and all this sort of thing. So you know he really was quite unwell so that's one of the more recent ones." Int 9 case 1 lines 37-76.

A chronic obstructive airways disease patient was admitted for intravenous antibiotics to treat a chest infection. The clinician used the patient's history of chronic obstructive airways disease and chest infection, knowledge of the patient's prolonged bed-rest and presenting symptoms to judge that the patient had an acute condition requiring referral to the medical consultant (the normal referral procedure for a private patient). This patient was subsequently treated for multiple pulmonary emboli (case 32.2).

Although knowledge of the patient history/medical condition generally contributed to the reported accuracy of the nurse's judgement of patient condition, in some cases clinicians under-estimated the severity of a patient's condition. Clinicians noted the age range of patients and their biographical characteristics and they appeared to make predictions based on the presenting condition and the usual course of events. In one case of pneumonia in a male patient in the 40 years age range, the nurse predicted a positive response to antibiotic and oxygen therapy, the most usual outcome in such cases, but this patient had a respiratory arrest and died (case 18.2). Other patients with very serious diagnoses had seemed to be improving clinically but deteriorated
unexpectedly. Cases in this category included a patient admitted to a medical assessment unit with hypothermia who had a cardiac arrest, was resuscitated, transferred to ICU, but later died (case 8.3). A second example was a patient recovering from acute myocardial infarction with mild chest pains but ECGs showed no acute changes, who was later found collapsed, successfully resuscitated and then given thrombolytic drugs for pulmonary embolus (case 1.3).

- The diagnostic cues clinicians’ report i.e. specific cues that indicate a particular clinical state such as elevated cardiac enzymes in acute myocardial infarction, or situations where a combination of cues are considered to be diagnostic

Clinicians reported using a range of diagnostic cues to diagnose clinical states; such as cardiac markers, electrocardiographs, and blood tests. Cardiac enzymes, particularly Creatinine Kinase and Troponin T, were used to diagnose acute myocardial infarction (cases 1.2, 12.1, 21.3). Abnormal ECGs were used as diagnostic cues for example ST segments going up after thrombolysis (case 4.2); evidence of cardiac ischaemia (case 5.2); ventricular ectopics (case 8.2); tachycardia and atrial fibrillation (case 12.1); ventricular tachycardia (case 16.1); tachycardia (case 25.1); and atrial fibrillation (case 30.4). Abnormal blood results were also used as diagnostic cues for example low blood sugar (cases 6.4, 7.2, 17.1, 28.1); low haemoglobin cases 23.2, 29.4); low serum potassium (case 15.2), and abnormal arterial blood gases (cases 8.2, 12.2, 16.2, 23.1).

Other diagnostic cues were used in combination with a range of cues and patient history to diagnose a particular clinical state. For example a case of sudden onset of acute severe leg pain, and urinary incontinence in a patient with atrial fibrillation (case 2.1) was used to diagnose potential deep venous thrombosis and the patient was referred to the medical team. Some diagnostic cues were negative yet the patient went on to have a life-threatening event. This is illustrated by the case of a young adult female with negative echocardiogram scans who had a cardiac arrest. This event was later attributed to the presence of a pericardial effusion and linked to a
recent diagnosis of Systemic Lupus Erythematos (case 1.5). A patient in recovery ward developed hypovolaemic shock after major abdominal surgery and was subsequently transferred to ICU for five days. The nurse had noticed a combination of signs such as reduced level of consciousness, sudden drop in blood pressure, reduced urine output and pyrexia (case 25.1).

- The cues that are considered to be clinical indicators of the current clinical state

A wide range of cues was reported as clinical indicators of patient condition. These included all the physiological measures such as blood pressure, urine output, respiratory rate, subjective clinician signs and behavioural signs, and patient self-report of symptoms (see Graphs 18-23).

- The cues considered to be clinical indicators of a change in the clinical condition

A range of cues was reported as clinical indicators of a change in the patient condition across the majority of cases. These included the following changes over time. Firstly changes in objective measures (such as increased respiratory rates, decreased blood pressure, increased or decreased pulse rate). Secondly, paraclinical/laboratory/investigative data changes (such as ECG ST segments becoming more elevated, and decreases in haemoglobin levels. Thirdly, changes in subjective clinician and behavioural signs (such as decreases in level of consciousness, and increasingly laboured breathing). Fourthly, changes in patient self-report of symptoms (such as increased chest pain, increased shortness of breath/breathlessness) and finally, response to treatment (condition either improving or deteriorating).

An example of changes in subjective clinician data is a patient admitted with chest pain query cardiac pain, and a history of dementia, who became more confused over the weekend. Nurses recognised that the patient's condition had changed and referred the patient to junior doctors twice but they did not attend because they were busy in the accident and emergency department. After referral to the medical registrar the
patient was transferred to the accident and emergency department for thrombolytic therapy to treat a large pulmonary embolus (case 12.3). The patient recovered and at the time of interview was being nursed in a less acute bay on the ward.

- The cues reported to be prognostic of a future clinical state or deterioration in patient condition

The cues reported in prognostic judgements included the diagnosis of the current patient condition, scores such as MET/ EWS, the patient history/ medical diagnosis and estimates of the patient's physiological reserve. The rate of change or deterioration may also be an important predictor of a future state. For example within the critical illness cases 96% (44/46) of cases presented with acute change or deterioration, and the two remaining cases were either already critically ill due to a large bleed (case 22.3) or severely ill with chronic pleural effusions (case 29.4). The majority of cardiac arrest cases also presented with acute deterioration in condition 70% (16/23) of cases. The persistence of a particular sign despite treatment may also be an important prognostic sign; for example a patient who complained of ongoing chest pain and had cardiac marker results in the borderline range for myocardial damage (case 1.2). A further example was a patient not responding to maximal anti-anginal therapy awaiting transfer to a tertiary referral centre (case 1.6). Clinicians reported using their diagnosis of the patient’s current condition to predict a future condition such as a patient developing respiratory distress where intervention may have prevented respiratory arrest (case 17.2).

No. 17* "...we had a patient who became em he was a gentleman with asthma who became acutely short of breath... That was a gentleman when I was working down on one of the other teams for the shift. He wasn’t a patient that I knew very well just that he was asthmatic I'm not sure if there was an element of COPD as well. Em he again had been in for a while and had been improving steadily. Em but at hand-over one of the other nurses had pointed out that she felt his breathing wasn’t as good as it had been. So straight away I was just that little more you know would observe him just that little bit more. Em and initially there was, he was worse, he wasn’t as well as I would have liked but he was still talking in sentences and whatever. So I had rung the doctor and said would you, I wasn’t overly concerned at that point, but I did mention to her you know I would
like you to come and see him sooner rather than later. So I'd given him the nebulisers and it didn't improve and then I did. I phoned her again... I had scored him then em and you know I told her the score and it was an SHO-Call the SHO score, so I said you know you need to come now. So she came she was literally on the two teams along so she was there in no time. Em and we started him on an Aminophylline infusion..."

Interviewer* Yes so em what's your judgement if you hadn't intervened at that stage with that gentleman?
No. 17* "I think it well he would have had a respiratory arrest in my opinion if we'd if we hadn't intervened when we did."
Interviewer* Emm
No. 17* "I don't think there is any doubt about it really; he would have had a respiratory arrest." Int 17 case 3 lines 267-296, 315-324.

A further example involved diagnosis of acute deterioration based on reduced respiratory function and behavioural changes in a patient admitted with night sweats. The clinician summoned the Medical Emergency Team and the patient had emergency intervention for cardiac tamponade. This prevented a catastrophic event, as after a pericardial drain had been inserted and the cardiac tamponade was relieved, the patient was “almost immediately well again” (case 18.3).

No. 18* "...She's a lady she's a [foreign] lady em in her early fifties I'm just trying to think what her, why she actually came into hospital. I think she'd been having night sweats and I don't believe you know anybody ever found out why. She was referred to all manner of people you know the Rheumatologist, the Haematologist while she was here. And em but she was virtually a self-caring admission. Anyway she did have, again her breathing she did like to have the odd bit of oxygen because you know she felt her breathing was a problem. ...But she was an extremely pleasant person and then em just her demeanour changed it was one lunchtime. You know she was you know she smiled a lot and all the rest of it and then one day you know I went in there and there was a slight change in her colour she looked sort of greyish really and she was quite a tanned person anyway. Em and she was stuck to her oxygen and it was that look again" [clinician had referred to the patient's look of fear in a previous example]
Interviewer* Erhm...
No. 18* "You know and em because I'd known her so well I knew she was sort of sort of pretty vivacious person suddenly she wasn't anymore you know and she was sitting in her chair. And I said let's you know let's go and lie down on your bed and we'll have a bit of a look at you and that was a struggle I had a struggle getting her there on my own." Interviewer* Uuhh
No. 18* “So em I did some obs and again her... now what were her obs. I know her resps were sky high don't ask me what they were I've got forty-one in my head. Em and I have to be honest I can't remember anything else. And so I called the MET team and but it was actually her Registrar who came down as well and he em....And it turned out she had and if you ask me how they diagnose this, I don't know, but they brought this big machine down from the cardiac department and she had a... (This was debated and cardiac tamponade, pericardial effusion was confirmed later) there's lots of fluid round the heart. And within you know you sort of took one look cardiac tamponade there was lots of fluid round the heart. And within you know... you sort of took one look at her and they had the machine and some sort of tubing”

Interviewer* Aha perhaps an echo?
No. 18* “Would it be just an echo?”
Interviewer* They might have done an echocardiogram
No. 18* “I think it might just have been and within ...a quarter of an hour she was whisked up to the cardiac department me with her and her poor husband trailing after saying what's happened she was all right this morning you know.. And she was sort of raced onto the ward there and they did em some sort of drain to it and she was almost immediately well again apparently I heard. I took her up and then I left. But it gave her immediate relief...”

Interviewer* So to summarise you noticed in her demeanour her appearance and the fact that she'd previously been quite quite bright?
No. 18* “Yes I knew what she was like before but also again the way they look at you and you know there's something seriously wrong. 'Cause you do get people who get, you know they say they've got something different wrong with them everyday, you keep kind of trying to dismiss it... But you do you know, you did a double take in her, there's something not right here”

Interviewer* Yeah aha aha aha right aha. Em undoubtedly your actions you know your actions were correct in that situation in calling the MET team. If the situation had been different and you didn't have the Medical Emergency Team you would have called the, her...
No. 18* “If I would have fast bleeped her Registrar”
Interviewer* Would you have got the same doctor?
No. 18* “it would have amounted to the same thing” Int 18 case 3 362-425, 470-496.

The above example illustrates that the nurse is evaluating the patient’s condition and predicting further deterioration as indicated by the raised MET score. A decision is made to refer the patient to the MET. However the clinician does not use the terms evaluative judgement, prediction or prognosis.
7.8 Analysis of clinical judgements according to clinical speciality

7.8.1 General medical ward clinicians

Medical cases were categorised according to clinical outcome as follows: critical illness (28 cases); cardiac arrest (19 cases); acute illness and vulnerable to deterioration (16 cases); chronic illness (7 cases); terminal illness (4 cases); and acute illness (1 case). The cue composition and time sequence of reporting of cues was examined for each outcome category. Within the critical illness category clinicians identified cues as shown in Appendix 26- Cross-case matrix of cues for critical illness medical cases.

Objective measures of the patient’s physical state were considered important, but the results also suggest that subjective clinician/ behavioural signs and patient self-report are important components of clinicians’ judgements of the patient’s condition and future condition. When the time sequence of cues was examined clinician subjective/ behavioural cues and patient self-report cues were considered the initial or earliest cues in 21/25 medical cases with a critical illness outcome state. The remaining four cases reported subjective data complementary to objective data as the earliest cues in clinical judgements. The research hypothesis that subjective/ behavioural cues and patient self-report cues were considered the initial or earliest cues was therefore supported in 21 out of 25 medical cases in the critical illness outcome category.

Within the 19 medical cases that went on to cardiac arrest clinicians reported the cues shown in Appendix 27: Cross case matrix for cardiac arrest medical cases. As in the critical illness cases, subjective clinician/ behavioural data and patient self-report were considered important initial cues in clinicians’ judgements with 14/19 medical cardiac arrest cases in this category. Subjective data were considered complementary to objective measures in 3/19 medical cases. The final two medical cases were cardiac arrest cases, and because of the overwhelming importance of objective measures they represent negative cases for the research thesis. One case was subsequently designated not for resuscitation due to severity of illnesses and poor
prognosis, and the other case was successfully resuscitated. However, the research hypothesis that subjective clinician/behavioural and/or patient self-report data were the initial or earliest cues was supported in 14/19 medical cases.

The cues considered important in the 16 acute illness and vulnerable to deterioration medical cases are shown in Appendix 28. In 8/16 medical cases subjective clinician/behavioural and/or patient self-report data were considered the most important initial cues. In the remaining 8/16 medical cases subjective clinician/behavioural data were considered complementary to objective data. The patients in this group did not have a critical illness or cardiac arrest event, but in many cases this was probably due to the intervention of nursing and medical staff. The research hypothesis that subjective clinician/behavioural and/or patient self-report data were the initial or earliest cues considered important was supported in 8/16 medical cases.

7.8.2 Contrast Cases

The cases reported by interviewees from intensive care and high dependency, the surgical wards/surgical high dependency/recovery, and coronary care areas were examined across the outcome states of critical illness, cardiac arrest and acute illness and vulnerable to deterioration.

The three intensive care/high dependency nurses reported three cases in the critical illness outcome category, one case in the acute illness and vulnerable to deterioration category, and one case in the cardiac arrest outcome category. The small sample size limits the conclusions that can be drawn. However within the critical illness outcome category for ICU/HDU cases objective measures and paraclinical signs, and the subjective clinician/behavioural sign of reduced level of consciousness were reported. The earliest cues to patient condition were subjective data in combination with objective measures, or objective measures only. The cases comprised the medical conditions of meningococcal septicaemia, chest pain with acute cardiac changes on ECG and left axis deviation, and chronic respiratory disease with respiratory failure. The acute illness and vulnerable to deterioration case was a patient
re-admitted to ICU following deficits in ward management where raised blood sugars had not been treated, and in this case the objective measure of blood sugar was considered the earliest cue to patient condition. The cardiac arrest outcome case was a patient with cardiogenic shock and a combination of objective measures and subjective cues of persistent chest pain, sweatiness or clamminess was considered important. These cases did not support the hypothesis that subjective clinician/behavioural and/or patient self-report data were the initial or earliest cues to patient deterioration.

The eight surgical interviewees (included one surgical high dependency and one recovery ward nurse) reported 10 cases in the critical illness outcome category, and eight cases in the acute illness and vulnerable to deterioration category. There were no surgical cases within the cardiac arrest outcome category. Within the critical illness category clinicians considered cues important across the range of cues, including clinician subjective/behavioural cues and objective measures. Subjective data were considered the earliest data in three cases, subjective data were more frequently considered complementary to objective data (5 cases), and objective data were considered the earliest cues in two cases. In the acute illness and vulnerable to deterioration category again, both clinician subjective/behavioural cues, and objective measures, were considered important. Subjective data were seen as the earliest important cues in three cases, and subjective data were viewed as complementary to objective data in four of the eight surgical cases in this outcome category. The small sample size limits conclusions that can be drawn. The research hypothesis that subjective clinician/behavioural and/or patient self-report data were the initial or earliest cues to patient deterioration was supported in six out of 18 surgical cases reported.

The two coronary care clinicians reported two cases in the critical illness outcome category, three cases in the cardiac arrest outcome category and no cases in the acute illness and vulnerable to deterioration category. The cases in the critical illness outcome category included a patient with an anterior myocardial infarction post
thrombolysis, and a patient in complete heart block in cardiogenic shock. Clinicians considered objective measures, paraclinical/ investigative data and subjective clinician, and patient self-report data important in judgements of the clinical condition. In one case subjective data were considered the earliest cue to patient condition, and in the other case subjective data were complementary to objective data in the earliest judgement of patient condition. The cardiac arrest outcome cases were already critically ill, two patients were located in CCU with acute myocardial infarctions followed by second cardiac events that precipitated cardiogenic shock, and one case of a patient with severe haematemesis experienced cardiac arrest on the general ward. The cues considered important were objective measures of blood pressure, respiratory rate, heart rate, oxygen saturation levels and MET score, paraclinical and laboratory data of ECGs and x ray, and clinician subjective data of breathing, abdominal distension, persistent chest pain, patient self-report of pain, and not responding to treatment. Subjective data were viewed as complementary to objective measures as the earliest cues to the patient condition in two cases, and objective data only were considered the earliest cues to patient condition in one case. This sample was too small to draw conclusions, but there was minimal support for the research hypothesis that subjective clinician/ behavioural or patient self report data were the initial or earliest cues to patient deterioration as it was only supported in one out of five cases. Within coronary care areas formal risk scores are already in place.

7.9 Accessing research participants at the clinical and university sites
The biographical characteristics of clinicians accessed at the clinical and university sites were reported in Table 20 (section 5.6.5, p.173). The two groups were similar in years of experience since qualification, and age ranges. The cases reported by clinicians accessed at the clinical site and the university site were compared and contrasted. The sample accessed at the university site was small so it was not possible to draw major conclusions. Two of the four surgical clinicians accessed at the university site were based in surgical high dependency or recovery ward whereas the four surgical clinicians accessed at the clinical site were based in general surgical or
orthopaedic wards. In the critical illness category the surgical high dependency and recovery ward nurses reported three cases whereas the general surgery ward nurses reported eight cases. In the acute illness and vulnerable to deterioration category the surgical high dependency and recovery ward nurses reported just one case whilst the general surgical ward nurses reported seven cases. The cues reported by surgical nurses at the hospital and university sites were examined. Generally both groups reported objective measures and subjective clinician/ behavioural and patient self-report data in the critical illness and acute and vulnerable to deterioration categories. A further two surgical cases were categorised as acutely ill, bringing the total number of surgical cases up to a total of 21. The small sample sizes made it impossible to draw conclusions beyond stating that both groups referred to objective measures and subjective clinician data.

The three intensive care nurses were drawn from two NHS Trusts; one clinician was based at the clinical site where the majority of clinicians were accessed. They reported cases where deficiencies in ward care led to the admission and readmission of cases to ICU, as well as direct admissions to ICU. The intensive care nurses reported cases where objective data were available and the subjective data complemented these; the research hypothesis that subjective clinician/ behavioural and/or patient self-report data were the earliest cues to patient deterioration could not be upheld for this group.

One medical ward nurse was accessed at the university site and reported just one case but this supported the research hypothesis that subjective clinician/ behavioural and/or patient self-report data were the initial or earliest cues in the identification of patient deterioration. This finding is neither significant nor generalisable as it refers to just one clinician and one clinical case.
7.10 Feedback and member validation

Copies of the draft results (chapter 7) were circulated to 10 of the research participants, one critical care outreach nurse, and another medical unit sister at the clinical site. Seven respondents replied within the time period requested by the researcher, and one respondent was on maternity leave. The remaining clinicians were contacted a second time by letter and two further replies were received. One respondent stated that she had not yet read the document due to other work commitments. The results of feedback from both ward and critical care outreach team clinicians are reported below:

*Please comment on the extent to which the research findings echo your experiences*

I managed to find my experiences in the draft and your research appears to accurately reflect my experiences. Interviewee 2

I would have to agree with the majority of findings. Hodgetts and Kenward (2002) in Resuscitation found similar findings with levels of cardiac arrests vs recording of observations and support your findings. Interviewee 4

Accurately reflects my experiences. Interviewee 9

The cues identified echo my experiences. Interviewee 18

In general I think the comments made by the other nurses in the study are very similar to my own. I thought it was really interesting that although abnormal observations assist in most cases, helping to identify the problem, there was definitely a place for the 'nurse concern' aspect, that is so hard to quantify. Interviewee 27

I would say that I would recognise at least 75% of the research findings that echo my experiences. Interviewee 29

The research reflects my experience and how things have changed for the better by nurses being trained to identify early warnings. Interviewee 30

The findings illustrate a clear pattern in the way in which cues for a patient's condition become apparent and the way in which a clinical judgement is made on these cues. I agree with the way subjective and objective measures are identified and utilised by nurses and medical staff to make a judgement. Critical care outreach nurse

It was very interesting to read the findings and most are consistent with clinical practice outcomes. Ability to predict critical illness/ cardiac arrest also depends on the clinician's years of experience. Interviewee 28
*Any further comments you wish to make about the cues identified in the research findings*

[Name of clinical site] use the MET scoring system as an adjunct to the observations of temperature, pulse, BP and respirations. This as you know prompts a call to the appropriate body to report changes - depending on the extent of changes, depends on the level of seniority to report to. Biochemical markers and investigations such as ECG, CXR, ABG will then support or prompt a referral to a critical care environment - Either ICU and anaesthetic review or CCU and cardiac registrar etc etc. Interviewee 4

It is experience that upholds more subjective cues such as behavioural changes, which are more difficult to quantify. Experience then enables the senior nurse to articulate these changes to a physician with regards to deterioration of physical condition. (Agitation, becoming fretful, or just struggling with ADLs). Interviewee 4

It is interesting to note that nurse concern does play a major factor in detecting patient deterioration, and that medical staff still tend to disregard this fact. Perhaps medical staff need to be educated that nurse concern is a valid reason for concern. Interviewee 9

The other point that I picked up was the need for a good relationship between the doctor and the nurse. A number of nurses said that the doctor knew they would only call if they had real cause to and that although they had little hard obs evidence the doctor responded as they trusted them. This relationship was also tested in a couple of cases, one cited was with a very junior HO, who wanted to wait until the morning, but the nurse did further tests on her own initiative and gave the junior doctor enough evidence to enable her to call her seniors. This shows how an experienced nurse can pursue her instinct and gain evidence to support this. Interviewee 27

The research identifies how we should be assessing the acutely ill patient/ critical illness/ chronic illness, their similarities and differences and how to manage these. Training in the appropriate skills is very important. Interviewee 30

As an Outreach nurse I take a lot of information regarding patients by telephone (at the first point of contact), interestingly conversations usually start with a subjective or behavioural measure first, for example the patient is more breathless, has chest pain or is more confused, aggressive. The staff may then go on to give me objective measures although I may need to prompt for these and they may also be normal. Staff generally forget to tell me the patient’s name in their haste to tell me the problem. Judging the extent of a patient’s illness/problem by telephone relies on the subjective measure and if it differs from the patient’s norm and how the objective measures fit with this and again if this differs from the norm. From experience objective measures can give a somewhat more tangible credibility to the subjective measure, which if you
are talking to a doctor may speed up their response to attend to a patient. Hence the use of the MET scoring system to provide a clear system of triggering help and providing information in a concise way. Critical care outreach nurse.

In the two years after data collection commenced for the current study substantial changes were made to the provision of ward-based critical care at the clinical site; these changes reflected what was happening nationally. At the clinical site a critical care outreach team was developed to provide a link between critical care and ward-based clinicians so that critically ill ward patients could be identified and referred to clinicians with critical care expertise as soon as possible. It was not possible to include critical care outreach nurses in the qualitative interviews because they were not in post when data collection commenced. Also the focus of the current research was on how ward based clinicians identified patients in transition from acute to critical illness or cardiac arrest and circumstances surrounding the initial referral of patients.

7.11 Discussion
The qualitative interview study elicited a range of cues clinicians considered important in judgements of patient condition in transition states from acute to critical illness or cardiac arrest, based on clinicians' self-report. The focus was on general medical ward clinicians. The particular contributions of this study are as follows:

- The identification of cues considered important in judgements of patient condition in transition states from acute to critical illness or cardiac arrest, the frequency of reports of cues, and the sources of cues,
- The analysis of cues considered early indicators of deterioration; this sheds light on the composition of the Medical Emergency Team/Early Warning Scores criterions of clinician/nurse concern.
- The perceived accuracy of clinicians’ predictions of the patients’ conditions,
- The study provides an insight into the nature of the cues used in clinical judgements, the importance of perceptual cues, and the types of judgements that
nurses make for patients in transition states from acute to critical illness or cardiac arrest, and finally,

- a comprehensive framework of nurses' clinical judgements of patients in transition states from acute to critical illness or cardiac arrest based on severity of illness is proposed.

Many of the objective measures of physical state, paraclinical, laboratory and investigative data cues had already been identified in the systematic review. It was not surprising that clinicians referred to these cues as they had been much highlighted in current policy documents and critical care initiatives arising from them (Audit Commission, 1999; DH 2000). However the current study adds to knowledge by providing a more comprehensive account of the range of subjective and behavioural data considered important by clinicians such as patient history, current admission details, temporal cues, clinical and behavioural data, and suggests possible functions of these cues in clinical judgements.

Patient history and current admission details in judgements of patient condition appeared to provide the context for clinical judgements. Patient history included the identification of risk characteristics, chronic illnesses, co-morbidities, severity of symptoms before current admission, and personal characteristics of age, gender and functional ability before admission. These factors seemed to be used to make judgements of the patient's usual health status and likely physiological reserve.

Hobus et al., (1987) found that the context of a patient case was very important in medical diagnosis by expert doctors. Extensive use of contextual information, particularly in the generation of initial diagnostic hypotheses, resulted in more correct hypotheses and better recall of relevant information. The findings suggest that information about patient history is highly relevant to judgements about patient condition in acute and critical illness or cardiac arrest; it may even provide clinicians with access to their domain-specific knowledge structures stored in long term memory.
Temporal cues refer to changes in condition over time. Clinicians often referred to the patient's condition becoming better/improving, remaining the same/unchanged, or worsening/deteriorating. The majority of critical illness cases occurred in the presence of acute deterioration in patient condition. Response to therapy also refers to temporal dimensions but in this case the focus is on patients' response to treatment viewed either as responding, or not responding. The temporal dimension highlights the dynamic nature of patients' conditions. Dealing with patients in transition is an important element in the domain of nursing (Meleis, 1991); transition along the health/illness continuum is the focus in the current study and a theoretical framework based on a comprehensive interpretation of severity of illness guided the investigation.

Clinical data included breathing difficulties, level of consciousness, abdominal distension, reduced mobility, abnormal posture, lethargy and psychological factors such as anxious looking, distressed or depressed mood. Clinical cues derived from a perceptual process included colour, clamminess, demeanour, and slumped posture. Interactive cues included being withdrawn, not conversing, altered responsiveness during nursing procedures, still talking in sentences/not talking in sentences, or speech being incoherent. It is suggested that nurses' ongoing contact with patients place them in a position to recognise significant clinical and behavioural data and to pick up subtle perceptual and interactive cues. Patient self-report of symptoms was also gained through interaction with patients. The findings suggest that many subjective clinician and behavioural cues are relevant to nurses' diagnoses of patient condition and predictions of deterioration.

Subjective clinician and behavioural data contribute to clinicians' judgements of concern about patient condition. Cioffi's (2000b) qualitative interview study investigated the criterion of clinician concern currently used in MET scores in Australia, and identified the components of patient feeling "not right", colour, agitation, and observations slightly changed or unchanged. These cues seemed to
trigger nurses to monitor the patient closely and ask more questions. Further evidence of the importance of clinician concern is reported in a recent quantitative study in Australia (Bellomo et al., 2003) where clinician concern is the most frequently reported criterion in a medical emergency (MET) scoring system. The National Outreach Forum (NORF, 2003) reports that clinician concern is frequently cited as an important indicator across the hospitals surveyed in England. Clinician concern alone is a sufficient criterion to trigger the MET in Bellomo et al., (2003); this suggests clinicians’ may be delaying calling assistance in other situations where more criteria are required before a trigger score is reached.

The current study adds to earlier research on nurses’ clinical judgements in critical illness (Cioffi, 2000b; Grossman & Wheeler, 1997; Smith, 1988) by identifying the cues considered important by medical ward clinicians, the time relationships between cues and judgements, and by analysing judgements on a case by case basis. Three time periods in clinical judgements were identified, initial, early and late (section 6.6, p.222). Subjective clinician/ behavioural and patient self-report data were frequently reported as the initial cues that alerted medical ward nurses to possible deterioration.

Clinicians’ reports of the perceived accuracy of their predictions seemed to indicate that cardiac arrest outcomes were more unpredictable than critical illness or acute illness and vulnerable to deterioration, acute illness or chronic illness. Patients who go on to cardiac arrest include those where premonitory signs could have been missed, and patients without premonitory signs who have sudden catastrophic deterioration.

A prospective study would be required to test clinicians’ predictions as the current study is limited by the self-report methods used and did not test their accuracy. The accuracy of clinicians’ subjective predictions have been documented elsewhere; Marks et al., (1991) found doctor and nurse clinicians’ subjective predictions of patient outcome on admission to ICU to be more accurate than Apache II predictions.
From the Social Judgement Theory perspective individuals do not experience the patient’s state directly, they infer the state of the patient using cues available to their perceptual system (Brehmer, 1988). Perceptual skill in the recognition of cues is therefore closely related to clinical judgement. Perceptual cues rely on the clinician both sensing and interpreting the cue (Oxford Dictionary of Psychology, 2001).

Perception in the context of the current study is viewed as an active process rather than merely a response to observable stimuli. Harré (2002, p.104) suggests that perception involves classification of an object as something rather than the behaviourist pattern of stimulus (retinal sensation)/ response (perception of object). Harré (2002, p.104) argues that there must be a cognitive component, in which there is an observable stimulus plus an unobservable cognitive process ('knowledge utilisation') which leads to an observable response (recognition of object).

The current findings suggest that nurses’ perceptual skills may be important in the detection of patients with acute physiological deterioration. Medical ward clinicians in the current study seemed to use recognitional skills, and in many cases gave examples of qualitative distinctions in cues such as colour, posture, and responsiveness. According to Benner et al., (1999) the clinician requires perceptual acuity to recognise clinical problems and clinical judgements are made on the basis of what is perceived.

Proctor and Dutta (1995) examine the perceptual component of skill acquisition and performance; they suggest that perceptual judgements become quicker and more accurate as individuals learn to discriminate between stimuli. Two types of perceptual processing and task performance are identified: firstly, there are those that need the person’s attention to process them; and secondly there are tasks that do not require attention for processing (Proctor & Dutta, 1995). It is thought that tasks that initially require attention later become automated to some degree (Proctor & Dutta, 1995); this may be the case in the perceptual judgements clinicians make in the early recognition and prediction of critical illness or cardiac arrest. With increased experience clinicians’ perceptual judgements may become more automatic and faster.
This study also identified the different types of judgements that general medical ward clinicians make for patients in transition from acute to critical illness or cardiac arrest. These included diagnostic judgements about the current condition of the patient, evaluative judgements about change in the patient's condition, and prognostic judgements about the likely future condition of the patient.

One of the difficulties in diagnostic judgements is that cues are often indicators of a number of clinical sub-states. For example laboured breathing or breathlessness can be found in respiratory states where there is increased work of breathing as in chronic obstructive airways disease and asthma, impaired chest expansion as in pulmonary embolism, in hypoxia conditions such as pneumonia, or where a disease has weakened respiratory muscles (Harris, 2002). However it may also indicate cardiovascular states such as pulmonary oedema in cardiac failure, metabolic acidosis as in ketoacidosis and renal failure, or anxiety (Harris, 2002). A further example is pale skin or pallor, a cue that can indicate anaemia, vasoconstriction possibly due to hypovolaemic shock, fright, or hypothermia. The clinician's task is to judge which clinical state is the most probable given the patient's other signs, symptoms, history and medical diagnosis.

In many cases the cues reported by clinicians could be linked to one or more clinical sub states. Physiological stability or instability seemed to be the important dimension within the clinical sub-states, and within the personal/ psychological state there were various properties such as distress/ no distress, altered/ unaltered mood. The clinical sub states included respiratory instability or failure, circulatory instability or failure, neurological instability/ altered level of consciousness, metabolic instability, gastrointestinal instability/ gastrointestinal haemorrhage, sepsis, malignancy, immune system disorders, renal instability or failure, and combinations of these sub states. The link between cues and clinical sub states was highlighted in the earlier conceptual framework in the systematic review (Figure 4, section 4.5, p.68).
The clinicians' judgements of the overall patient condition (diagnostic hypothesis or major assessment conclusion) could be categorised as one of the following:

- Acute deterioration in patient condition, or acute illness with persistent or new clinical signs or symptoms
- Chronic deterioration in patient condition
- No change in patient condition or a stable/unchanging physiological clinical state
- Improved patient condition

Based on the diagnostic hypothesis or major assessment conclusion a prognostic judgement could be made. In the interview study prognostic judgements ranged from generalised predictions of further deterioration in clinical condition, or improvement in clinical condition, to more specific predictions of critical illness or cardiac arrest.

Dimensions of the severity of illness theoretical framework were evident in general medical ward nurses' judgements as follows:

**Biological severity** Clinicians frequently referred to the patient's age; this seemed to provide important contextual information alongside which further cues were interpreted. Direct indicators of biological severity apart from age were inaccessible and so clinicians drew on other indicators of biological severity, such as physiological and functional severity, which will now be discussed.

**Physiological severity** The majority of cues reported by clinicians could be categorised as indicators of physiological severity. These included physiological measures and paraclinical/laboratory or investigative data, clinical signs comprising clinician subjective, behavioural and functional data, patient history and patient self-report of physical symptoms. Physiological severity refers to acute and/or chronic disease processes. Clinicians' reports documented the patient's main medical condition(s) contributing to the clinical outcome condition. Clinicians referred to the severity of particular diseases, for example patients who had previous admissions for chronic respiratory or long-standing cardiac diseases; and those who had none were described as previously *fit and well*. The severity of any co morbidity, whether there was decompensation or no decompensation of a major organ system (Feinstein,
Physiological reserve refers to biological severity, and physiological factors such as cardiac reserve, the immune, and nutritional status. Physiological reserve is assessed using indirect factors such as the patients’ functional ability prior to the current admission, and their nutritional status. Although clinicians rarely used the term *physiological reserve*, the findings suggest that clinicians used information about the patient’s previous functional ability, and general state of health, as well as the presence of chronic illness and co-morbidity, to predict the potential for further deterioration or recovery. References to functional ability included decreased ability to mobilise, reduced participation in personal hygiene tasks, or reduced interaction, such as talking less. There were references to patients who were not making the expected progress after acute myocardial infarction or surgery. There were occasional references to patients’ nutritional states, however this cue was reported infrequently.

**Psychological and personal factors** Anxiety, fear especially related to breathing difficulty, and changes in mood were reported by clinicians as important indicators of the patient’s current condition.

**Temporal factors/ type of change** The rate of change in the patient’s condition was frequently reported by clinicians. Many of the patients who went on to critical illness or cardiac arrest were reported to have acute and sudden deterioration in their conditions.

**Organisational factors** Although the context of care was not the main focus in the current study clinicians frequently referred to organisational factors such as skill mix and workload. In some of the later cases clinicians reported that the critical care
outreach team's presence freed up time for them to attend to other nursing duties. Summoning the team was seen as a way of obtaining more skilled nursing input on the ward. The process of referring patients to medical staff was also described. Generally the Medical Emergency Team calling criteria were considered useful for succinctly describing the patient’s current clinical condition and eliciting the input of the medical team. Problems in the nurse/doctor relationship arose in situations where the nurse was only able to report subjective clinical signs; objective measures were within acceptable ranges. Some clinicians persisted with their concerns about a patient’s condition even when medical staff reported that they could find no major problem. Often their concerns were validated by future events for example a patient with a CVA who developed aspiration pneumonia, and a chest pain patient with ongoing chest pain who required emergency cardiac stents (interview 9 case 1; interview 1 case 2 respectively). In other cases clinicians did not persist with their initial diagnostic hypotheses. These situations included a patient the nurse suspected had a deep venous thrombosis (DVT). Medical staff diagnosed muscular-skeletal pain and treatment of the patient’s life-threatening DVT was delayed (interview 2 case 1). In a post-operative surgical case nurses questioned the intravenous fluid regime but did not persist with their concerns when the doctor confirmed that the prescription should continue. The patient subsequently developed fluid overload and required admission to ICU (interview 27 case 1).

7.12 Conclusion
This chapter presented the findings of a qualitative interview study with 32 general ward, and critical care nurses with at least three years’ experience. A range of cues was considered important in the judgements of the current patient condition and predictions of deterioration in condition, critical illness or cardiac arrest in patients’ in general medical wards. In particular the time sequence when cues were noted by clinicians in the judgement process was examined. Many of the cues reported by clinicians feature in the current medical emergency and early warning scores, but this study also identified further clinical cues considered important in judgements. Some
of these were subjective cues present before physiological measures changed, in other cases subjective data complemented objective measures, and in a minority of cases clinicians considered only objective measures were important. The study provides evidence of the types of cues clinicians may be responding to when they use the MET/EWS criterion clinician concern.

The clinicians’ self-report of the accuracy of their predictions of patient outcome condition was examined. The highest rates of reported inaccuracy were for cases with cardiac arrest outcomes. The psychological properties of cues were also examined, and clinicians reported cues that could be categorised as diagnostic, prognostic, clinical indicators, clinical indicators used to identify a change in patient condition, and patient history cues that provided the context for the case.

The results of this interview study need to be tested. However the findings suggests that experienced clinicians are often able to identify deterioration in condition, and predict further deterioration, critical illness or cardiac arrest using an array of data that complements the more objectively measured information contained in current early warning scores.

The next chapter brings together the findings from the systematic review of predictors of critical illness and cardiac arrest reported in chapter 4 and the qualitative interview study reported in the current chapter. These findings are linked to the clinical and theoretical frameworks presented in chapters 2 and 3. A typology of cues for the prediction of deterioration in condition, critical illness and cardiac arrest in general medical ward patients is presented, and the contribution of the thesis to the literature on clinical judgements in transition states from acute to critical illness or cardiac arrest is discussed.
Chapter 8
General Discussion and Conclusions

8.1 Introduction
This chapter discusses the findings in relation to the research thesis that experienced clinicians frequently diagnose deterioration in clinical condition and predict further deterioration in condition, critical illness or cardiac arrest, using cues available before measurable indicators of physiological deterioration are evident. A number of qualitative hypotheses were developed to examine the research thesis.

The methodological approaches and level of analysis were designed to describe both the predictors of critical illness and cardiac arrest reported in the research literature and the cue composition reported in clinical judgements, with a focus on general medical ward nurses. This cue identification process represents an early phase in a Judgement Analysis study (Cooksey, 1996a). The aim was to identify the core cues, including those reported most frequently in the systematic review, and by clinicians in a qualitative interviewing study. According to Cooksey (1996a) cue identification is the most subjective part of a judgement analysis study because self-report of cues is necessary to establish those cues considered important. To address the potential problem of omitting an important cue from any future judgement analysis study, experienced nurses were recruited to the cue identification study and data analysis was directed towards identifying convergent cues (Cooksey, 1996a). Before research can investigate the empirical accuracy of judgements and whether accuracy could be improved, descriptive research is needed to establish what the judgement tasks in nursing are (Harbison, 2001). This position is different from descriptive research that regards nurses judgements or decisions as accurate and merely recounts what nurses do, thereby failing to grapple with the quality of nurses judgements or decisions (Harbison, 2001).

The limitations of the research are reported first and the research findings then discussed in the light of these limitations. Progress towards the achievement of the
aims of the research and evidence for the research thesis is presented. The theoretical contribution of this research is discussed. A typology of cues for clinicians' judgements of patients' conditions in transition states from acute to critical illness or cardiac arrest is presented. Implications of the research for clinical practice and future research are addressed.

8.2 Limitations of the studies

The claims that can be made in the current research reflect the strength of published evidence available for inclusion in the systematic review (study 1) and the nature of self-report data used in the empirical study (study 2). The findings from the systematic review suggest trends rather than firm conclusions. The research evidence finally included in the review comprised evidence from all levels in the hierarchy of evidence (Phillips, Ball & Sackett et al., 1998). There were few randomized controlled trials available for inclusion. The nature of the topic, the identification of predictive cues, meant that it was appropriate to include prognostic, retrospective, descriptive observational studies, and other systematic reviews, as well as a small number of qualitative studies, that substantially met pre-set quality criteria. A further complexity is the large number of medical conditions that can culminate in critical illness or cardiac arrest. The heterogeneity of the clinical conditions leading to critical illness or cardiac arrest, and the variety of research approaches, meant that statistical meta-synthesis was inappropriate.

The main challenges of the systematic review were as follows. Firstly, a lengthy period was required to develop a sensitive search strategy and a thorough search of the research literature was undertaken, that will have found the vast majority of available studies but the author acknowledges that some studies may have been missed. Secondly, the identification of studies from different levels in the hierarchy of evidence required the development of a rigorous and meaningful way to achieve a synthesis of evidence. Thirdly, studies reported after completion of the review synthesis were noted at the end of the reference list, although the numbers of relevant
papers are not considered sufficient to significantly affect the current results. Fourthly, the review was the work of one person rather than a team of researchers. To make the processes transparent an audit trail was presented (chapter 4) and the results of reliability testing on the coding of cues was reported for approximately 10% of the review papers. The approaches used were considered appropriate for the purposes of the current research where the aim was to identify the range and frequency of reports of predictive cues.

Qualitative interviewing is a time consuming research method and so the sample size in study two is relatively small, representing what the researcher could reasonably achieve in the time available for data collection. The findings from the study should therefore be regarded as indicating trends in the data rather than presenting firm conclusions. The main purpose of this study was to describe the cues that clinicians considered important and to begin to identify the cues that may be early predictors of deterioration, critical illness or cardiac arrest for inclusion in a future judgement analysis study. A qualitative interviewing approach was considered a feasible and appropriate way to elicit the clinicians' perspective on cues and is one of the approaches to cue identification suggested by Cooksey (1996a).

The limitations of using qualitative interviewing were highlighted in chapter 6, but one of the main issues is that interviews provide fallible information about events external to the interview (Maxwell, 1996), a factor that the researcher kept in mind during data analysis. Clinicians may be less likely to report events that reflect badly on their clinical expertise. Clinicians were asked to report critical illness and cardiac arrest cases, and non-critical illness/ cardiac arrest cases. No restriction was placed on when these cases would have occurred and so loss of information due to memory effects could have occurred in some cases. Clinicians generally reported current or most recent cases first, but other more distant cases were also recalled. With self-report of experiences it is possible that more unusual rather than typical cases would be recalled; in the current study clinicians reported both common and unusual cases of critical illness or cardiac arrest. The accuracy of clinicians’ accounts was not
systematically checked against external evidence such as the patients’ notes, but the
main purpose of this study was to find out what clinicians perceived to be the most
important cues. Other methods would be more suited to the analysis of adverse events
such as documentary analysis (Vincent et al., 2001). A less threatening way to
examine the accuracy of judgements may be to construct scenarios of common
clinical cases where the research can take on a more educational focus rather than
concentrating on current patient cases; the second phase of a judgement analysis
study could adopt such an approach. Clinicians could have declined to participate in
interviews if the accuracy of their clinical judgements was the focus rather than the
cues they considered important.

Various methods were undertaken to examine validity and reliability. The
transparency of the process of data collection and data analysis was increased by the
inclusion of an audit trail in chapters 6 and 7. This included extracts from various
stages in the conduct of the research. During data analysis two coders independently
check coded a sample of cases and the results were reported (chapter 6). The findings
were also disseminated to research participants and feedback comments were
reported (chapter 7). Generalisability was addressed using a number of strategies
(chapter 6) including provision of data about the study sample and the context so that
readers could judge the potential generalisability of findings to other locations. The
methods used in data collection, analysis and interpretation were discussed (chapters
6 and 7). The study’s clinical and theoretical frameworks were presented (chapters 2
and 3) and theoretical inferences arising from the study were linked to theory; the aim
was to achieve theoretical rather than statistical generalisation.

It is important to acknowledge the uncertain nature of the data used in clinical
judgements about the physical state of the patient reflected in both the systematic
review and the qualitative interview study. There are a number of potential sources of
uncertainty (Weinstein et al., 1980, p.2). These include: errors in the observation or
reporting of clinical data, the inherent ambiguity of physical assessment data where
different interpretations can be made by different observers, and the uncertain
relationship between clinical signs and symptoms and the presence or absence of disease. There are few signs whose occurrence always indicates a particular condition (Weinstein et al., 1980).

8.3 Discussion of findings

Although there were limitations in the studies reported, progress was made towards the achievement of the aims of the research. Evidence for predictors of critical illness and cardiac arrest in general ward patients was identified in the systematic review (chapter 4). The cues experienced clinicians considered important in judgements of patient condition in transition states from acute to critical illness or cardiac arrest were also reported (chapter 7). A number of interesting findings arising from the empirical study prompt discussion about current knowledge surrounding cues in clinical judgements concerned with the diagnosis and prediction of patient condition in transition states from acute to critical illness or cardiac arrest. The qualitative hypotheses reported in the qualitative interview study were used to examine the research thesis stated in chapter one.

The finding that clinicians often reported subjective and behavioural data as the initial indicators of deterioration (section 7.4, pp.241-269) provides tentative support for the hypothesis that subjective clinician, behavioural and/ or patient self-report data are frequently the earliest cues that a medical patient’s clinical condition is deteriorating. The systematic review identified predominantly objective data and measures as predictor cues.

The finding that clinical judgements referred to diagnoses of current condition, evaluations of change in condition, and predictions of future conditions (section 7.7, pp.278-285) tentatively supports the hypothesis that clinicians make diagnostic, evaluative and prognostic judgements of patients’ conditions in transition states from acute to critical illness or cardiac arrest. Prognostic judgements included generalised predictions of deterioration in condition, and more specific predictions of critical
illness or cardiac arrest. Prognostic judgements appeared to draw on the diagnosis of the current condition, a prognostic score if currently in use, the patient history including medical diagnosis, age, chronic health used to estimate the patient's physiological reserve, and the rate of deterioration in condition as either acute/sudden or chronic/gradual. Deterioration in critical illness and cardiac arrest cases was often acute and sudden.

Diagnoses of patient condition and generalised predictions of patient outcome were reported to be most accurate in critical illness cases, followed by acute illness and vulnerable to deterioration cases (section 7.6.1, pp.274-277). The predictions of cardiac arrests were less accurate and were frequently reported as sudden and unexpected. The hypothesis that clinicians make accurate diagnoses and predictions of patient outcome was therefore tentatively supported in critical illness cases, and weakly supported in acute and vulnerable to deterioration cases, but was not supported in cardiac arrest cases.

Clinicians reported cues across the dimensions of severity of illness identified in the clinical conceptual framework (section 2.2, pp.17-18) including biological, physiological, functional, temporal, psychological/personal and organisational factors, but the majority related to physiological severity (section 7.11, pp. 299-301). This finding suggests tentative support for the hypothesis that general medical ward clinicians draw on cues from various dimensions of severity of illness when judging patient condition in transition states from acute to critical illness or cardiac arrest.

Discussion of the findings in the qualitative interview study led to tentative conclusions concerning the importance of intuitive judgements, the time relationships between cues and clinical judgements in transition states, and the severity of the patient's clinical state.
8.4 Conclusions

Intuitive judgements seem to be important in the early recognition of deterioration and prediction of critical illness or cardiac arrest. Clinicians often reported using subjective, behavioural and perceptual cues, to identify changes in the state of the patient and to predict deterioration, critical illness or cardiac arrest. Frequently reported cues included colour changes, clamminess, altered respiratory function, changes in level of consciousness, patient self-report of pain, and behavioural changes. Clinical expertise seems to be linked to the ability to draw on subtle perceptual cues in the earliest phases of clinical deterioration. Experience may be a key factor in the clinician’s ability to perceive subtle changes in the patient’s clinical state.

Some patients with developing critical illness or cardiac arrest in the empirical study did not match the early warning score criteria for referral, yet the clinicians still referred them (section 7.4.1, pp. 244-247, cases 1.4, 2.1, 29.4). In these cases clinicians may have been using their domain knowledge in combination with, or instead of, an early warning score. For example clinicians reported patients with persistent subjective signs such as back or leg pain that went on to cardiac arrest or critical illness. Even though patients did not present with the classic signs of physiological deterioration nurses interpreted the subjective signs as early predictors of a change in state; they were placed within high-risk categories for deterioration, critical illness or cardiac arrest and were referred to medical staff.

Early warning scores (Lee et al., 1995; Morgan et al., 1997; Subbe et al., 2001) tend not to focus on the initial perceptual cues or the more complex subjective clinical data that experienced clinicians often reported as early predictors of deterioration. Instead scores concentrate on the more objective measures of the clinical state and take a menu-driven approach to assessment. The clinical judgements arising from the application of early warning scores tend to be more analytic than intuitive in nature. By focusing on physical measures of a change in state, rather than more subjective cues, opportunities for early intervention could be missed.
A few MET/EWS scores do include the criterion *clinician concern/ seriously worried about a patient* and a few subjectively assessed clinical signs (Bellomo et al., 2003; Hodgetts et al., 2002b; Hourihan et al., 1995). Bellomo and colleagues report that *worried about the patient* was the most frequently cited cue for triggering the MET in their study.

Many authors refer to the importance of nurses’ perceptual judgements within critical care and acute adult nursing (Benner et al., 1996; Cioffi 2000b; Crow et al., 1995; Grossman and Wheeler, 1997; Jacavone and Dostal, 1992; Pyles and Stern, 1983; Smith, 1988; Tanner et al., 1993). Benner (1984) uses the term *perceptual grasp* to refer to expert nurses’ use of subtle cues that they recognise as significant because of their knowledge of the particular context. Jacavone and Dostal (1992) describe expert cardiac nurses’ ability to perceive subtle physiological and behavioural indicators of pain while Pyles and Stern (1983) comment that an experienced nurse could gain much more information about a patient’s condition than an inexperienced nurse, just by observing them.

Clinicians in the empirical study appeared to compare the condition of the patient in their care to their expectations for particular types of cases and then judged if the condition was different from that expected (for example, section 7.4.1, pp.244-245, cases 7.1, 27.1). Knowledge of the person may also have enabled clinicians to detect subtle behavioural changes in early deterioration, for example patients who became less talkative, more withdrawn, or lethargic (section 7.4.2, pp.256-257, cases 2.2, 24.1). Nurses often appeared to access knowledge of the person because of their prolonged contact with patients in contrast to other professional groups whose contact may be more intermittent. These findings suggest that knowledge of the case and knowledge of the patient were often inter-linked in the early prediction of critical illness or cardiac arrest cases. This adds to understanding of the phenomenon of *knowing the patient* identified by various authors (Benner & Tanner, 1987; Jenny & Logan, 1992; Liaschenko & Fisher, 1999; Radwin, 1995; Tanner et al., 1993;).
According to Tanner et al., (1993) knowing the patient refers to knowledge of the patient's usual responses and knowledge of the person. Jenny and Logan (1992) describe knowing the patient as knowledge of the patient, the particular context and how this is used to judge the patient's status and prognosis, and to decide upon treatments. Liaschenko and Fisher (1999) argue for a broader interpretation of knowing the patient that includes knowledge of the case, patient and person linked together using social knowledge of the hospital setting and the preferences of particular medical clinicians, or knowledge of the patient's usual social setting. Case knowledge refers to theoretical knowledge, patient knowledge refers to how they became a patient, how the patient compares to non-specific case knowledge, and how the patient's responses to treatment are judged according to what is expected. Person knowledge refers to knowledge of the individual, their desires, and history.

A further conclusion is that medical nurses' clinical judgements of patient condition in transition states from acute to critical illness or cardiac arrest can often be divided into initial, early and late phases. These correspond to the initial period when the clinician first recognises a change in the patient's condition; the next phase (early) refers to when the clinician undertakes a patient assessment and either makes a referral, and/or intervenes. The last phase (late) refers to the period after referral or the first intervention.

Within the initial phase subjective cues (including perceptual, interactive and behavioural cues) were frequently reported as the earliest indicators of deterioration in medical ward patients. Experienced medical nurses' seemed to use subjective cues to discriminate between subtle changes in skin colour, facial expression, alterations in behaviour, responsiveness, and mood changes. Such changes may become significant because they are viewed in the context of the patient's past history, estimated physiological reserve and current predicament. These cues often prompted clinicians to undertake a more thorough patient assessment. In contrast the earliest cues in judgements of patient condition in surgical and critical care patients frequently
included both objective measures and subjective cues, or objective cues alone. The findings in chapter 7 suggest that medical nurses' judgement tasks typically comprised a high degree of uncertainty and ambiguity; subjective and perceptual cues were often the only early indicators of developing problems. Critical care and surgical nurses seemed to encounter more structured and less ambiguous judgement tasks than medical nurses' and the actions to take in response to problems also seemed more clear-cut. However these tentative conclusions would need to be tested in a larger sample of cases.

Nurses' clinical judgements of the condition of the patient in transition states from acute to critical illness or cardiac arrest clearly have a temporal component; they fit Hammond's description of dynamic judgement tasks (Hammond, 1988). The empirical study examined clinicians reports of the types of cues and their time sequence in actual clinical cases. Earlier research had suggested a link between temporal factors and the types of cues considered important in judgements of patient condition. Grossman and Wheeler (1997) identified early, imminent and late cues for deterioration and early, mid-way and complete recovery in medical intensive care patients. Cioffi (2000b) investigated the MET calling criterion seriously worried about a patient and concluded that it was sometimes used before other objective physiological data start to indicate deterioration but did not focus on specific clinical cases.

Within the three phases identified in the empirical study nurses' judgement tasks appeared to move along a task continuum from intuition inducing to analysis inducing (Hamm, 1988). Medical nurses' judgement tasks in the initial stages of clinical deterioration typically lacked structure, they often involved perceptual cues, there was uncertainty between cues and clinical states, there was limited time available to analyse cues, and an intuitive mode of cognition resulted. Medical patients often have more than one chronic disease process going on and this can increase the complexity of the judgement task.
As more information became available in the clinical situation the judgement task often became more structured. This often appeared to coincide with the clinical state becoming more physiologically severe than previously. Cues such as blood pressure and ECGs provided more objective evidence about the patient’s condition, and the judgement task thus included more analytic elements. When objective measures were combined with subjective clinician data a *quasirational* mode of cognition (Hammond, 1996a) with analytic and intuitive elements appeared to be induced because clinicians reported both objective and subjective data as important. As clinical tasks moved along the task continuum clinicians’ judgements appeared to reflect the corresponding position on the cognitive continuum as proposed by *Cognitive Continuum Theory* (Hammond, 1996a).

EWS may induce a more analytic type of judgement by focusing on objective measures but this could be problematic when the judgement task tends towards the intuition-inducing pole of the cognitive continuum. Cases where only subjective, behavioural or perceptual cues are available could be missed and intervention delayed. Cognitive Continuum Theory proposes that intuition-inducing tasks involve the clinician using *pattern recognition* to categorise new cases, whereas analysis-inducing tasks encourage the clinician to focus on the relationship between objective measures and the prediction of an external event or clinical state (Cooksey, 1996a; Hammond, 1988). In a number of cases clinicians referred patients that did not meet the MET referral criteria; they made an intuitive judgement that the patient’s condition was deteriorating and this was later reported to be confirmed (section 7.4.1, p.247, case 12.3, section 7.4.2, p.256, case 1.1). These findings suggest support for Hammond *et al.,* (1987) who found that reasoning was more effective in situations where the task matched the mode of cognition selected.

A further conclusion is that the severity of the patients’ clinical state appears to distinguish between patients more than their medical diagnosis; severity of illness may be an important mechanism underpinning the states of critical illness or cardiac arrest. The medical diagnosis focuses on the patient’s disease(s) or illness(es) but
severity of illness also includes the effects of illness or injury on the individual. Severity of illness comprises a number of dimensions, as outlined in chapter two, including biological severity, the patients' physiological reserve, physiological severity, functional severity, personal and psychological factors. The clinical indexes included in the systematic review focused on the patient's physiological status rather than the patient's medical diagnosis suggesting that physiological severity was considered more significant than the medical diagnosis. The clinicians in the empirical study appeared to note changes in cues across various dimensions of severity including physiological severity and used these to judge if the patient's condition was deteriorating or improving, and how rapidly it was changing. They did not restrict their search to physiological measures. A clinical framework based on a broad conceptualisation of severity of illness may therefore have advantages over more focused physiological scores in the early prediction of critical illness or cardiac arrest.

The clinical conceptual framework presented in chapter two proposed that increasing severity of illness was related to the development of critical illness and risk of cardiac arrest. The empirical study findings suggest that even when objective measures of physiological deterioration are absent, clinicians with expertise may use subjective, behavioural and perceptual cues to recognise increasing severity of illness and patients with limited physiological reserve who require active intervention to prevent critical illness or cardiac arrest. The clinical conceptual framework based on severity of illness and critical illness is one of the major contributions of this thesis. Previous studies of clinical judgement in critical illness had not specified a clinical conceptual framework (Cioffi, 2000b; Grossman & Wheeler, 1997; Smith, 1988).

The major clinical states emerging from the empirical study are acute illness, acute illness and vulnerable to deterioration, critical illness, cardiac arrest, terminal illness, and chronic illness which can also be a factor in all of the preceding states. A large range of medical diagnoses was reported in cases progressing to critical illness or cardiac arrest, a number of disease processes were often evident in one case (section
Cases in the acute and vulnerable to deterioration category did not proceed to acute deterioration within the immediate period and comprised a range of medical conditions (chapter 7). The latter may have been less severely ill. Patients were not undergoing rapid deterioration, deviations in the indicators of physiological severity either responded to interventions or did not deteriorate further, and physiological reserve may have been greater than in the critical illness and cardiac arrest patients.

As well as the overall clinical state, various clinical sub-states could be identified as in the model of clinical states preceding critical illness or cardiac arrest, Figure 4 (section 4.5, p.68). These included: cardiovascular instability, respiratory instability, neurological derangements, haematological, biochemical, metabolic, renal instability, gastrointestinal haemorrhage, sepsis, malignancy, and combinations of these states. Clinicians drew on cues or indicators of clinical sub-states to make judgements about the patient’s overall condition. However there is considerable uncertainty associated with the cues reported, as they are often not specific to one clinical sub-state. For example an elevated pulse rate could indicate a cardiac, cardiovascular, respiratory or sepsis problem.

Severity of illness was identified as an important concept for nurses in other studies. Rosenthal et al., (1992) uses severity of illness in a study of medical and surgical nurses’ predictions of in-hospital mortality, Crow and Spicer (1995) found that hospital and community nurses used severity of illness to categorise patient’s conditions as curable, long-term chronic, long-term extremely disabling and life-threatening. Lamond (1998) reports medical and surgical ward nurses’ use of severity of illness as an organising concept around patients’ conditions. The above interpretations of severity of illness, and that adopted in the current study, are broader than the physiological severity focus evident in medical scoring systems such as APACHE II (Knaus et al., 1984) or early warning scores (Hourihan et al., 1995; Subbe et al., 2001).
By combining the findings from the systematic review (critical illness and cardiac arrest outcome states), and the qualitative interview study, a typology of cues for the prediction of critical illness and cardiac arrest in general medical patients is proposed (Appendix 29). The main contribution within this cues typology is the identification of eight main categories of cues that contribute to judgements of deterioration and prediction of critical illness or cardiac arrest after Hammond (1996b). These categories could be used in the construction of paper cases for a future judgement analysis study (Cooksey, 1996a) where the detailed cues could be selected according to the type of case and submitted to an expert panel to check face validity prior to their use.

A number of interesting speculations arise from the research findings and will be presented.

A major speculation is that experienced medical nurses may be using subjective and behavioural cues to identify patients moving to more physiologically unstable clinical states, or patients who are on the cusp of a parabolic curve (Bingham, 1994; Mitchell, 1999) as presented in Figure 2 (section 2.2, p.21). Such data may provide information that periodic measures of vital signs do not capture. Patients may appear to have vital signs that are within acceptable ranges, but in reality they are located on a precarious part of the curve and are at risk of major deterioration. The goals in such cases are to recognise physiological problems early, intervene, and minimise physiological stress and deterioration.

It would be important to know if minute-to-minute variations in patients' vital signs in those who deteriorate are different in character from patients who do not deteriorate. Kim et al., (1995) found that low-frequency periodic fluctuations in physiologic variables were predictors of mortality in a group of patients' with planned ICU admission. These represent cases where the patient's system appears to be under stress and physiological patterns are characterised by slow responses and then the system may overshoot as it tries to find a stable state. Kim et al., (1995)
speculates that the loss of complexity observed was similar to patterns found in other situations such as aging, fetal distress syndrome, and severe congestive heart failure.

A number of factors may account for subjectively assessed non-specific signs and symptoms adding information about early deterioration that is not evident in physiological measures. Extreme values may be missed when intermittent objective measures are recorded which could result in an inaccurate picture of the physical state. Measures may be inaccurately recorded; the inter-rater reliability of early warning scores has yet to be examined. To date no studies have examined the possibility of inaccurate recordings contributing to false negative early warning scores and failure to identify patients' at risk of critical illness or cardiac arrest. Physiological patterns over time require further investigation to see if any patterns predict developing critical illness or cardiac arrest states. Finally, subjective and non-specific signs and symptoms could be the earliest cues in some cases.

A further speculation concerns differences between judgements of individual cases compared to models derived from the aggregation of a large number of cases. Clinical judgement is concerned with identifying individuals with deteriorating conditions as shown in Figure 7a (section 8.4, p.318). Their clinical course may look very different from the linear view presented in the Intensive Care Society (ICS) diagram (Figure 7b, section 8.4, p.318) which may well reflect the trend over a large number of cases (ICS, 2002b).
Figure 7a&amp;b: Clinical judgements for individuals compared to a model derived from a large numbers of cases

a: The nurse looks for cues that the individual patient is at a precarious stage on the curve- physical signs may be unchanged or just slightly abnormal, but the patient may have a precipitous deterioration

b: Model of Levels of dependency (0,1,2,3) and the overlap of groups of patients (ICS, 2000b,p.7).

The demarcation between levels of critical illness may be less clear-cut than that portrayed in the Comprehensive Critical Care document (DH, 2000). The ICS (2002b) subsequently acknowledges the problem of ambiguity associated with classifying patients in the various levels of critical illness. The ICS suggests areas of overlap between levels zero and one, between levels one and two, and between levels two and three in critical illness. Some patients may proceed rapidly from acute to critical illness or cardiac arrest. Patients with collapse due to acute arrhythmias or massive pulmonary embolism may not exhibit signs of physiological deterioration that can be detected in the preceding hours and so these patients would move swiftly to level three (ICS, 2002b).
It is notable that the subjective and behavioural cues clinicians reported in the earliest phase of clinical judgements often corresponded to the cues identified in the early physiological patterns of shock and circulatory dysfunction in Shoemaker (1996a) and Shoemaker et al., (1996b). Shoemaker (1996a) notes that shock was a factor in all fatal illnesses and that circulatory failure was one of the elements in the final common pathway. Shoemaker (1996a) argues that hypotension was a late sign of shock but there may be earlier subjective non-specific signs and symptoms. The earlier signs included cold, clammy skin, pallor, weak and thready pulse, unstable vital signs, cyanosis, mottled skin, restlessness, and altered level of consciousness (Shoemaker, 1996a). The time-sequence of changes in the circulatory system were crucial to the understanding of patterns in survivors and non-survivors of shock (Shoemaker et al., 1996b). In the early stages of shock measured values may be within normal ranges and continuous non-invasive monitoring techniques are needed to titrate therapy (Shoemaker et al., 1996b). Shoemaker and colleagues advocate early treatment of shock using non-invasive, continuous on-line monitoring because hypotension was a late sign of shock. Pyles and Stern (1983) refer to nurses’ use of early cues for cardiogenic shock and argue that the non-specific nature of cues means that their significance has to be judged according to the particular context. Cioffi (2000b) suggests that nurses should act when subtle signs and symptoms indicate early deterioration because objective measures may initially appear acceptable due to the body’s homeostatic responses.

8.5 Methodological contributions
The current research makes important methodological contributions in the following areas. The study’s clinical conceptual framework (section 2.2, p.17) was based on a broad conceptualisation of severity of illness and included biological severity, physiological severity, physiological reserve, psychological/ personal factors, functional severity, temporal and organisational dimensions. Using this framework it
was possible to trace the many aspects that experienced clinicians consider when assessing the state of the patient, not just the physiological dimensions.

By dissecting clinicians' reports of clinical judgements it was possible to identify the areas where changes in the patient's state were becoming apparent. Often in the earliest phases clinicians reported subjective clinical and behavioural signs relating to physiological severity such as changes in level of consciousness, breathing difficulties, or changes in functional severity and psychological state. These clinical signs could be quite subtle and relied on the expertise of clinicians for early identification. Physiological measures could be within acceptable ranges initially. As severity worsened objective measures of physiological severity were often available and deterioration was more readily quantified. In the latest phase a combination of abnormal subjective clinical and behavioural signs and objective measures from the dimensions of physiological severity, functional severity and psychological state were frequently seen.

Within the systematic review the conceptual framework guided the search for papers on predictors of critical illness and cardiac arrest and clinical indexes. The clinical indexes or early warning scores identified were mostly unidimensional and focused on physiological severity. This contrasted with the empirical study where clinicians appeared to use multiple dimensions of severity of illness in the early prediction of critical illness or cardiac arrest.

The theoretical framework for the investigation of judgement was presented in chapter 3 and chapter 5. It was based on Social Judgement Theory which provides methods to describe human judgement (Hammond et al., 1986), the Inference-Correspondence Model for Diagnostic Judgement (Hammond, 1996b) where the clinician uses different types of cues to infer the patient's clinical state, and Cognitive Continuum Theory (CCT) (Hammond, 1996a). The current study findings appear to support some of the premises of CCT. The structure of the judgement task seemed to stimulate a corresponding type of cognition in experienced clinicians. In cases where
mainly subjective and perceptual cues were available an intuitive form of cognition seemed to be elicited. A more analytic judgement that focused on objective measures of the physical state could have missed the earliest clinical signs of deterioration in many of the cases reported.

The systematic review reported in chapter 4 described the application of a computerised database package (FileMaker Pro 5) in the content analysis of research papers and the identification of predictor cues. The database was crucial for the management of the large amount of information generated in this study due to the number of papers, the wide range of cues, and because the analysis was at the cues level rather than a more abstract thematic level. The systematic review required the application of narrative and tabular synthesis methods rather than statistical meta-synthesis; the research evidence was drawn from different modes of enquiry.

8.6 Clinical and educational implications
A number of clinical and educational implications arise from the current research findings and tentative suggestions will now be made.

Firstly, clinicians need to see their patients to be able to pick up subjective and perceptual cues indicating changes in clinical states. Whilst it is possible to train individuals to accurately record patients’ vital signs, the perception and interpretation of subjective clinical signs and perceptual cues may require extensive clinical experience and theoretical knowledge. Experienced clinicians therefore need to have regular contact with their patients so that they can perform thorough physical assessments drawing on the full range of clinical data and notice subtle changes. Physical assessment is a complex skill that requires knowledge, experience and technical skill.

Secondly, early warning scores focus on physiological deterioration mainly through objective physical measures of the patient’s state. These scores adopt a menu-driven
approach to assessment rather than one based on domain knowledge. Cases of deterioration could be missed when subjective clinical and behavioural data are the earliest indicators of a change in state.

Thirdly, clinicians require opportunities to refine their judgements and ways of thinking through critical analysis and critical reflection on clinical cases during basic nurse preparation and after qualification. It is important that clinicians learn from experience and that errors of judgement are not repeated. Through a process of critical reflection clinicians may increase their understanding of cues that are associated with particular clinical outcomes, make explicit links to theoretical knowledge such as physiology and pathophysiology, and so develop and refine their schemata or knowledge structures.

Fourthly, the quality of written patient records could be improved. Clinicians should articulate their diagnostic judgements about the state of the patient, their evaluative judgements about changes in patients' conditions, and predictions about a future state. Judgements about the state of the patient are different from statements of nursing problems. The state of the patient is at a higher level of abstraction than nursing problems and refers to the overall condition of the patient whereas nursing problems or needs arise from the state of the patient and clinical sub-states. Problems are concepts articulated at the basic descriptive level (Spicer, 1993) and they are used in care planning. A judgement that the patient's state is critical or life-threatening illness would indicate the need to summon the emergency medical team and undertake emergency interventions.

Finally, in depth knowledge of a particular context seems to be important for the recognition of subtle perceptual cues but these could be missed where staff are inexperienced, or where there are insufficient numbers of experienced staff. Diagnostic skill in medicine seems to be closely linked to substantial experience of cases within the particular domain (Custers et al., 1996; Schmidt et al., 1991), this may also hold for nursing's diagnostic tasks. High rates of staff turnover and moving
clinicians to different areas of practice may disrupt their acquisition of domain-specific knowledge; they may not develop detailed schemata for a particular domain of practice. A lack of schemata or scripts could result in failure to recognise developing critical illness, or failure to take action. The need for EWS with guidelines on actions to take suggests that some clinicians' domain-specific knowledge may be limited. Clinicians could be supported in their development of domain specific knowledge by minimising staff movements across clinical domains.

8.7 Suggestions for further research
Research into the clinical judgement process is important because clinical judgements underpin decisions and interventions and these can affect patient outcomes. The current research focused on the analysis of the cue composition of clinical judgements.

Clinical indexes currently emphasise objective physical data but there is evidence from clinicians' reports that initial judgements of patient condition often draw on subjective and perceptual cues that refer to physiological, functional, and psychological dimensions. As the current qualitative study is limited by its reliance on self-report data further investigation is required to assess the predictive validity of subjective and perceptual cues.

A series of Judgement Analysis studies (Cooksey, 1996a) could be conducted with medical ward nurses to add to knowledge of the clinical judgement process. Such studies could draw on the cues identified in the current research and examine how different clinicians use and weight cues in the early recognition of deterioration or prediction of critical illness or cardiac arrest. Some of the cues considered important in the empirical study were not reported as predictor cues in the systematic review and so these require further examination.
A key requirement of clinical judgements is that they should be accurate. However research to date has not tested clinicians’ early predictions of critical illness or cardiac arrest in general ward patients. Accurate judgements are those in which the judge’s statement of the patient state and the actual state agree (Cooksey, 1996a). A Judgement Analysis study could use cases where the patient outcome is known to examine the accuracy of clinicians’ judgements- a double-system design (Cooksey, 1996a). Judgement Analysis could also be used as an educational strategy that aims to improve clinical practice. Clinicians could receive feedback on their judgement policies and the accuracy of their judgements. Following feedback and the completion of a new set of tasks their performance could be re-assessed. Such a study could reveal that some clinicians do not use cues that many others consider important, that the weighting of cues differs across clinicians, or that individual clinicians are inconsistent in their judgements.

The three different temporal phases in judgements identified in the empirical study could be used to structure cue profiles or cases in a Judgement Analysis study (Cooksey, 1996a). By incorporating temporal dimensions more could be learnt about very early cues that nurses value, how the weights attached to different cues may change as the patients’ condition changes, and differences between clinicians’ judgement policies.

Cue identification studies using qualitative interviewing methods similar to the current one could be undertaken with other groups of nurses. The current study sample comprised volunteers from the population the researcher had access to. The generalisability of the cues identified in the current study could be investigated by repeating the research with medical nurses in other research sites. It would be also be important to know if the phenomenon of deterioration is different in surgical patients compared to medical patients. Accident and emergency clinicians, paramedics’, physicians and critical care outreach nurses’ perspectives on early cues for clinical deterioration and physiological instability should also be examined and compared to ward nurses’ perspectives. The latter represent a new group of specialist nurses.
Clinicians' internal representation of knowledge about patients in transition from acute to critical illness or cardiac arrest requires investigation. It appears that clinicians store and retrieve clinical information but little is known about how they do this and how this affects judgements. It seems possible that cues become significant because the individual associates them with a schema held in memory. Lamond (1998) proposes that medical and surgical ward nurses have knowledge-based schemata focused on patients' diagnoses or surgical operation, and that these are used in planning care. The current research findings suggest that the severity of the patient's state, the medical diagnosis or surgical procedure, and whether the condition is improving, deteriorating, or unchanging, may be important factors in schemata. Some experienced clinicians may be using illness scripts as cognitive structures to store and organise their clinical knowledge about prototypes or individual patients (Schmidt et al., 1990). Alternatively they could be using schemata more akin to perceptual maps that result in the clinician using a type of pattern matching when a new case is encountered.

Prospective studies of temporal variations in vital signs could be undertaken to identify if there are differences between patients who deteriorate compared to those who do not. Such a study could be designed to test the propositions that patients susceptible to catastrophic deterioration are located on the cusp of a parabolic curve. It could also look for any patterns in the physiological data such as low frequency variations that may predict critical illness or cardiac arrest. This would involve the collection of high frequency data using a large sample of patients. Substantial resources would be required to undertake such a study.

The current research is important and timely in view of the NHS Knowledge and Skills Framework and the Development Review Process (NHS, 2004). By highlighting the range of clinical data required to make accurate assessments of the
current state of the patient and predict future states (chapter 7 and Appendix 29), the thesis contributes information to the *Health and Wellbeing* dimension of the NHS KSF. The importance of learning in practice through critical reflection on actual clinical cases is emphasised in the final chapter (section 8.6, p.322) and this area should be targeted within individuals' learning and development in the *General* dimension of the NHS KSF.
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**Publications after the completion of the review**

A number of recent publications are relevant to the subject of the current review but were not included in the tabular analysis of cues. They include the following:

Ball C, Kirby M, Williams S 2003 Effect of the critical care outreach team on patient survival to discharge from hospital and readmission to critical care: non randomised population based study *BMJ* 327(7422): 1014-6


Hodgetts T J, Kenward G *et al.*, 2002 The identification of risk factors for cardiac arrest and formulation of activation criteria to alert a medical emergency team *Resuscitation* 54: 125-131


Pittard A J 2003 Out of reach? Assessing the impact of introducing a critical care outreach service *Anaesthesia* 58: 874-910
Appendix 1.
Quality assessment instruments for evaluation of randomised controlled trials (RCTs), observational (quantitative), qualitative studies and review articles.

Quality Criteria for Assessment of RCTs (based on Greenhalgh & Donald, 2000 p.61).
1. The question addressed in the trial was clear and specified the population, intervention and outcome.
2. There was random selection of patients from a specified population.
3. There was random allocation of patients to intervention and control groups.
4. Participants and researchers were both blinded to control and experimental groups (double blinding). (Single blinding- weaker, or not blinded – weakest).
5. Apart from the intervention both groups had equal treatment.
6. Power of study was sufficient to detect an effect if it was present.
7. Follow-up of patients exceeded 80%, and analysis was based on groups patients were randomly allocated to.
8. Results reported the effect of treatment; confidence intervals, p-values were given.
9. Similarity of study patients to clinician’s patients (or research focus) was assessed.

The above quality criteria applied to RCT studies and overall each paper was assessed as good when all of the criteria were met, reasonable when most of the criteria were met (three or less criteria not met), or poor when few criteria were met (more than three criteria not met).

Quality Criteria for Assessment of Observational Studies (includes cohort, case-control, case-series and retrospective follow-up studies) based on Altman (2001) and Khan, ter Riet (2001).
1. Sample- Definition of inclusion criteria, process of sample selection explained, diagnostic criteria described sufficiently, clinical and demographic data supplied, representative of population, and in prognostic studies entry to study at similar point for all subjects, inclusion of all eligible patients. For cohort and case-control studies the groups should be comparable on significant confounding variables and there should be sufficient adjustments for potential effects of confounding variables.
2. Follow up of patients- refers to the adequacy of the patient follow up period in prognostic studies.
3. Outcome- Objective, unbiased, defined fully, suitable outcome selected, outcome reported for all or most patients.
4. Prognostic variable (for prognostic studies)- Use of a precise definition, method of measurement reported on, accurately measured, available for all or most patients.
5. Analysis- Appropriate analysis for type of variable studied, records made of any statistical adjustments.
6. Treatment subsequent to inclusion in cohort for prognostic studies—Described in detail.
7. External validity—Applicability of the study findings to other locations.
8. Methodological quality of study—Includes evidence of the effect of the design and conduct of the study on results. Retrospective studies require accurate records to have been kept.
9. Bias—Systematic errors affecting the validity of the results.

The Quality Criteria were applied to each study and overall each paper was assessed as good when all of the criteria were met, reasonable when most of the criteria were met, or poor when few criteria were met.

1. The method used was appropriate—the research was concerned with the exploration of individuals' subjective meanings of particular experiences, and the method was suited to the question being investigated.
2. A clear research question was formulated either at the beginning or by the conclusion of the research (Mays & Pope, 2000).
3. The research was linked to an existing body of knowledge, and there was sufficient detail about the theoretical framework for the study.
4. The description of methods was sufficiently detailed.
5. The context for the study was made clear.
6. The sampling strategy was justified and described adequately.
7. The fieldwork was described sufficiently.
8. Different sources of knowledge and understanding were used and compared in the study and an audit trail provided.
9. The data analysis methods were adequately described. Data were analysed by another researcher. There was evidence of a search for contradictory observations. An audit trail was provided.
10. The process for moving from data to interpretation was adequately described. Findings were reported in a systematic way. The validity of findings was checked. There was evidence to support or challenge the researcher's interpretation. There was enough original material included to make links between evidence and the conclusions.
11. If claims for generalisability were made, they followed on logically from the data and/or theoretical framework.
12. The researcher's position in relation to the research topic was stated.
13. The ethical issues were identified and addressed appropriately.
14. Clinical usefulness of study was discussed.
The Quality Criteria were applied to each study and overall each paper was assessed as *good* when all of the criteria were met, *reasonable* when most of the criteria were met, or *poor* when few criteria were met.

**Quality Criteria for Assessment of Review Articles** - based on Oxman (1995) and Greenhalgh (2001)

1. A review that addressed a clinical problem using a clear review question.
2. A thorough search of relevant database(s) and other possible sources was undertaken.
3. An assessment of methodological quality was made and papers rated accordingly.
4. Sensitivity of the results of the review to changes in the way the review was conducted were reported e.g. Consideration of how changes to the inclusion criteria would have affected the results.
5. The conclusions of the review followed on logically from the evidence presented in the review.
6. The clinical implications of the results were considered. This refers to the generalisability of study findings and the extent to which the care of individual patients should be affected.

The Quality Criteria were applied to each study and overall each paper was assessed as *good* when all of the criteria were met, *reasonable* when most of the criteria were met, or *poor* when few criteria were met.
Appendix 2
Final searches

Ovid Technologies, Inc. Email Service Accessed 15/11/02

Search for: from 14 [limit 13 to (human and english language and all adult <19 plus years>)] keep
7,13-14,49,52,65,68,76,79,90,105,111,130,15
9,163,177-178,200,209,226,264,266,276,286,301,303,329,331,343,351,354,376-377,394,398-400,410,421-422
Citations: 1-40

Database: Medline <1993 to Present>
Search Strategy:

1 exp Critical Illness/ (3789)
2 Internal Medicine/ (3224)
3 exp diagnosis/ or exp critical care/ or exp intensive care/ or exp preoperative care/ or exp subacute care/ (1176726)
4 exp Heart Arrest/nu, di, pc, ep [Nursing, Diagnosis, Prevention & Control, Epidemiology] (2150)
5 exp CAUSALITY/ (153554)
6 exp Cohort Studies/ (254035)
7 exp RISK/ (193142)
8 5 or 6 or 7 (412144)
9 1 and 8 (1085)
10 limit 9 to (human and english language and all adult <19 plus years>) (709)
11 2 and 8 (259)
12 3 and 8 (165796)
13 1 and 12 (652)
14 limit 13 to (human and english language and all adult <19 plus years>) (438)
15 from 14 keep 7, 13-14, 49, 52, 65, 68... (40)
16 4 and 8 (975)
17 limit 16 to (human and english language and all adult <19 plus years>) (532)
18 from 17 keep 1, 28, 64, 75, 95, 119... (25)

Ovid Technologies, Inc. Email Service Accessed 15/11/02

Search for: from 4 [limit 3 to (human and english language and all adult <19 plus years>)] keep 18,25,30,40,124
Citations: 1-5

Database: Medline <1993 to Present>
Search Strategy:

1 exp Critical Illness/ (3789)
2 exp CAUSALITY/ (153554)
3 1 and 2 (294)
4 limit 3 to (human and english language and all adult <19 plus years>) (151)
5 exp Heart Arrest/ (7500)
6 2 and 5 (1153)
7 limit 6 to (human and english language and all adult <19 plus years>) (584)
8 prediction.ab,sh,tw,ti. (22919)
9 1 and 8 (69)
10 5 and 8 (126)
11 exp RISK/ or exp RISK FACTORS/ (193142)
12 1 and 11 (421)
13 exp critical care/ or patient admission/ or patient readmission/ (19944)
14 11 and 13 (2314)
15 limit 14 to (human and english language and all adult <19 plus years>) (1260)
16 prediction.ab,sh,tw,ti. (22919)
17 assessment.mp. (118790)
18 1 and 17 (235)
19 from 18 keep 38 (1)
20 limit 18 to (human and english language and all adult <19 plus years>) (113)

349
from 20 keep 4 (1)
from 20 keep 4, 17, 21, 26, 37, 53... (12)
5 and 17 (265)
limit 23 to (human and english and all adult <19 plus years>) (131)
from 24 keep 2-3, 9, 11, 15, 24, 48... (10)
medical emergency teams.ab,sh,tw,ti. (6)
from 26 keep 1-5 (5)
early warning score.ab,sh,tw,ti. (1)
from 28 keep 1 (1)
patient at risk.ab,sh,tw,ti. (864)
1 and 30 (8)
from 31 keep 2 (1)
unexpected admission.ab,sh,tw,ti. (9)
prediction of critical illness.ab,sh,tw,ti. (0)
cardiopulmonary arrest.ab,sh,tw,ti. (359)
limit 35 to (human and english and all adult <19 plus years>) (172)
from 36 keep 22-23, 27, 56, 58, 74, 76... (19)
critical illness.ab,sh,tw,ti. (4189)
8 and 38 (70)
from 39 keep 3-4, 10 (3)
limit 39 to (human and english language and english and all adult <19 plus years>) (51)
from 41 keep 9, 19, 42 (3)
from 4 keep 18, 25, 30, 40, 124 (5)

Ovid Technologies, Inc. Email Service Accessed 14/11/02
Search for: from 36 [limit 35 to (human and english and all adult <19 plus years>)] keep 22-23,27,56,58,74,76,105-106,123,125-126,131,141,144,162,168,171-172
Citations: 1-19

Database: Medline <1993 to Present>
Search Strategy:

1  exp Critical Illness/ (3789)
2  exp CAUSALITY/ (153554)
3  1 and 2 (294)
4  limit 3 to (human and english language and english and all adult <19 plus years>) (151)
5  exp Heart Arrest/ (7600)
6  2 and 5 (1153)
7  limit 6 to (human and english language and english and all adult <19 plus years>) (584)
8  prediction.ab,sh,tw,ti. (22919)
9  1 and 8 (69)
10  5 and 8 (126)
11  exp RISK/ or exp RISK FACTORS/ (193142)
12  1 and 11 (421)
13  exp critical care/ or patient admission/ or patient readmission/ (19944)
14  11 and 13 (2314)
15  limit 14 to (human and english language and english and all adult <19 plus years>) (1260)
16  prediction.ab,sh,tw,ti. (22919)
17  assessment.mp. (118790)
18  1 and 17 (235)
19  from 18 keep 38 (1)
Ovid Technologies, Inc. Email Service Accessed 14/11/02

Search for: from 47 [limit 46 to (human and english language and english and all adult <19 plus years)] keep 4,19-20,26,39,66,101,125,132,151,160,170,187-188,207,219,230,235

Citations: 1-18

Database: Medline <1993 to Present>

Search Strategy:

1 exp Critical Illness/ (3789)
2 exp CAUSALITY/ (153554)
3 1 and 2 (294)
4 limit 3 to (human and english language and english and all adult <19 plus years) (151)
5 exp Heart Arrest/ (7600)
6 2 and 5 (1153)
7 limit 6 to (human and english language and english and all adult <19 plus years) (584)
8 prediction.ab,sh,tw,ti. (22919)
9 1 and 8 (69)
10 5 and 8 (126)
11 exp RISK/ or exp RISK FACTORS/ (193142)
12 1 and 11 (421)
13 exp critical care/ or patient admission/ or patient readmission/ (19944)
14 11 and 13 (2314)
15 limit 14 to (human and english language and english and all adult <19 plus years) (1260)
16 prediction.ab,sh,tw,ti. (22919)
17 assessment.mp. (118790)
18 1 and 17 (235)
19 from 18 keep 38 (1)
20 limit 18 to (human and english language and english and all adult <19 plus years) (113)
21 from 20 keep 4 (1)
22 from 20 keep 4, 17, 21, 26, 37, 53... (12)
23 5 and 17 (265)
24 limit 23 to (human and english and all adult <19 plus years) (131)
25 from 24 keep 2-3, 9, 11, 15, 24, 48... (10)
26 medical emergency teams.ab,sh,tw,ti. (6)
27 from 26 keep 1-5 (5)
28 early warning score.ab,sh,tw,ti. (1)
29 from 28 keep 1 (1)
30 patient at risk.ab,sh,tw,ti. (864)

31 1 and 30 (8)
32 from 31 keep 2 (1)
33 unexpected admission.ab,sh,tw,ti. (9)
34 prediction of critical illness.ab,sh,tw,ti. (0)
35 cardiopulmonary arrest.ab,sh,tw,ti. (359)
36 limit 35 to (human and english and all adult <19 plus years) (172)
37 from 36 keep 22-23, 27, 56, 58, 74, 76... (19)
38 critical illness.ab,sh,tw,ti. (4189)
39 8 and 38 (70)
40 from 39 keep 3-4, 10 (3)
41 limit 39 to (human and english language and english and all adult <19 plus years) (51)
42 from 41 keep 9, 19, 42 (3)
43 from 4 keep 18, 25, 30, 40, 124 (5)
44 3 and 8 (9)
45 risk.ab,sh,tw,ti. (259700)
46 1 and 45 (494)
47 limit 46 to (human and english language and english and all adult <19 plus years) (238)
48 from 47 keep 4, 19-20, 26, 39, 66, 101... (18)

< Ovid Technologies, Inc. Email Service Accessed 15/11/02

Search for: from 28 [early warning score.ab,sh,tw,ti.] keep 1

Citations: 1

Database: Medline <1993 to Present>

Search Strategy:

1 exp Critical Illness/ (3789)
2 exp CAUSALITY/ (153554)
3 1 and 2 (294)
4 limit 3 to (human and english language and english and all adult <19 plus years) (151)
5 exp Heart Arrest/ (7600)
6 2 and 5 (1153)
7 limit 6 to (human and english language and english and all adult <19 plus years) (584)
8 prediction.ab,sh,tw,ti. (22919)
9 1 and 8 (69)
10 5 and 8 (126)
11 exp RISK/ or exp RISK FACTORS/ (193142)
12 1 and 11 (421)
13 exp critical care/ or patient admission/ or patient readmission/ (19944)
14 11 and 13 (2314)
15 limit 14 to (human and english language and english and all adult <19 plus years) (1260)
16 prediction.ab,sh,tw,ti. (22919)
17 assessment.mp. (118790)
18 1 and 17 (235)
19 from 18 keep 38 (1)
20 limit 18 to (human and english language and english and all adult <19 plus years) (113)
21 from 20 keep 4 (1)
22 from 20 keep 4, 17, 21, 26, 37, 53... (12)
23 5 and 17 (265)
24 limit 23 to (human and english and all adult <19 plus years) (131)
25 from 24 keep 2-3, 9, 11, 15, 24, 48... (10)
26 medical emergency teams.ab,sh,tw,ti. (6)
27 from 26 keep 1-5 (5)
28 early warning score.ab,sh,tw,ti. (1)
29 from 28 keep 1 (1)
30 patient at risk.ab,sh,tw,ti. (864)

31 1 and 30 (8)
32 from 31 keep 2 (1)
33 unexpected admission.ab,sh,tw,ti. (9)
34 prediction of critical illness.ab,sh,tw,ti. (0)
35 cardiopulmonary arrest.ab,sh,tw,ti. (359)
36 limit 35 to (human and english and all adult <19 plus years) (172)
37 from 36 keep 22-23, 27, 56, 58, 74, 76... (19)
38 critical illness.ab,sh,tw,ti. (4189)
39 8 and 38 (70)
40 from 39 keep 3-4, 10 (3)
41 limit 39 to (human and english language and english and all adult <19 plus years) (51)
42 from 41 keep 9, 19, 42 (3)
43 from 4 keep 18, 25, 30, 40, 124 (5)
44 3 and 8 (9)
45 risk.ab,sh,tw,ti. (259700)
46 1 and 45 (494)
47 limit 46 to (human and english language and english and all adult <19 plus years) (238)
48 from 47 keep 4, 19-20, 26, 39, 66, 101... (18)
23  5 and 17 (265)
24  limit 23 to (human and english and all adult <19 plus years) (131)
25  from 24 keep 2-3, 9, 11, 15, 24, 48... (10)
26  medical emergency teams.ab,sh, tw, tl (6)
27  from 26 keep 1-5 (5)
28  early warning score.ab, sh, tw, tl (1)
29  from 28 keep 1 (1)

<1>

Unique Identifier
11589210
Medline Identifier
21472546
Authors
Subbe CP. Kruger M. Rutherford P. Gemmel L.
Institut

Ovid Technologies, Inc. Email Service Accessed 15/11/02

Search for: from 33 [medical emergency team.ab,tw,tl] keep 1-26
Citations: 1-26

Database: Medline <1989 to 1992>

Search Strategy:

------------------------
1  exp Critical Illness/ (3789)
2  Internal Medicine/ (3224)
3  exp diagnosis/ or exp critical care/ or exp intensive care/ or exp preoperative care/ or exp subacute care/ (176728)
4  exp Heart Arrest/nu, di, pc, ep [Nursing, Diagnosis, Prevention & Control, Epidemiology] (2150)
5  exp CAUSALITY/ (153554)
6  exp Cohort Studies/ (254035)
7  exp RISK/ (193142)
8  5 or 6 or 7 (412144)
9  1 and 8 (1085)
10  limit 9 to (human and english language and english and all adult <19 plus years) (709)
11  2 and 8 (259)
12  3 and 8 (186796)
13  1 and 12 (652)
14  limit 13 to (human and english language and all adult <19 plus years) (438)
15  from 14 keep 7, 13-14, 49, 52, 65, 68... (40)
16  4 and 8 (975)
17  limit 16 to (human and english language and english and all adult <19 plus years) (532)
18  from 17 keep 1, 28, 64, 75, 95, 119... (25)
19  predictors.ab, tw, tl (23249)
20  1 and 19 (61)
21  limit 20 to (human and english language and english and all adult <19 plus years) (52)
22  from 21 keep 2, 5-6, 10, 12, 21, 30-31... (9)
23  3 and 19 (11700)
24  4 and 23 (57)
25  limit 24 to (human and english language and english and all adult <19 plus years) (44)
26  from 25 keep 5, 12, 14 (3)
27  unexpected admission.ab, tw, tl (9)
28  readmission to ICU.ab, tw, tl (13)
29  from 28 keep 1, 7, 9, 12-13 (5)
30  early warning score.ab, tw, tl (1)
31  from 30 keep 1 (1)
32  early warning scores.ab, tw, tl (0)
33  medical emergency team.ab, tw, tl (26)
34  from 33 keep 1-26 (26)

Ovid Technologies, Inc. Email Service Accessed 15/11/02

Search for: from 30 [1 and 19] keep 3
Citations: 1

Database: Medline <1993 to Present>

Search Strategy:

------------------------
1  exp Critical Illness/ (3789)
2  Internal Medicine/ (1144)
3  exp diagnosis/ or exp critical care/ or exp intensive care/ or exp preoperative care/ or exp subacute care/ (388503)
4  exp Heart Arrest/nu, di, pc, ep [Nursing, Diagnosis, Prevention & Control, Epidemiology] (389)
5  exp CAUSALITY/ (41825)
6  exp Cohort Studies/ (66022)
7  exp RISK/ (45320)
8  5 or 6 or 7 (104626)
9  1 and 8 (81)
10  limit 9 to (human and english language and english and all adult <19 plus years) (42)
11  2 and 8 (47)
12  3 and 8 (37711)
13  1 and 12 (45)
14  limit 13 to (human and english language and all adult <19 plus years) (28)
15  from 14 keep 7, 13-14, 49, 52, 65, 68... (0)
16  4 and 8 (141)
17  limit 16 to (human and english language and all adult <19 plus years) (70)
18  from 17 keep 1, 28, 64, 75, 95, 119... (0)
19  predictors.ab, tw, tl (4066)
20  1 and 19 (3)
21  limit 20 to (human and english language and english and all adult <19 plus years) (2)
22  from 21 keep 2, 5-6, 10, 12, 21, 30-31... (0)
23  3 and 19 (1733)
24  4 and 23 (7)
25  limit 24 to (human and english language and all adult <19 plus years) (6)
26  from 25 keep 5, 12, 14 (0)
27  unexpected admission.ab, tw, tl (0)
28  readmission to ICU.ab, tw, tl (1)
29  from 28 keep 1, 7, 9, 12-13 (0)
30  early warning score.ab, tw, tl (0)
31  from 30 keep 1 (0)
32 early warning scores.ab.tw.ti. (0)
33 medical emergency team.ab.tw.ti. (0)
34 [from 33 keep 1-26] (0)
35 critical care outreach.ab.tw.ti. (0)
36 [from 35 keep 1-5] (0)
37 limit 9 to (human and english language and
english and all adult <19 plus years>) (42)
38 from 10 keep 18, 42 (2)
39 limit 11 to (human and english language
and english and all adult <19 plus years>) (17)
40 from 39 keep 6 (1)
41 1 and 3 and 8 (45)
42 limit 41 to (human and english language
and english and all adult <19 plus years>) (28)
43 from 42 keep 11, 25 (2)
44 from 17 keep 20, 65 (2)
45 from 20 keep 3 (1)

Search for: from 42 [limit 41 to (research and
english and (adult <19 to 44 years> or middle
age <45 to 64 years> or aged <65 to 79
years> or "aged <80 and over") and english)]
keep 16,40,60,65,82-83

Citations: 1-6

Database: CINAHL <1982 to 1997>
Search Strategy:

1 exp Critical Illness/ (274)
2 exp Critical Care/ (1990)
3 exp Subacute Care/ (257)
4 exp Hospital Units/ (5718)
5 (cardiopulmonary arrest or cardiac
arrest).mp. [mp=title, cinahl subject heading,
abstract, instrumentation] (350)
6 exp Heart Arrest/ (740)
7 exp Prospective Studies/ (8040)
8 exp Relative Risk/ (372)
9 exp Risk Assessment/ (670)
10 exp Risk Factors/ (8914)
11 (odds and ratio$).tw. (549)
12 (relative and risk).tw. (524)
13 (case and control$).tw. (1101)
14 or7-13 (17644)
15 1 and 14 (44)
16 limit 15 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and
over") and yr=1990 and english) (0)
17 limit 15 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and
over") and english) (24)
18 from 17 keep 20 (1)
19 2 and 14 (121)
20 limit 19 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and
over")) (36)
21 from 20 keep 18 (1)
22 3 and 14 (2)
23 from 22 keep 1-2 (2)
24 4 and 15 (13)
25 4 and 14 (388)
26 limit 25 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and
over") and english) (118)
27 from 26 keep 45, 69-70, 94 (4)
28 5 and 14 (58)
29 limit 28 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and
over") and english) (29)
30 from 29 keep 23 (1)
31 6 and 14 (90)
32 limit 31 to (research and (adult <19 to 44
years> or middle age <45 to 64 years> or aged
<65 to 79 years> or "aged <80 and over") and
english) (34)
33 from 32 keep 26 (1)
34 from 17 keep 1, 14, 16 (3)
35 from 20 keep 1, 7, 24 (3)
36 [from 22 keep 1-12] (0)
37 [from 26 keep 134, 152, 187] (0)
38 from 29 keep 21-22 (2)
39 from 32 keep 31 (1)
40 exp Critical Care/ or intensive care.mp. (4167)
41 14 and 40 (405)
42 limit 41 to (research and english and (adult
<19 to 44 years> or middle age <45 to 64 years>
or aged <65 to 79 years> or "aged <80 and over")
and english) (132)
43 [from 42 keep 8, 49, 51, 59, 123, 173, 177... (0)
44 from 42 keep 16, 40, 60, 65, 82-83 (6)

Ovid Technologies, Inc. Email Service Accessed
24/11/02

Search for: from 42 [limit 41 to (research and
english and (adult <19 to 44 years> or middle
age <45 to 64 years> or aged <65 to 79
years> or "aged <80 and over") and english)]
keep 8,49,51,59,123,173,177

Citations: 1-7

Database: CINAHL <1998 to September 2002>
Search Strategy:

1 exp Critical Illness/ (278)
2 exp Critical Care/ (1310)
3 exp Subacute Care/ (232)
4 exp Hospital Units/ (4536)
5 (cardiopulmonary arrest or cardiac arrest).mp. [mp=title, cinahl subject heading, abstract, instrumentation] (326)
6 exp Heart Arrest/ (618)
7 exp Prospective Studies/ (13519)
8 exp Relative Risk/ (2014)

353 App.2
9 exp Risk Assessment/ (1894)
10 exp Risk Factors/ (10812)
11 (odds and ratio$).tw. (1948)
12 (relative and risk).tw. (1423)
13 (case and control$).tw. (1918)
14 or7-13 (26777)
15 1 and 14 (54)
16 limit 15 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and yr=1990 and english) (0)
17 limit 15 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and english) (18)
18 [from 17 keep 20] (0)
19 2 and 14 (117)
20 limit 19 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) (33)
21 from 20 keep 18 (1)
22 3 and 14 (12)
23 from 22 keep 1-2 (2)
24 4 and 15 (23)
25 4 and 14 (595)
26 limit 25 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and english) (197)
27 from 26 keep 45, 69-70, 94 (4)
28 5 and 14 (60)
29 limit 28 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and english) (26)
30 from 29 keep 23 (1)
31 6 and 14 (84)
32 limit 31 to (research and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and english) (31)
33 from 32 keep 26 (1)
34 from 17 keep 1, 14, 16 (3)
35 from 20 keep 1, 7, 24 (3)
36 from 22 keep 1-12 (12)
37 from 26 keep 134, 152, 187 (3)
38 from 29 keep 21-22 (2)
39 from 32 keep 31 (1)
40 exp Critical Care/ or intensive care.mp. (3100)
41 14 and 40 (541)
42 limit 41 to (research and english and (adult <19 to 44 years> or middle age <45 to 64 years> or aged <65 to 79 years> or "aged <80 and over")) and english) (183)
43 from 42 keep 8, 49, 51, 59, 123, 173... (7)
## Appendix 3

<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>#</th>
<th>category</th>
<th>Quality rating</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyd O (1999)</td>
<td>7</td>
<td>background</td>
<td>Reasonable</td>
<td>Systematic review and meta-analysis.</td>
</tr>
<tr>
<td>Charlson ME, Sax FL, MacKenzie R et al (1986b)</td>
<td>14</td>
<td>removed from core-duplicate sample</td>
<td>Reasonable</td>
<td>Prospective study and retrospective review case notes.</td>
</tr>
<tr>
<td>Cioffi J (2000a)</td>
<td>15</td>
<td>background</td>
<td>Reasonable</td>
<td>Descriptive observational study.</td>
</tr>
<tr>
<td>Cioffi J (2000b)</td>
<td>16</td>
<td>core</td>
<td>Reasonable</td>
<td>Qualitative, descriptive, exploratory study.</td>
</tr>
<tr>
<td>Escarce JJ, Kelley MA (1990)</td>
<td>21</td>
<td>background</td>
<td>Good</td>
<td>Prospective study.</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>#</td>
<td>category</td>
<td>Quality rating</td>
<td>Method</td>
</tr>
<tr>
<td>---------------</td>
<td>----</td>
<td>----------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>Sax F L and Charlson M E (1987a)</td>
<td>57</td>
<td>core</td>
<td>Reasonable</td>
<td>Prospective cohort study.</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>#</td>
<td>category</td>
<td>Quality rating</td>
<td>Method</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----</td>
<td>-----------------</td>
<td>----------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Sax F L, Charlson M E (1987b)</td>
<td>58</td>
<td>removed from core-duplicate sample</td>
<td>Reasonable</td>
<td>Prospective study and retrospective review.</td>
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<tr>
<td>Shoemaker W C (1996a)</td>
<td>61</td>
<td>background</td>
<td>Good</td>
<td>Theoretical paper.</td>
</tr>
<tr>
<td>Smith A F, Wood J (1998)</td>
<td>63</td>
<td>core</td>
<td>Reasonable</td>
<td>Qualitative research study (In- depth interviews).</td>
</tr>
<tr>
<td>Fieselmann J F, Hendryx M S, Helms C M et al 1993</td>
<td>70</td>
<td>core</td>
<td>Good</td>
<td>Retrospective case-control study.</td>
</tr>
<tr>
<td>Hillman K M, Bristow P J, Chey T et al 2001</td>
<td>71</td>
<td>core</td>
<td>Reasonable</td>
<td>Retrospective review.</td>
</tr>
<tr>
<td>Buist M D, Moore G E, Bernard S A et al 2002</td>
<td>72</td>
<td>core</td>
<td>Reasonable</td>
<td>Non randomised population study with historical control.</td>
</tr>
<tr>
<td>Daly F F S, Sidney K L, Fatovich D M 1998</td>
<td>73</td>
<td>exclude</td>
<td>Poor</td>
<td>Descriptive prospective study.</td>
</tr>
<tr>
<td>Durbin C G, Kopel R F 1993</td>
<td>77</td>
<td>core</td>
<td>Good</td>
<td>Retrospective case-control chart review study.</td>
</tr>
<tr>
<td>Smith L, Orts C M, O'Neill I et al 1999</td>
<td>80</td>
<td>core</td>
<td>Reasonable</td>
<td>Prospective observational study.</td>
</tr>
<tr>
<td>Coombs M, Dillon A 2002</td>
<td>83</td>
<td>exclude</td>
<td>Poor/insufficient information on cues.</td>
<td>Audit</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>#</td>
<td>category</td>
<td>Quality rating</td>
<td>Method</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----</td>
<td>----------</td>
<td>----------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Bion J F 2000</td>
<td>84</td>
<td>core</td>
<td>Good</td>
<td>Review/ theoretical paper</td>
</tr>
<tr>
<td>Stenhouse C, Coates S et al 2000</td>
<td>85</td>
<td>core</td>
<td>Insufficient detail</td>
<td>Prospective study</td>
</tr>
<tr>
<td>Odell M, Forster A et al 2002</td>
<td>86</td>
<td>core</td>
<td>Reasonable</td>
<td>Prospective study</td>
</tr>
<tr>
<td>Sterling C, Barrera Groba C 2002</td>
<td>87</td>
<td>core</td>
<td>Reasonable</td>
<td>Audit- prospective study</td>
</tr>
<tr>
<td>Carberry M 2002</td>
<td>88</td>
<td>core</td>
<td>Reasonable</td>
<td>Prospective observational study</td>
</tr>
<tr>
<td>Robson W 2002</td>
<td>89</td>
<td>background</td>
<td>Reasonable</td>
<td>Review (not systematic).</td>
</tr>
<tr>
<td>Cutler L R 2002</td>
<td>90</td>
<td>core</td>
<td>Reasonable</td>
<td>Focussed ethnographic case study</td>
</tr>
<tr>
<td>Lawrence A, Havill J H 1999</td>
<td>91</td>
<td>background</td>
<td>Reasonable</td>
<td>Retrospective review.</td>
</tr>
<tr>
<td>Covinsky K E, Justice A C et al 1997</td>
<td>92</td>
<td>core</td>
<td>Reasonable</td>
<td>Prospective cohort study</td>
</tr>
<tr>
<td>Dubois R W, Brook R H 1988</td>
<td>93</td>
<td>background</td>
<td>Reasonable</td>
<td>Retrospective study</td>
</tr>
<tr>
<td>Daly K, Beale R, Chang R W S 2001</td>
<td>94</td>
<td>core</td>
<td>Good</td>
<td>Prediction model and validation in separate data set.</td>
</tr>
<tr>
<td>Parr M J A, Hadfield J H et al 2001</td>
<td>95</td>
<td>core</td>
<td>Reasonable</td>
<td>Retrospective review</td>
</tr>
<tr>
<td>McArthur-Rouse F 2001</td>
<td>96</td>
<td>core</td>
<td>Reasonable but not cues in depth</td>
<td>Literature review.</td>
</tr>
</tbody>
</table>

Note: Five core papers were based on the same sample and so four of these were removed prior to statistical analysis.
## Appendix 4.
### Levels of Evidence, the Oxford Centre for Evidence-based Medicine
*(after Phillips, Ball & Sackett *et al.*, 1998, pp.1-2).*

<table>
<thead>
<tr>
<th>Level</th>
<th>Therapy/ Prevention/ Aetiology/ Harm</th>
<th>Prognosis</th>
<th>Differential diagnosis/ symptom prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Systematic review (SR) (H) of RCTs</td>
<td>SR (H) of inception cohort studies validated in different pops</td>
<td>SR (H) of prospective cohort studies</td>
</tr>
<tr>
<td>1b</td>
<td>Individual RCT (and narrow confidence interval)</td>
<td>Individual inception cohort study with &gt; 80% follow-up; CDR validated in 1 population</td>
<td>Prospective cohort study with good follow-up ***</td>
</tr>
<tr>
<td>2a</td>
<td>SR (H) of cohort studies</td>
<td>SR (H) of retrospective cohort studies or untreated control groups in RCTs</td>
<td>SR (H) of 2b and better studies</td>
</tr>
<tr>
<td>2b</td>
<td>Individual cohort study (and low quality RCT)</td>
<td>Retrospective cohort study or follow-up of untreated control patients in an RCT; CDR based on split-sample validation§§</td>
<td>Retrospective cohort study, or poor follow-up</td>
</tr>
<tr>
<td>2c</td>
<td>Outcomes research; Ecological studies</td>
<td>Outcomes research</td>
<td>Ecological studies</td>
</tr>
<tr>
<td>3a</td>
<td>SR (H) of case-control studies</td>
<td></td>
<td>SR (H) of 3b and better studies</td>
</tr>
<tr>
<td>3b</td>
<td>Individual case-control study</td>
<td></td>
<td>Non-consecutive cohort study, or limited population</td>
</tr>
<tr>
<td>4</td>
<td>Case-series (and poor quality cohort and case-control studies§)</td>
<td>Case series and poor quality prognostic cohort studies***</td>
<td>Case-series</td>
</tr>
<tr>
<td>5</td>
<td>Expert opinion without formal critical appraisal, reports of expert committees and descriptive studies.</td>
<td>Expert opinion without formal critical appraisal, reports of expert committees and descriptive studies.</td>
<td>Expert opinion without formal critical appraisal, reports of expert committees and descriptive studies.</td>
</tr>
</tbody>
</table>

**Key**

- **H**- with homogeneity or free of significant variations
- **CDR**- Clinical Decision Rule (scoring systems estimating prognosis or diagnostic category).
- ****- good reference standards are separate from the test and applied blindly or objectively.
- *****- good follow-up is > 80% giving enough time for other diagnoses to be revealed (e.g. 1-6 months acute, 1-5 years chronic).
- §- studies where all patients died before the treatment became possible, but some now survive, or when some used to die before the treatment became possible, but none die on it now.
- §§- Split sample validation where information is collected in one go and then artificially divided into *derivation* and *validation* samples.
- ±- Poor quality cohort refers to where comparison groups not clearly defined, exposure and outcomes not measured objectively in exposed/ non-exposed subjects, “failed to identify or control for confounders, or insufficient follow-up of patients”. Poor quality case-control refers to studies that did not clearly define comparison groups and/or did not measure exposures and outcomes rigorously in cases and controls, and/or “failed to identify or control for confounders”.

Method summary

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Description of characteristics and outcome of patients with suspected in-hospital cardiac arrest.</td>
</tr>
</tbody>
</table>

Method
Prospective observational study. Cardiologist in CPR team and ward nurse collected data - characteristics, outcomes of all events attended by CPR team during 14 months. Patient follow up to hospital discharge, outcome measure was survival/ non survival at discharge. Functional status evaluated retrospectively - patient status matched to verbal descriptors in the Cerebral Performance Score (CPC) calculated by first author for admission and discharge points. No definition of cardiac, respiratory or other life-threatening illness given.

Results
Chest pain and planned surgery - most common reasons for hospital admission. Myocardial infarction - the most common diagnosis on admission, followed by angina pectoris, congestive heart failure and arrhythmia. Congestive heart failure, myocardial infarction, bradyarrhythmia and hypotension frequently preceded the emergency call. Location - 61% true cardiac arrests occurred in patients monitored continuously. 56% of cardiac arrest patients had ventricular fibrillation or ventricular tachycardia initially, rhythms found most in monitored patients (68% compared to 35%, p<0.001). CPR and defibrillation earlier prompt in monitored patients. 42% cardiac arrest patients discharged alive, compared to 62% in respiratory arrest, and 87% in others. More cardiac arrest patients with ventricular fibrillation survived than those with pulseless electrical activity. 95% resuscitation attempts judged appropriate.

Conclusion, comments
Level 4 evidence. High survival to discharge rates after CPR reported (42% compared to around 15% elsewhere). Cerebral performance- minimal change reported for patients sustaining CPR (cited as evidence of successful resuscitation). Reliability in data collection- categorisation of type of arrest and data extracted in chart review for CPC score were not checked independently. Chart review relied on professional judgement for data extracted -no predefined list of variables used. External validity - limited generalisability due to small sample and differences in case mix in study sample compared to elsewhere (66% admissions had cardiac disease). Possible source of bias - procedure for summoning CPR team may contrast with other hospitals - large number of arrests in study site not attended by CPR team (only 14% of all hospital cardiac arrests resulted in CPR team being called). Limited information on post arrest treatment. Quality, reasonable. Core


Method summary

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>background</td>
<td>Assessment of efficacy of Simplified Acute Physiology Score II (SAPS II) for measuring severity of illness in intermediate care units.</td>
</tr>
</tbody>
</table>

Method
Prospective study. Follow-up was to discharge from hospital. Demographic data, preadmission health status, reason for admission, diagnosis, outcome at hospital discharge, and parameters required for calculation of SAPS II within first 24 hours were collected. SAPS II uses worst values of each parameter within first 24 hours. Calibration and accuracy of SAPS II for this sample assessed by comparing predicted deaths with actual deaths.

Results
Patients were admitted from emergency department (60.9%), general medical ward (31.3%), other hospital wards (6.4%). 1.3% were admitted from ICU. Reasons for admission 90% medical, with respiratory failure (21.7%), neurological failure (17.3%), and suicide attempts (19.4%). Length of stay average 3.1+2.3 days. 65% patients were transferred to medical ward at discharge, 5% to ICU, 26% discharged from hospital. Death rate 2.7% (n=11), but 47 patients had a >20% probability of death. SAPS II scores averaged 22.3±12.0. Hospital death rate 8.1% compared to probability mortality using SAPS II was 8.7% (difference was non significant). Over the study period 35 died in hospital (11 in the unit). Probability of in hospital death <5%, 5-20%, 20-40%, >40% was 60%, 30%, 7% and 3% respectively. Calibration was good (C=2.4 p=5), and SAPS II discriminant power (accuracy assessed by measuring area under the receiver operating characteristic curve, AUC) was excellent (AUC 0.85±0.04).

Conclusion, comments
Level 4 evidence. SAPS II (third generation severity score) variables selected and weighted according to results of multiple regression analysis. SAPS II performed well in this intermediate care unit with similar expected and observed mortality rates. Possible bias- large number of patients could not be included as parameters were missing in 128 of 561 patients. Results supported value of intermediate care units as either step up from the wards or step down from ICU for selected patients- achieving positive patient outcomes at less cost than ICU. SAPS II calculated at 24 hours after admission therefore not used as part of decision making for decision to admit to intermediate care- clinical judgement remains crucial. Limited generalisability- requires further confirmation in other intermediate care units with different case-mixes. Quality of study reasonable. Background paper.

Method summary

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>Category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Sample</td>
</tr>
</tbody>
</table>

**Method**

Prospective study and retrospective review.

Prospective study of patients experiencing cardiac arrest within 24 hours of the event and retrospective review of medical case notes to determine any iatrogenic complications possibly associated with cardiac arrest.

**Results**

Medical diagnoses and medications of iatrogenic and non-iatrogenic arrests were compared. No differences for prior history of acute stroke, chronic pulmonary disease, or chronic renal failure. In the iatrogenic group patients were less likely to be in cardiogenic shock (P<.02) or have acute myocardial infarction (P<.05) prior to arrest. They were more likely to be taking digoxin (P<.005) or antiarrhythmics (P<.05). 18 of the in-hospital cardiac arrests were judged to be preventable. Medications accounted for 15 (54%) "iatrogenic" (8 preventable), 4 procedures resulted in cardiac arrest (1 preventable). Fluid and electrolytes (2 preventable). Errors of omission (7 preventable) - signs and symptoms misinterpreted, poor response to laboratory data.

**Conclusion, comments**

Level 2b evidence. Definition of iatrogenic cardiac arrest; complications from procedures, medication errors, poor recognition or response to fluid and electrolyte balance, abnormal laboratory data, electrocardiographs, clinical signs and symptoms. Items for inclusion based on earlier research evidence (Bedell et al 1983). Process of chart review and classification process documented. Of the 28 iatrogenic arrests 18 (64% of all arrests) were potentially preventable. Small number of iatrogenic arrests - limitation of study. Medication errors and toxic effects accounted for 44% potentially preventable arrests, and inadequate response to clinical signs and symptoms such as dyspnea and tachypnea was found in 28% of potentially preventable arrests. Recommends quick responses to abnormal drug levels, ECO signs of drug toxicity (torsades de points, prolonged QT interval), signs and symptoms of congestive heart failure, and digoxin toxicity. Independent checks used in chart review process, and process by which disagreements were processed also described (2 unresolved cases - later eliminated). Core paper

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>Evaluation of in-hospital cardiopulmonary resuscitation with reference to patient and clinical characteristics, outcomes, predictors of outcomes, quality of survival.</td>
</tr>
</tbody>
</table>

**Method**

Prospective study

Prospective study of consecutive resuscitation patients in a US teaching hospital over 18 months. Definition of cardiac arrest given. Recorded demographic and clinical data for each patient (diagnoses, functional status pre-admission, medical history before cardiac arrest, clinical condition 24 hours before and after the resuscitation). Reviewed all death certificates of all patients in hospital, interviewed all survivors at discharge and 6 months later. Multivariate analysis used to identify variables that were independently related to outcome after cardiopulmonary resuscitation.

**Results**

128 of the 294 patients survived initial resuscitation, but 31 died within 24 hours, and a further 56 died before discharge - 41 patients (14% of total study group) survived to discharge, and 33 were alive 6 months later. 31% of initial survivors were subsequently not for resuscitation. Majority of patients were admitted from home, 51% were married, 10% were employed full/ part-time (remainder were retired or unemployed). Almost half had been active outside the home prior to hospitalisation. Significant predictors of in-hospital mortality after CPR by logistic regression analysis: before arrest- hypotension, pneumonia, renal failure, cancer, reduced function (homebound) (Urinary output< 300 ml/24 hours seemed clinically significant yet failed to be significant on multivariate analysis possibly because this cue overlapped with hypotension in 60% patients with this cue); during arrest- arrest > 15 minutes, intubation, hypotension, pneumonia, homebound, after resuscitation- coma, need for pressors to maintain blood pressure, arrest lasting> 15 minutes. Survivors’ 6 month follow-up, depression reduced, functional status possibly affected by fear rather than incapacity.

**Conclusion, comments**

Level 1b evidence. Cardiogenic shock and advanced cancer associated with high mortality, and previously unreported finding that pneumonia was also strongly associated with in-hospital mortality in CPR patients. Activity level before hospitalisation was a strong predictor of survival. Duration of arrest was more significant than the initial cardiac arrest rhythm. Regaining consciousness within 24 hours of arrest also predicted neurological recovery. Study unable to make detailed comparison of mental status pre and post arrest as pre arrest data not available. Age not significant predictor of outcome. Limitation - small sample size- recommended validation using larger sample in other settings. Variables for inclusion in multiple regression were based on professional judgement of authors. Core paper

Examined CPR events in non critical care over 45 months - part of quality assurance programme in an acute-care hospital in Kentucky, US. Concerned with ethical and economic issues presented by CPR and if age could be used as a criteria for selecting patients who could benefit from CPR does age predict survival in non critically ill patients sustaining cardiac arrest in non critical care areas?

422 code events, 387 met study definition of cardiorespiratory arrest, 255 in non critical areas - included in study. Excluded cardiac arrests in critical care areas and emergency department, and patients with incomplete data (91% of total meeting criteria were included in study sample).

**Method**
Prospective study. Defined cardiorespiratory arrest as: no palpable spontaneous pulse or detectable blood pressure, no effective spontaneous respiration, and needed endotracheal intubation; failed resuscitation - CPR efforts for > 5 minutes before death pronounced. Report form used for data collection on all patients, additional data from medical records for diagnosis, retrospective APACHE II score for 24 hrs before arrest. All forms reviewed by 1 investigator and a critical care nurse. Follow up of immediate survivors until death or end of study. Costings study also included. Statistical analysis - analysis of variance for continuous scale variables, comparisons made between groups to assess impact of age and APACHE II score on CPR survival.

**Results**
Immediate survival 52% (n=132), survival post ICU 22% (n=55), survival to discharge 11% (n=28), 4% (n=10) survived to follow-up (average of 22 months). Survivors had no new neurological deficits, only one did not return to preadmission location. Costs for survivors estimated at 63,000 dollars each. Long term survival not predicted by age, admitting diagnosis or main comorbidity.

Post-CPR APACHE II predictive of ICU survival, but not long-term survival.

**Conclusion, comments**
Level 1b evidence. Age not accurate predictor of survival in the non critically ill hospitalised patient when CPR attempted. (Did not include analysis of elderly patients made DNR during study period). Study design did not permit stratification of diagnosis by severity. APACHE II unreliable as predictor of outcome in individual patients. Patients with ventricular arrhythmias at outset of CPR had a better outcome immediately post-CPR than asystole or EMD patients (p<0.05). Advised evaluation of patient's health status, prognosis and patient preferences when deciding on CPR. Cost analysis - CPR justified despite substantial costs incurred. Data collection using identical report forms by team experienced in this clinical problem, independent checks made to ensure all cases were reported (cases reported late were not included, but education to encourage early reporting was in place). One investigator and a critical care nurse specialist reviewed all forms. Consultant biostatistician was involved and Statistical Analysis System programme was used for data analysis. CPR team composition with ACLS and BCLS certification. Background paper - focuses on survival post CPR. Background paper
**Results**

Diagnoses included 25%-respiratory insufficiency, 18%-acute cardiac disease, 11%-drug overdose, 10% upper gastrointestinal bleed. 16% of the 221 at risk patients had one or more MICU readmission (n=30), or died (n=7). These at risk patients (n=37) were compared to the group who had no further complications (n=192), and differences were found in age (p=0.0011), diagnosis (p=0.001), severity of illness on admission - APACHE II, (p=0.002). At discharge from MICU the at risk group were sicker—significant differences found in heart and respiratory rates which were elevated, haematocrit values which were lower. 30% patients with sepsis, upper gastrointestinal bleed, and 25% with respiratory failure or acute cardiac disease required readmission or died. Chest pain patients, not myocardial infarction, and overdoses - none readmitted. Multivariate analysis-age, APACHE II score on admission and diagnosis of upper gastrointestinal bleed significant and independent predictors of unexpected outcome.

**Conclusion, comments**

Level of evidence- 1b. Patients experiencing post ICU deterioration -significant differences in clinical features were found. Heart rate, respiratory rate and haematocrit did not achieve significant results in multivariate analysis - may reflect the interdependence of the variables.Limitations-Veterans' hospital therefore majority male population, but gender not known to affect ICU outcome. Case mix differences between ICUs could limit generalisability. Sample too small to stratify by diagnosis, or time to complication. Heterogeneous sample- predictive model could not be developed. Other factors such as bed availability may have affected decision to discharge patients. Core paper.

Method summary

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| 8      | Quantitative  | Good           | background | Perioperative interventions for high-risk surgical patients.

Method

Randomised clinical trial over 18 months. Patients randomly assigned to control (n=54) and protocol (n=53) groups. Control received "best standard periooperative care", protocol received "deliberate increase of oxygen delivery index to > 600 mL/min per square metre by use of doxaxime hydrochloride infusion" p.2699. Measured mortality and complications up to 28 days postoperatively. Sample size determined by analysis of predicted mortality rates based on studies of high-risk surgical patients. Should have had 120 patients, but effect of treatment made it unethical to continue study up to the 120 sample. 107 high-risk patients using previously identified criteria. Location: UK teaching hospital general ICU.

Results

Demographics, admission criteria, type of surgery, haemodynamic assessment on admission were similar for both groups. Treatment was similar for both groups but addition of doxaxime chloride for protocol group resulted in significantly greater oxygen delivery preoperatively. Conduct of interventions for both control and experimental groups detailed. Overall 75% reduction in mortality recorded for protocol group compared to control (5.7% vs. 22.2%; P=0.015). Complications were halved in protocol group compared to control. Finding: Increasing oxygen delivery periooperatively with doxaxime chloride reduced mortality and morbidity in high risk surgical patients.

Conclusion, comments

Level 1b evidence. Criteria used to identify high-risk surgical patients: Previous severe cardiorespiratory illness, extensive surgery planned for carcinoma, acute massive blood loss > 8 units, age >70 years with less physiological reserve in one or more vital organs, sepsicaemia, respiratory failure (PaO2, 8kPa on FiO2 > 0.4 or mechanical ventilation > 48 hours), acute abdominal problem with haemodynamic instability, acute renal failure (urea > 20 mmol/L, creatinine > 260 micromol/L [2.9 mg/dl], late stage vascular disease (after Shoemaker, Appel et al 1988). Further refinement of high-risk criteria may be possible in the future to target patients who would benefit most from periooperative increases in total body oxygen delivery and best methods to achieve this. This study included pre and postoperative patients admitted to intensive care. Balanced statistical requirements of study design with ethical requirements to give best treatment-stopped at 107 patients. Background paper.
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**Method**

Prospective cohort study.

Prospective cohort study - 3 hospitals. Hypothesised that hospital with early intervention team (MET) would have fewer adverse patient events compared to 2 others after adjustments for case mix differences. Records examined after event by critical care nurse at each hospital, using predesigned and pilot tested form. Outcome measures: ICU/HDU unplanned admissions, cardiac arrests, deaths, deaths without DNR order.

**Results**

1510 adverse events out of 50,942 admissions. Unanticipated rates ICU/HDU admissions were significantly less at Hospital 1 (case mix adjusted odds ratio Hospital 1, 1.00; Hospital 2, 1.59 [95% CI, 1.24-2.04]; Hospital 3, 1.73 [95% CI, 1.37-2.16]). Overall no significant difference in total cardiac arrests or deaths between the 3 hospitals but Hospital 2 had a significantly higher case-mix adjusted death rate in patients with no DNR order (27 extra deaths). Case mix adjustment -probability of adverse event adjusted for demographic and diagnostic patient data. Modelled all events (ICU/HDU unanticipated admissions, cardiac arrest, death and deaths without DNR in place), and separately looked at index events where an event led to further events e.g. cardiac arrest leading to unanticipated ICU admission. Simple and multiple regression used to model likelihood of event happening after case-mix adjustment. (Parameters were added until area under the receiver operator curve reached 0.85 (less than 6 parameters were used to achieve this) as did not want minor differences to mask larger ones. The performance of the model was satisfactory when assessed using Hosmer-Lemeshow goodness-of-fit tests. Hospitals 2&3 were compared to hospital 1 (with MET in place).

**Evaluation**

Evaluation of effectiveness of Medical Emergency Team (MET) in reducing adverse outcomes compared to two hospitals with traditional cardiac arrest teams.

The 3 hospitals were similar in size and type. Data were collected for all events -cardiorespiratory arrest calls, deaths, and ICU/HDU admissions for patients aged 14 and over- in 6 month period in 1992.

**Conclusion, comments**

Level 4 evidence. Comparison 3 hospitals rather than randomisation - one hospital where MET had been in place for a number of years. Acknowledged different results could be obtained if alternative methods of case mix adjustment used- limitation of this methodology. Stepwise multivariate analysis used to minimise risk of concealing actual differences in the data. Results may demonstrate effectiveness of MET in earlier intervention (fewer unanticipated admissions to HDU/ICU). MET less effective in preventing cardiac arrest, possibly the criteria are not sensitive enough, or they are underused. Perhaps MET criteria identify deterioration at a late stage when potential for recovery is reduced. Limitation- study did not consider differences in DNR practices. Further study needed to assess how well the MET criteria are used, reasons for possible under use. Recommends further evaluation of MET intervention such as before and after introduction of MET in one hospital (MET at FPH project is an example of this). Possible cost savings of reducing unanticipated ICU admissions. Core paper.

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**Method**
Retrospective survey of medical records (pilot study). Defined critical event CE, as unplanned ICU admission or a cardiac arrest call. Frequency of CE, antecedents, number of medical reviews during instability period, patient outcomes were recorded by 2 fifth year medical students - supervised by lead researchers.

**Results**
The 122 CEs took place in 112 patients (median 1; range 1–4). Of the 79 unplanned ICU admissions 14 followed cardiac arrest calls. Location of CEs: medical wards, 52; surgical wards, 11; coronary care unit, 16; labour ward, 2; psychiatric ward, 1. Admission diagnosis: pneumonia, myocardial infarction, post surgery (not cancer), orthopaedic trauma were most common, remainder - range of diagnoses represented. None of the 8 patients with more than 1 CE survived to discharge. Instability was found in 93 CEs (76%) >1 hour prior to event. Mean period of instability prior to CE was 6.5 hours (range 0-432 hours). For periods of instability > 1 hour 258 instability criteria were noted with haemodynamic, respiratory, abnormal laboratory results being most frequent, and reduced level of consciousness, abnormal temperatures making up the remainder. In 29 CEs (24%) clinical instability noted for <1 hour (5 were admitted to ICU and survived), remaining 24 had cardiac arrest call, 19 died.

**Conclusion, comments**
Level 4 evidence. Ethics Committee Approval obtained. Clinical instability defined by MET criteria (Lee et al., 1995). Overall study mortality rate, 62% (2 ward patients with cardiac arrest calls survived to discharge). CEs incidence in wider hospital population (122/19853, 0.6%). Mortality for total hospital admissions, 2%. Unplanned ICU admissions - 15% of total ICU patients and 1/3 of ICU deaths (18% total hospital deaths in 1997). Resuscitation treatment principles not always operating in the general wards. Response to clinical instability in wards was often delayed. Retrospective study, risk of bias in reporting data. No control group to investigate patients with clinical instability who recovered after interventions. Need better strategies for managing patients with prolonged clinical instability (MET). Core paper.
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<td>11</td>
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**Method**
Prospective cohort study and retrospective review of case notes. Doctors rated patients for stability on admission, reason for admission, severity of illness, long term prognosis, and functional ability. Physicians reviewed 603 of the 607 hospital records post discharge -blinded to residents' predictions.

**Results**
Stability ratings- 65% of patients were rated as stable; 25% somewhat unstable; 10% most unstable. Multiple logistical regression found residents stability ratings was the most significant predictor of morbidity (p<0.001) in acute illness. Severity of illness ratings also significant in predicting morbidity (p<0.005). Types of morbidity-15% patients had deterioration of pre-existing problems (comorbid diseases or other conditions necessitating admission), 17% had new complications, 8% had both. 12% of stable patients developed morbidity compared to 39% of somewhat unstable and 61% of the most unstable.

**Conclusion, comments**
Level 4 evidence. Initial rating of patients as unstable may have caused doctors to look for morbidities more closely. Findings should not be generalised beyond general medical wards in teaching hospitals. Descriptors for anchor points on the stability rating scale could be ambiguous. Patients' medical conditions were classified as being at high or low risk of hospital mortality-process outlined. All active comorbidities were recorded, and two types of morbidity noted 1. new complications, 2. decompensation of pre-existing problems. Rather than developing an index this research investigated the clinical construct of stability. Recommended further study of how patients are classified as stable or unstable following the clinimetric procedures described by Feinstein—what evidence is used when classifying patients as stable/ unstable (what cues are used-similar to current study of nurses' judgements). Limitation -20 junior doctors did 82% of the assessments on admission therefore relatively inexperienced. Senior doctors reviewed all the records after discharge blinded to the initial assessment predictions, but no systematic reliability checks were conducted at the chart review stage. However coding of data used specific criteria. Core paper.
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**Method**

Prospective study. Within 24-48 hours of admission patients’ illness severity was categorised by admitting doctors’ as not ill, mildly, moderately, severely ill, or moribund, and predicted level of function at discharge as excellent, good, fair, or poor. Recorded in-hospital mortality, diagnosis, length of stay, costs. Pre-designed computer programme “SIGNOUT” was used to collect data, with illness severity and functional status rated using clinical judgement. Logistic regression analysis used to analyse mortality and ROC curves examined predictive ability of the logistic model.

**Results**

Mean age was 63 ±18 years; 51% male. 43% were aged >70 years; 20% were >80 years. On admission illness ratings - not ill, 9%; mildly ill, 47%; moderately ill, 41%; severely ill or moribund, 4%. Admission predictions of function at discharge - excellent, 16%; good, 48%; fair, 31%; poor, 5%. Overall in-hospital mortality, 2.7% (n=47). Greater illness severity was significantly associated with mortality (P= 0.003). For not ill or mildly ill mortality was 1.1% (n=11 of 972), and for moderately ill, 3.6% (n=26 of 724), severely ill, 15% (n=9 of 60). Mortality rates also increased with reduced anticipated function (P<0.01). Illness severity and function were significant predictors of increased length of stay and in-hospital costs (all P< 0.001). Mortality rates also increased with reduced anticipated function (P<0.01).

**Conclusion, comments**

Level 4 evidence. Defends use of clinical judgement to rate illness severity and function by comparing performance of this approach to predictions made using APACHE, MEDISGRPS and other scores in earlier studies. Ratings are based on judgements using multidimensional constructs (severity of illness, functional status) rather than using particular signs and symptoms- potential for error or bias in subjective assessments. Majority of patients were rated as mildly or moderately ill, and for anticipated functional status, the two middle categories were used most often (Oye, 2000 asked if ratings should be more structured?). Sample of 1st year house officers - subjective assessments’ validation of accuracy of judgements not attempted, no objective assessments of illness severity were made, no operational definition of illness severity, did not measure time between admission and doctor’s evaluation (if patient’s condition changed later evaluations likely to be more accurate) and location on one site limits generalizability. Further prospective validation is needed in other sites before findings should be widely implemented. Positive and negative consequences of this system should be examined before widespread implementation (Oye, 2000). Clinical judgement of illness severity is refined over many hours work with patients (these doctors - relatively inexperienced). Core paper.

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<td>13</td>
<td>Quantitative</td>
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<td>What determines doctors' preferences for types of interventions for hospital patients if condition deteriorates? Basis of “Do not resuscitate” orders.</td>
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**Method**
Prospective/ Retrospective study.

**Results**
Full intervention in cases of deterioration favoured in 81% of patients. Intensive nursing alone (no invasive procedures) favoured in 8%, and comfort only on general ward in 10%. Patient's age >75, doctors' predictions of long-term prognosis, functional ability correlated most with intervention preferences (P<.001 for each). Mortality rates for the full intervention group were less than for the other groups with poorer function and prognosis. More critical care admissions in full intervention groups.

607 (all patients admitted to medical service / 1 month). 604 (99.5%) in final analysis. Prospective study-25 doctors evaluated patients.

**Conclusion, comments**
Level 4 evidence. Statistical analysis using logistic regression techniques and differences between proportion examined using x2. Prognosis major determinant of preferences in full- intervention groups, and overall functional ability very important where less than full-interventions preferred. Patients with metastatic solid tumour, acquired immunodeficiency syndrome, and cirrhosis with portal hypertension, and those with "bad" reasons for admission had the worst outcomes. Study omits the patients' perspective. Cautions against use of age as a factor in levels of intervention decisions. 27 (4%) patients had CPR, all but one in the "full-intervention" group, but only 4 (14%) of these survived to discharge. Patients who arrest after gradual progressive decline have the poorest outcomes. Function measured as a whole, no way of knowing how this was assessed or the weighting given to mental or physical function nor the extent to which the patient would self-assess similarly. Background paper

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<td>14</td>
<td>Quantitative</td>
<td>Reasonable</td>
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<td>Evaluation effectiveness of clinical judgment to estimate severity of illness in medical unit patients. Various severity of illness scales for acute myocardial infarction, Glasgow Coma Scale, surgical / trauma / burns patients, and APACHE in critical illness, but few disease-specific scales available in general medicine.</td>
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**Method**
Prospective study. Objective-systematic analysis of physicians' assessments of clinical severity so that this could be used to stratify patients in research studies. Doctors' prospectively estimated how sick patients were on admission using 9 point scale and noted other patient characteristics. Retrospective review of patients notes at discharge (reasons for admission and comorbidities noted).

**Results**
Overall mortality rate=10.9%. Mortality rates increased with increased sickness rating, tripled from one strata of severity rating to the next (not ill, 0%; mildly ill 2%; moderately ill 6%; severely ill 23%; moribund 58%) x²=69.21, p=0.0001. Age, sex, race, insurance status did not affect mortality rates. Sickness ratings were predictive of time to death. Mildly ill died only after prolonged hospitalisation, moribund died soon after admission, and moderate and severely ill fell between these. Serious comorbidities (metastases, AIDS, cirrhosis) were associated with higher mortality rates (p<0.001). Acute neurologic and acute cardiovascular patients had worst prognoses. Physicians' illness severity ratings -the most significant predictor of mortality.

**Conclusion, comments**
Level 4 evidence. Focus is prediction of mortality. Refers to importance of stratifying patients according to illness severity in research to avoid bias. However ability to stratify patients by severity is also important in clinical practice. Study does not investigate what cues physicians use in their assessments of how sick patients are. Diagnosis and comorbidities do not completely assess risk of mortality. Study demonstrated clinicians make accurate predictions about illness severity, but it does not analyse how these judgements are formulated. No independent validation of doctors' assessments was undertaken- potential biases may exist which could limit the validity of the results. No detailed analysis of doctors' level of expertise, demographic information. Small sample may also limit generalisability of findings. Background paper.
Cioffi J (2000a) Nurses’ experiences of making decisions to call emergency assistance to their patients. *Journal of Advanced Nursing* 32 (1) pp. 108-114

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<tr>
<td>15</td>
<td>Qualitative</td>
<td>Reasonable</td>
<td>Investigated nurses experience of calling the Medical Emergency Team (MET).</td>
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**Method**

Descriptive observational study.

Descriptive study. Unstructured interviews of 45 minutes duration, invited to recount their experiences of calling the MET. Clarification/ expansion of points sometimes requested by interviewer. Interviews were tape-recorded.

**Results**

Interviews were transcribed verbatim. All transcripts were read twice and phrases relating to experiences of calling the MET were extracted. Similar phrases were taken from all the transcripts and these were clustered together resulting in 5 categories and sub categories. “Fittingness” of categories was checked by 2 clinical nurse consultants, verified that these reflected what they currently knew about personal experiences and staff accounts of calling the MET. The 5 categories were: “uncertainty associated with calling, identification of change in patient’s condition, identification of at risk situations, associated feelings, and valuing of the MET”. Nurses were anxious to perform correctly but were worried about making inappropriate calls. Nurses described “gut feelings” about patients who needed a MET call, behaviour changes (value of knowing individual patients usual behaviour) observations could be within normal limits. Relyed on past experiences with similar patients and patterns derived from previous experience with similar conditions.

**Conclusion, comments**

Level 5 evidence. Study was approved by Ethics Committee. Sample not fully described according to clinical specialties/ numbers from each site or unit, but the types of units were reported. No interview schedule, but one main question was reported- asked about experiences where they summoned the MET- researcher asked for expansion on some points during the interview. Does not state how interview transcriptions were checked for accuracy, nor who transcribed them. Within the categories reference was made to original comments. This empirical study refers to earlier work on nurses’ recognition of clinical deterioration, previous MET studies and some decision making literature, a theoretical framework is not stated explicitly. Focuses on nurses’ experiences at a descriptive level. Does not state what cues were used, refers to feelings about the patient being different- deteriorating. Relies on nurses’ recall of cases, no way of checking with actual events, judgements made, if the MET criteria were used, and patient outcomes. Quality assessment- meets some of the criteria. Background paper.

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<td>Nurses’ recognition of adult patients needing emergency assistance-analysis of MET criterion seriously worried about a patient.</td>
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Method
Qualitative, descriptive, exploratory study using in-depth, unstructured interviews. Setting- teaching hospital and peripheral hospital in Sydney, Australia. MET introduced >10 years earlier. Asked to describe experiences of calling the MET - Research questions 1. “What characteristics do patients display that cause nurses to seriously worry” 2. “How do nurses recognize patients about whom they are seriously worried”.

Results
Interviews taped with participants consent, numerical codes used to safeguard anonymity. Transcribed verbatim, coded. Analysis- all transcripts read twice, then phrases relating to experiences of calling MET extracted from transcripts. Words and phrases described recognition of patients about whom nurses were seriously worried. Categories checked by two MET experienced clinical nurse consultants. Categories were then combined resulting in 4 characteristics of patients causing concern were feeling not right, colour, agitation, and observations- usually found in combination. These early signs alerted nurse to monitor patient. Nurses used “touching, observing, listening, feeling or sensing, and “knowing” to collect information. Past experience, knowledge of patient, progress patterns important. Quotations illustrated development of categories.

Conclusion, comments
Level - qualitative. Ethics committee approval obtained. Literature review limited to MET studies, nurse decision making and earlier nursing papers on deterioration. Severity of illness/physiological severity papers were not included. Sample details did not state numbers of participants by type of clinical unit. When seriously worried criterion used often objective signs not yet evident. Proposes that nurses able to detect subtle changes in patients because they have more patient contact time enables them to use intuition based on experience. Refers to subjective and objective data but has not defined these precisely. Does not define them. Does not refer to cases where nurse failed to recognise early signs of deterioration. No independent verification of cues, relies on retrospective accounts of clinicians who volunteered to participate. Quality grading reasonable, but strong links to theory not made. Core paper.

Crispin C, Daffurn K (1998) Nurses’ responses to acute severe illness Australian Critical Care 11 (94) pp. 131-133

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<td></td>
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<td>Reasonable</td>
<td>Evaluation of nurses’ responses to patients in acute clinical deterioration. MET introduced in 1990, study examined nurses’ responses to clinical antecedents cardiopulmonary arrest.</td>
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Method
Retrospective review. Descriptive study. Data collected using predesigned form; patient demographics, MET call details, clinical details, patient complaints <24 hours before call. (Validity and reliability checks were not done).

Results
Location of patients with MET calls; ward areas (n=84, 50%), emergency department (n=71, 42.2%), critical care areas (n=6, 3.6%). Time of calls; office hours (43.4%), 1801-2400 hours (34.5%), 0001-0800 hours (22%). Reasons for calls: cardiac arrest (n=42,25%), airway/breathing difficulties (n=37,22%), decreased level of consciousness (n=35, 20.8%), other problems (chest pain, fitting) (n=41, 24.4%), hypotension (7.9%). Most cardiac arrests occurred in emergency department, followed by ward areas. Patient complaints in 24 hours before call: pain (n=18, 10.7%); shortness of breath (n=16, 9.5%); nausea / vomiting (n=9, 5.4%). 75% had no patient complaints recorded.27 patients (16.8%) had at least 2 critical clinical antecedents. 114/168 patients (67.8%) - no delay in treatment. Ward nurses contacted junior medical staff, not the MET, when changes were noted, emergency department staff more readily called the MET. 11 cases - action unclear.

Conclusion, comments
Level 5 evidence. Ethics’ committee approval of study obtained. Ward staff delay in calling MET - a cause for concern. This may be related to lack of awareness of benefits of early intervention and poor recognition of emergency situations (did not examine levels of expertise in nursing staff). Unable to confirm if some delays were related to do not resuscitate debate. Postulates that ward nurses may be fearful of making inappropriate calls and therefore delay action. Study addresses initial research questions to quantify nurses responses, but scope for more in-depth analysis of reasons underpinning decisions to call/not call the MET. Core paper.

Method
Survey-style research. (Questionnaire).
Survey. Questionnaire completed by nursing staff.

Results
Statistical analysis - group means and frequency tables, and confidence intervals of 95% to compare nurses in different locations. 62% nurses worked in medical and surgical wards, 20% in emergency department, operating theatre, and recovery, 19% in maternity unit. Most recent MET call - majority calls were for cardiac arrest (28.5%), respiratory arrest (14.2%), followed by fitting, and collapse. 11 hypothetical cases were also examined.

Conclusion, comments
Level 5 evidence. Nurses had a positive attitude towards the MET system based on team's performance when called. Knowledge of information booklet insufficient - suggests this information may be too detailed for ease of use. In scenarios nurses underrated hypotension as cue to call MET - possibly related to fear of "false-calls", and severe distress of hypothetical case of asthma did not always prompt decision to call MET. Found nurses sometimes reluctant to implement the MET criteria, recommended further education. Background paper.


Method
Prospective cohort study.
Prospective cohort study. Patients with high-mortality hospital diagnoses were included. Patients who passed cognitive screening (memory) were included. Demographic, markers of comorbidity, previous function, quality of life, severity of illness, hospital and medical team data were collected. Interviews were conducted for some of the above data. Symptoms reported were tabulated (quantitative content analysis).

Results
Patients who were not interviewed tended to be more dependent, had more comorbidities, were older, sicker, and less affluent (all recorded as P<0.001). Logistic regression analysis tested the association of symptoms with demographic, psychological, and illness measures. The symptoms producing most burden were pain (67.3%), drowsiness (7.0%), anxiety (9.4%), and depression (5.0%), and various combinations of these. The hospital, being male, disease category, more comorbidities, more pre hospital dependencies in activities of living, and poorer quality of life were associated with increased symptom burden.

Conclusion, comments
Level 4 evidence. Patients with acute respiratory failure or multiple organ failure with sepsis, exacerbation of chronic obstructive airways disease, metastatic lung cancer suffered the greatest symptom burden. Cited the Pareto principle that minority of symptoms accounted for a majority of symptom burden, and found evidence to support this here - improved control of one or more symptom could have very positive effect on combinations of symptoms reported. Did not find association between symptom burden and severity of illness (but all patients in study were categorised as seriously ill). Exclude paper.
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**Method**
Prospective study. Patients completed baseline SIP, and SIP and self rated function (7 point scale), before appointments for 6 months. Clinicians noted ARA classification after visits - recorded change on 5 point scale. 4 approaches used to quantify “sensitivity to clinical change” including comparisons and correlations between scales and patient and doctor ratings, sensitivity, specificity, predictive value of functional scales to predict clinical change.

**Results**
In 75 of the 140 visits both clinician and patient agreed on direction of change or no change in status, in 56, 1 recorded change, the other stated “no change”, and in 9 they each noted change in different directions. All scales had reduced mean scores when status judged as improved. ARA ratings and psychosocial part of SIP increased when patients status judged as unchanged (this was even greater than when patient judged worse). Small SIP changes in large groups can correspond to clinically important changes in individuals. For correlations of clinically estimated change and change on the functional scales, the SIP physical dimension and patient self-rating scale where the only ones to correlate with clinically estimated changes. Patients self ratings were more strongly correlated with clinically estimated change than SIP scale (but the former is included in “clinically estimated change”). The SIP was better than ARA at identifying differences in ARA single classes.

**Conclusion, comments**
Level 4 evidence. No gold standard to identify what ‘clinically important change’ might be, therefore used judgements of patients and clinicians as the measure of “clinically estimated change”. One major problem was that ALL scales had low sensitivity and predictive ability for clinical change. The same, better, worse scale used here is an example of a transition scale after Feinstein. Generalizability limited due to small sample, potential for bias in subjective nature of judgements of change, possible effect of patients ratings on clinicians’ judgements, emphasis on physical rather than psychosocial changes in physicians’ judgements. SIP reflects changes in groups of patients, but less sensitive to change within individuals where patient self-ratings were better. Greater attention to measuring clinically important change is needed- detecting changes in clinical condition predicting critical illness in general ward patients is the focus of the current judgement analysis study. Exclude paper.
Escarce J J Kelley M A (1990) Admission source to the medical intensive care unit predicts hospital death independent of APACHE II score JAMA 264 pp. 2389-94

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<td>21</td>
<td>Quantitative</td>
<td>Good</td>
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**Method**
Prospective study, consecutive admissions to MICU in 4 time periods (before expansion, immediately after, 4 months after, 16 months after expansion). Categorised patients by source of admission: emergency department (110), floor (general wards) (73), intermediate care unit (27), other hospital (25). APACHE II scores and predicted risk of death calculated.

**Results**
Analysis of variance (for continuous variables) and x2 (for variables expressed as proportions) tests analysed differences across admission groups. Predicted death rates for groups calculated. Predicted and actual death rates were compared (using x2 tests). Multiple logistic regression used-examined relationship between admission source and hospital death after adjusting for illness severity using APACHE II in two different ways. [APACHE II formula for risk of death used and age, chronic health score, acute physiology score, diagnostic category as separate measures of severity of illness]. Actual deaths exceeded predicted deaths (38% vs. 30%). Actual deaths=89 out of 235 total sample. Emergency Department predicted and actual death rates were very similar (25% and 22%, P= .39); but predicted rates in the “Floor” (P=.004), intermediate care unit (P=.003), others (P=.077) were all less than actual deaths. Logistic regression analyses - Emergency Department group more likely to survive compared to other groups and after taking severity of illness into account.

**Conclusion, comments**
Level 1b evidence. Logistic regression models - methods were explained. Odds ratios, 95% confidence intervals calculated, goodness -of-fit tested using Hosmer-Lemeshow method. APACHE II does not appear to measure severity of illness accurately in all ICU patients- may be affected by treatment prior to ICU admission. Physiological indicators of severe illness concealed as treatment already underway - an effect called lead-time bias. Treatment before ICU not covered in APACHE II. Lead time bias important in the results witnessed in this study. Patient groups, excluding emergency department transfers, likely to comprise poor responders to treatment. Duration of physiological abnormalities may also be significant (later work- see Shoemaker (1996a, 1996b). Local admission procedures may also have affected results- separate monitoring unit also available, therefore ICU admissions more severely ill. Cautions against using APACHE II to compare performance of ICUs. Quality rating, good. Background paper.

267 first admissions to MICU during 4 time periods (as above). Excluded transfers from other ICUs within the hospital (14), and total of 18 others. Final sample n= 235. mean age 57 years. 46% male, 30% had chronic health problems. Mean APACHE II score 18, range 0-50. Respiratory insufficiency most common reason for admission (46%).
<table>
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<tr>
<th>Subject</th>
<th>Method summary</th>
<th>Quality rating</th>
<th>Sample</th>
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<tbody>
<tr>
<td>Evaluation of impact of intermediate care unit on case fatality rate (instead of admission to intensive care for high-risk patients)</td>
<td>Prospective study evaluating 12 beds in one intermediate care unit for 12 months before and after the unit's establishment. Data collected on patient characteristics and outcomes.</td>
<td>Reasonable</td>
<td>876.1405</td>
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<th>Sample</th>
<th>Method summary</th>
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<tr>
<td>Total medical admissions: 11,238 pre-intermediate care, 11,745 post-intermediate care. ICU/CCU admission rates: 3.4% vs 6.8%. Intermediate care admissions: 0.6% vs 0.8%.</td>
<td>Prospective study evaluating 12 beds in one intermediate care unit for 12 months before and after the unit's establishment. Data collected on patient characteristics and outcomes.</td>
<td>Reasonable</td>
<td>876.1405</td>
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<th>Results</th>
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<td>Overall case fatality rate (CFR) decreased from 4.5% in the first 12 months to 3.8% in the 12 months after the unit's establishment.</td>
<td>Improved outcomes due to better allocation of resources and targeting of patients needing intensive care.</td>
<td>Admissions to ICU could then be for patients with specific clinical needs for intensive care (rather than rationing).</td>
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The decrease in CFR was statistically significant (P<0.05). The results were not significantly different between the two study periods.
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<td></td>
<td>Method summary</td>
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Franklin C, Mathew J (1994) Developing strategies to prevent inhospital cardiac arrest: Analyzing the responses of physicians and nurses in the hours before the event *Critical Care Medicine* 22 (2) pp. 244-247

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<tr>
<td>23</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Premonitory signs and symptoms prior to cardiac arrest, nurse and physician responses, and examined if cardiac arrests on wards were associated more with patients discharged from medical ICU than other patients.</td>
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</table>

**Method**

Prospective study - consecutive cardiac arrests in medical wards of one US hospital. All charts reviewed by 1 researcher < 48 hours of cardiac arrest using predetermined protocol: recent ICU discharge, nurse recorded abnormal vital signs < 6 hours prior to arrest, nurse notification to doctor if abnormality recorded, subsequent action such as referral to ICU triage officer and whether appropriate treatment had been given/ resuscitation before transfer to ICU.

**Results**

Cardiac arrest rate: 7.0/1,000 patients corresponds to hospital mortality rate = 91% for this group. Nurse or physician documented deterioration in 99 of 150 cases within 6 hours of event. Reported common issues: nurses' failure to inform medical staff of changes in patients' mental state, physicians' failure to obtain or analyse arterial blood gas measurements in respiratory distress cases, failure of physician to stabilise patient's condition before admission to ICU. Patients recently discharged from ICU were more likely to suffer cardiac arrest than other patients, cardiac arrest rate for the former was 14.7/1000, compared to 6.8/1000 (p= .004). Main cases identified within the 6 hours before cardiac arrest using predefined criteria: deterioration in mental status (confusion, restlessness, or lethargy), unstable vital signs (BP <70 or >130mmHg, heart rate<45 or >125 beats/min, respiratory rate <10 or>30 breaths/min), chest pain, respiratory distress, abnormal arterial blood gases (PO2, PCO2, pH, bicarbonate concentration).

**Conclusion, comments**

Level 4 evidence. Did not review records of patients who didn't have cardiac arrest. Cardiac arrest was clearly defined. Protocol for recording pre-arrest information precise and unambiguous, but only one investigator reviewed the charts and no reliability checks were reported. Study relies on the accuracy and completeness of data originally recorded in notes which was not checked. Also it is not known how many patients with abnormal signs did not go on to cardiac arrest. Descriptive statistical methods used. Premonitory signs and symptoms frequently precede cardiac arrest on general wards. Significant problem not lack of information, but the clinical response when patients' deteriorate. Recommends increased training for nurses and physicians in cardiopulmonary stabilisation and appropriate responses to neurological and respiratory instability. Core paper.

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<td>24</td>
<td>Quantitative</td>
<td>Good</td>
<td>Sample</td>
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Method
Prospective, multi-centre study (5 US hospitals). Enrolled on SUPPORT, height and weight recorded as part of demographic data and asked about recent weight loss. Body mass index (BMI) stratified by percentile rank (<15, 15 to 85, and 85 and above percentiles), and mortality risk ratios using Cox Proportional Hazards were calculated. Acute Physiology and Therapeutic Intervention Scores were collected. Followed up for 6 months.

Results
Subjects within the 15th to 85th percentile of BMI formed the reference group, selected variables were controlled for (prior weight loss, albumin, Acute Physiology Score). 3 models were developed based on reduced sample of 723 reviewed effect on outcome when different variables were manipulated (survival analysis undertaken). Latter sample excluded subjects with loss of 10 lbs or more before study admission, surrogate responses, subjects with incomplete data.25% of total sample (n=4301 in low body mass index group, 9% - high body mass index group, 1/3 - reference group); further 30% - incomplete records (critically ill). BMI in 15th percentile or less demonstrated to predict mortality in seriously ill hospitalised patients - first study to demonstrate this (earlier work with community and elderly care samples). Effect still found after multiple disease states, physiological variables controlled for, and after removal of subjects with significant prior weight loss. Current data found being slightly overweight may offer some protection to seriously ill patients - possibly related to nutritional reserve. Limitations- use of self-reported height and weight data. Recommended further studies into prediction of mortality should include BMI. Quality rating, good. Core paper.

Conclusion, comments
Level 4 evidence. BMI in 15th percentile or less demonstrated to predict mortality in seriously ill hospitalised patients - first study to demonstrate this (earlier work with community and elderly care samples). Effect still found after multiple disease states, physiological variables controlled for, and after removal of subjects with significant prior weight loss. Current data found being slightly overweight may offer some protection to seriously ill patients - possibly related to nutritional reserve. Limitations- use of self-reported height and weight data. Recommended further studies into prediction of mortality should include BMI. Quality rating, good. Core paper.
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<tr>
<td>25</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Complications in the first 24 hours after surgery and poor outcome subsequently.</td>
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**Method**
Prospective cohort, descriptive study. Operating lists; nursing staff reports on patients causing concern, nursing notes examined; patients interviewed post surgery. All charts reviewed. Records of all cardiac arrest calls.

**Results**
Major complications occurred in 109 (5%) patients with unstable or potentially life-threatening conditions. There were 23 deaths, and 6 suffered serious disabilities at discharge. Mortality rate: 0.24% at 24 hours, 0.3% at 48 hours, and 0.8% at 30 days. Of the 109 patients suffering major complications 25 had minor or intermediate surgery (2 of these had cardiac arrest calls initiated, and 15 developed hypotension) the remaining 84 were in the major surgery group. Details of the types of deterioration were listed by surgery type and outcome; these included hypotension, ICU admission, confusion and others. Incidence of post operative complications in major surgery increased with increasing age.

**Data collected in 2 hospitals in UK until target of 2153 cases reached (within 22 days). Pre-determined tools used for data collection, nursing staff were interviewed about any patient who caused concern and nursing notes were examined, all surgical patients were interviewed, patients with documented complications followed up, and all cardiac arrest calls noted. Patients who died within 30 days post surgery were recorded. Types of surgery in sample: Major, 568 (26%); intermediate, 784 (36%); and minor, 801 (37%).**

**Conclusion, comments**
Level 4 evidence. Descriptive statistical methods used- tables with percentages. Major surgery was defined, but the distinction between minor and intermediate surgery was less clear. Detailed analysis of the signs and symptoms in patients developing post operative complications was beyond the scope of this study. No independent reliability checks for data collection reported-limitation of study. A link between problems in the first 24 hours and poor outcomes was described, also evidence that certain operations were associated with a higher incidence of post operative complications. The impact of medical history or severity of illness on the incidence of post operative complications was not examined in depth (but patient data included age and ASA grade - a physical status scale which prospectively describes risk of anaesthesia and surgery depending on underlying systemic disease). Argues for provision of more high dependency facilities in high risk cases. Core paper.

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<tr>
<td>26</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Analysis of factors affecting outcome in CPR and development of patient survival prediction tool.</td>
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**Method**
Prospective cohort study in one US hospital. Patients suffering CPR were identified and medical records reviewed. A Pre-Arrest Morbidity (PAM) Index identified 15 variables with values assigned based on research and clinical judgement.

**Results**
77 (55%) successfully resuscitated, 34 (24.3%) discharged alive, 29 (20.7%) survived>3 months post discharge. Pre-arrest factors -hypotension (p<.001), azotemia or GUN> 17.9 mmol/L (p<.003), age>65 years (p<.001) were significantly correlated with mortality but none of these independently predicted fatality. Factors relating to during resuscitation - length of resuscitation effort was inversely correlated with likelihood of successful outcome (r=−0.938,p<.001). Factors related to post resuscitation period- New cases of azotemia, continuing hypotension, persistent coma or confusion and further cardiopulmonary arrest correlated with failure to survive post successful resuscitation, but none were independently predictive of mortality. PAM scores of 7 and above significantly associated with in-hospital mortality.

140 consecutive hospital patients in non specialised areas who experienced cardiopulmonary arrest and received CPR in a 6 month period. Sample comprised 91 male and 49 females aged 18-92 years. Main diagnoses were ischaemic heart disease and other cardiovascular conditions.

**Conclusion, comments**
Level 4 evidence. Defined cardiopulmonary arrest with resuscitation as acute circulatory failure in which cardiac compression and artificial ventilation given. Consecutive patients but reported possible selection bias in sample as excluded patients with poor prognosis (DNR status, advanced malignancy, cerebral damage, end-stage heart disease). Did not report reliability checks for data derived from review of notes. PAM index weighted variables based "partly" on characteristics identified in multivariate study by Bedell et al (1983). Hypotension, azotemia, malignancy, pneumonia, homebound lifestyle point values were tripled in the PAM index. Through the PAM Index this study quantitatively assessed pre-arrest morbidity factors (earlier studies reported trends in data, rather than precisely measuring this). Generalisability limited as study conducted in one hospital, but authors suggest PAM Index may usefully augment clinical judgements about patients who may not survive in the long term. Core paper.

Method summary
- Analysis of intensive care database - 24 ICUs in North Thames Region, UK.
- Analysis of intensive care database - 24 ICUs in North Thames Region, UK.

Results
Hospital mortality rate overall -32.5% (4,151 patients), but varied between ICUs. Survivors were younger than non survivors, average age 54 compared to 63 years (P<.01). Patients admitted from wards- higher mortality rates than those from theatre, recovery or accident and emergency - 52.9%, 22.3% and 30.2% respectively. APACHE II under predicted mortality. 1,123 (27.1%) ICU deaths occurred after discharge from ICU. 50% of patients with postoperative insufficiency died after ICU discharge- recommended further research to establish cause of death in this group. 71% of patients admitted after CPR died (50% of all deaths). Mortality rate of patients admitted after CPR with ICU stays>2 days was 63.1% compared to 35.6% for non CPR patients with >2 days in ICU.

Conclusion, comments
Level 1b evidence. Ethics Committee approval obtained. Reliability of data recording method was checked using a sample of 100 cases from one site (earlier publication). Definitions for all the fields used in the database guided classification. 71% ICU patients with cardiorespiratory arrest before ICU admission died. Patient outcomes across different ICUs varied greatly. 30.3% of all the patients who died were admitted after CPR. Underlines importance of early intervention to prevent cardio arrest as outcomes for this group are poor. Perceived shortage of ICU beds in the UK makes admission of seriously ill patients difficult. Risk of death in UK ICUs is greater than published figures for US- patients may be admitted to ICU later than in US- this also supports idea of earlier intervention before ICU admission to decrease mortality. Scope for improved provision of high dependency step-down units, to avoid hazards of early discharge to wards in patients at-risk of deterioration. Core paper.
Goldhill D R, White S A, Sumner A (1999) Physiological values and procedures in the 24h before ICU admission from the ward *Anaesthesia* 54 pp. 529-534

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<td>28</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
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**Method**
Prospective study. Examined medical, nursing and physiotherapy documentation on admission to ICU, recorded demographic, past medical history, recent surgery and admission details. Highest and lowest documented values of physiological variables in preceding 24 hours noted. Treatments recorded. 3 time periods were identified and results recorded for each. APACHE II calculated for 24 hours before and after ICU.

**Results**
Main reasons for ICU admission- problems with airway n=6, breathing n=54, circulation n=19. Medical diagnosis also listed with chest infection / pulmonary aspiration being most frequent. Chronic health recorded using APACHE II criteria. For each category; airway, breathing, circulation, CPR was required in 33%, 30%, 47% cases respectively. Changes in respiratory rate over the 3 time periods within the 24 hours was the only variable found to be statistically significant (p=0.003), but full data on all variables not available. Increases in use of CPAP were noted in the 24 hours before admission. 75% patients received oxygen from 12 hours before ICU admission. By 6 hours before admission 60% were monitored. 44 patients (55.7%) died during hospital admission. Incidence of ICU or hospital deaths and receipt of CPR revealed no statistical difference. No significant difference in APACHE II scores before and after ICU admission (p=0.055) but statistically significant increase in respiratory rate noted. Core paper.

**Conclusion, comments**
Level 4 evidence. Ethics’ committee approval obtained. Patients admitted to ICU from wards were seriously ill. Routine physiological observations on severely ill ward patients were often not available, or poorly recorded. Raised respiratory rate - the best indicator of urgent need for ICU admission, and tachycardia identified patients at risk. Level of consciousness and presence of renal failure may be important predictors of imminent deterioration. Many seriously ill patients given oxygen, had increased monitoring (pulsoximetry), but often CPR was needed. Perceived shortage of ICU beds may have contributed to delays in requesting admission to ICU (no HDU). Nurses and doctors know about most critically ill patients, but fail to take appropriate action which supports earlier findings. Limitations- small sample size and heterogeneous sample, no reliability checks reported during data collection, did not examine abnormalities in records of patients not admitted to ICU. Missing data- a problem in chart reviews.
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Method
Prospective study over 6 month period. Reported that PART similar to medical emergency team criteria (Lee et al, 1995), but differed in that it required 3 criteria to be fulfilled, or decreased consciousness and either respiratory rate 35 and over/min, or heart rate 140 /min and over (no explanation given for items and their combination in this index). Aim: To test whether physiological criteria used to summon PART useful in screening patients for ICU admission. PART protocol designed, nurses to use this in decisions to call doctor, but only in emergencies could nurses call team directly. Data collected for each PART call, and all admissions to ICU. Compared patients seen / not seen by PART<48 hours before ICU admission from wards.

Results
N=28,44% were admitted to ICU within 48 hours of assessment (32% mortality). Of the remaining 35 patients, 29% were admitted later, and 26% died in hospital. Do not resuscitate orders - 2 patients. Most frequent reasons for ICU admission were respiratory, cardiovascular, followed by neurological, gastrointestinal, and metabolic. 97% patients met one or more criteria for calling the PART. Tachypnoea, depressed level of consciousness and tachycardia occurred most frequently. Median APACHE II scores for admissions to ICU within 48 hours was 14, and 12 for non ICU cases. Of patients seen by PART before ICU admission n=1, 3.6% required CPR before admission, compared to n=21, 30.4% of those not seen (p<0.005). Mortality was n=7, 25% for patients seen by the PART, and n=31, 45% for those not seen (not significant, p=0.07).

Conclusion, comments
Level 4 evidence. Ethics' committee approval obtained. Introduction of PART supported by educational programme but majority of patients were not seen by the PART prior to ICU admission (this group - high incidence of CPR before admission, therefore should aim to prevent need for CPR). Many of those not seen by PART had similar physiological abnormalities to those seen. Many of the former were being monitored closely at ward level. APACHE II less useful for predicting individual outcomes before ICU admission. Concludes physiological criteria alone insufficient to identify critically ill patients on the wards - some ICU admissions met none of the criteria, and many just fulfilled 3 out of 6. However 89% patients admitted to ICU fulfilled one criteria for the PART- this could indicate that the requirement to satisfy a pre set number of criteria is inappropriate. Lack of high dependency facility at this site and atypical case mix (high percentage emergency, trauma, and seriously ill) could limit generalisability of findings. Description of study sample omits detailed medical history / main diagnosis on admission- useful for interpretation of results. No reported reliability checks on data collection. Complex calling procedures could limit effectiveness of PART system. Core paper.
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<tr>
<td>Development of method to measure biological severity of disease using staging criteria from 1 to 4 for medically diagnosed diseases. Hospital reimbursement is based on procedures done after the severity of illness within 14 days of discharge. Cases per hospital, of 362,181 records were &quot;staged&quot;.</td>
<td>Good</td>
<td>Quantitative</td>
<td>Analytic - discharge summaries to develop case-mix classification system. Recorded most of the diagnoses into diagnostic codes (K20 diagnostic categories) - technicians coded diagnoses / disease stage from discharge summaries initially.</td>
<td>21 medical facilities were assigned to particular stages. 362,181 patients, 21 primary staging stages. Medical facilities were assigned to particular stages. 362,181 patients, 21 primary staging stages.</td>
<td>21 medical facilities were assigned to particular stages. 362,181 patients, 21 primary staging stages.</td>
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**Results**

Referred to example of Diabetes melitus (DM) - high frequency condition, 50% rated as stage 1 as mild, 35% as stage 1 as moderate, 50% as stage 1 as severe, 35% as stage 1 as very severe, and 35% as stage 1 as extreme. There were no further complications. Epidemiologically analysis increased severity associated with increased age, emergency admissions related to the number of hospitalizations and other treatments. Inaccuracies could also have affected results, and reliance on historical data possible source of error. These data were collected at a single hospital in 1977-1978.

**Conclusions**

Level 2B evidence. Theoretical framework thoroughly described, illness severity and treatment related to outcomes. Case-Mix analysis is useful tool for clinicians, more precise classification of illness. The approach recommended for initial evaluation. The study is limited. Over the next few years, clinical treatment may require change. Future study is needed.
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<td>Method summary</td>
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<td>Sample</td>
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<tr>
<td>31</td>
<td>Qualitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Identification of patient cues used by expert critical care nurses in judgements about deterioration or recovery in selected medical intensive care patients. An exploratory study.</td>
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<td>Qualitative study- Grounded Theory Method.</td>
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<td>Qualitative study: Grounded Theory Method. In-depth interviews, lasting 1-1.5 hours, were audio taped (with participants' permission). 4 open-ended questions focused on patterns of cues in recovery or deterioration, which cues occur early, or late, and which cues can be grouped together? Nurses were asked to refer to heart failure/ post myocardial infarction, gastrointestinal bleeding, and pulmonary oedema cases only.</td>
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<td>32</td>
<td>Review</td>
<td>Good</td>
<td>exclude</td>
<td>Convenience sample of 33 expert nurses with minimum 2 years critical care experience. Drawn from a US Medical Intensive Care Unit. 32 females in sample, 50% had baccalaureate degrees, ages 24-53 years, critical care experience ranged from 3-18 years.</td>
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<td>Systematic review.</td>
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<td>Systematic review.</td>
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<td>Method included searches of major databases (including Medline, CINAHL, EMBASE, Psyclit, the Cochrane Library and SIGLE) from 1970- August 1998. Also searched 5 main journals, and conference proceedings. Additional references retrieved from reference lists. System for data extraction described.</td>
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<td>Results</td>
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<td>Results presented in sections: Measures used in critical care [the section most relevant to the current review]; assessment of outcome measures; health of critical care survivors. Current level of knowledge is “poor” and it was not clear which measures should be recommended for use. Wide variety of measures are used; current measures of impairment were judged to have limited value except in respiratory disease. The KATZ ADL and Karnofsky index were appropriate for physical functioning assessment and 2 other disease specific measures were recommended. Profile of Moods States and Hospital Anxiety and Depression scales were recommended for assessment of mental functional status. Measures of recovery were limited, but the work on Health related quality of life was more substantial. Recommended measures should be rigorously examined as a matter of urgency.</td>
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<td>Conclusion</td>
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<td>Level 2a evidence. Quality rating, good. Background literature - focused on outcomes of critical care rather than identification of patients-at-risk of critical illness or cardiac arrest. Exclude paper.</td>
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**Method**

Review paper (selective review of literature, appraisal of current practices). Review paper (selective review of literature, appraisal of current practices). Presents possible outcome indicators for acute hospital care. Potentially unexpected deaths (deaths minus all not for resuscitation (NFR); potentially unexpected cardiorespiratory arrests (minus all NFR); unanticipated intensive care admissions (minus all elective or expected admissions from theatre, recovery, emergency department).

**Results**

Deals with problem of how to identify patients at risk of preventable deaths in hospitals. Retrospective reviews of cases by experts is one way, another approach uses an MET system hospital-wide, with calling criteria to respond to the seriously ill. Latter could identify seriously ill patients and use this data to measure effectiveness of the response (Outcome indicator). The number of adverse events (where treatment was delayed, abnormalities not acted on) should decrease when such a system is implemented. Emphasised critical role of junior doctors and nurses in monitoring and evaluating acute care as well as commitment of senior clinical staff to outcome driven culture in hospitals.

**Conclusion, comments**

Level 5 evidence review paper. Not a systematic review, a position paper. Early stages of developing outcome indicators for evaluating clinical care. Through quality of care evaluation can identify weaknesses, areas for improvement. Use of criteria and MET provides opportunity for “real time incident monitoring” to monitor system and solve clinical problems. An important way to achieve improved patient outcomes. Relatively cheap compared to expensive technology and medicines. Quality grading of review paper not systematic review, but important position paper reflecting current research evidence and contemporary practice. Background paper as does not directly address cues.

### Method
- Prospective study.

### Results
Total MET responses - medical patients 71%, surgical 21%, paediatric 5%. 5 calls for psychiatric and obstetric patients. Cardiorespiratory arrest - 70 (24%), threatened airway -35 (12%), seizures -24 (8%), and respiratory arrest in 15(5%). 166(60%) of calls arose from evidence of abnormal physiological variables, in 135 (49%) these alone accounted for alerting the team. The worried category- 22(7%) calls (included 9 cases of dyspnoea), and other signs evident.

### Conclusion, comments
- Level 4 evidence. Extension of cardiac arrest team to medical emergencies. Ethics' committee approved need for informed consent waived. Identification of high risk patients, main alerting signs (cited earlier research for source of signs) - decreased level of consciousness, hypotension, and dyspnoea. Respiratory rate<5 and >36, and pulse rate<40 and >140 were also important signs. Nursing staff were asked to use the MET criteria to summon the team and any one criteria sufficient justification to call team. Important signs identified when worried about criteria used- dyspnoea, chest pain, nausea/vomiting, active bleeding, unstable blood sugars, accidental ventilator disconnection. 264 (90%) of cases required therapeutic interventions. 31 (70%) deaths after MET intervention were due to cardiorespiratory arrest. 33 were transferred to critical care of whom 90% survived the first 24 hours and 60% of the critical care admissions survived to discharge. Incidence of cardiorespiratory arrest was highly significant in overall mortality rates at discharge, 84% compared to 27% in other medical emergencies ($\chi^2= 51.24, P<0.01$). Does not quantify how many hospital patients met the MET criteria but team were not summoned, how many of these had problems treated successfully/ unsuccessfully. Reliability checks for data collection-none reported. Limited generalisability as details of case-mix not given and few other units have exactly the same system in place. Did not examine effect of access to MET on cardiac arrest rates and patient outcome (plans for such a study reported). Core paper.
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<td>Sample</td>
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<tr>
<td></td>
<td>Prospective cohort study.</td>
<td>Quantitative</td>
<td>Good</td>
<td>core</td>
</tr>
<tr>
<td>35</td>
<td><a href="#">Method</a></td>
<td></td>
<td></td>
<td>Risk factors present on admission predictive of physiological problems leading to critical illness in patients with gastrointestinal (GI) haemorrhage.</td>
</tr>
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</table>

### Results
- Statistical analysis- risk ratios calculated and multiple regression model developed- to identify variables which independently predicted meeting ICU admission criteria. ROC curves assessed predictive capacity of combined predictors. Best model from this study was compared with criteria identified in BLEED tool. 4% (n=8) of total, died in hospital. 34 patients met ICU admission criteria and 29 of these were actually admitted. A further 18% (n=36) didn't meet ICU admission criteria but were admitted. Patients who met ICU admission criteria were more ill on admission. Multiple regression of variables within 2 hours of hospital admission identified raised PT INR (>1.2), hypotension (systolic pressure<90mmHg), new neurologic problems, and APACHE II scores greater than or equal to 15 were associated with meeting ICU admission criteria in the future. ROC area for this study model = 0.86, compared to BLEED criteria ROC area = 0.83.

### Conclusion, comments
- Level 1b evidence. Low mortality in study ruled out analysis of mortality prediction.
- Generalisability limited- would only apply to institutions with similar ICU admission criteria.
- Access to ICU beds affected by availability of beds locally. Does not address question of whether ICU admission actually improves outcomes in GI Haemorrhage (clinicians assume greater physiological derangements more likely to benefit from ICU care). 4 variables identified in this study: simple/usable triage tool. Sensitivity (88%in this study), minimising risk of not admitting patient who needs ICU admission; and specificity (74%in this study), minimising unnecessary admissions. Results in this study similar to current clinical judgements. Core paper.


**Clinical Intensive Care** 8 (2) pp 106

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<tr>
<td>36</td>
<td>Prospective study.</td>
<td>Quantitative</td>
<td>Insufficient information for quality rating</td>
<td>exclude</td>
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<tr>
<td></td>
<td><a href="#">Method</a></td>
<td></td>
<td></td>
<td>The care of acutely ill patients before admission to ICU.</td>
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</table>

### Results
- Respiratory rate > 36/min was the most frequent and earliest criterion met. Oxygen saturation of < 90% was the most common reason for ICU referral. There was delay in referring patients with abnormal signs (52% were referred within 4 hours of first abnormal physiology, and 60% within 4 hours of the last abnormal physiology variable). 41% ICU mortality reported for patients meeting 1, 2 or 3 MET criteria present.

### Conclusion, comments
- Implementation of MET may increase awareness of abnormal physiological indicators which require early intervention leading to possible reduction in morbidity and mortality in high risk patients. Conference abstract therefore report is brief. No report of reliability checks for data collection in chart review. Focused on patients admitted to ICU, excluded patients who met MET criteria but remained on the wards. Quality rating- insufficient evidence to assess study quality. Exclude paper.
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<tr>
<td>37</td>
<td>Quantitative</td>
<td>n/a - incomplete</td>
<td>core</td>
<td>Identification of general ward patients developing critical illness. <em>Duplicate entry- see 87</em></td>
</tr>
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</table>

**Method**

Retrospective and prospective analysis. Score devised using routine physiological measures (heart rate, blood pressure, respiratory rate, temperature, conscious level)- criteria selected using clinical judgement. Retrospective and prospective analysis of ICU patients used to specify trigger threshold score of 3. Scoring system developed based on observations routinely recorded at ward level and review of ICU patients’ records (number ICU patients in score development sample not reported). Score tested on 100 surgical patients to assess sensitivity. Then score was introduced for everyday practice.

**Results**

Patients could score maximum of 3 points for derangements in heart rate, blood pressure, respiratory rate, temperature, central nervous system status respectively. An overall score of 3 was given as the trigger threshold for patient referrals for more experienced intervention. The authors reported that the early identification of patients had enabled earlier transfers to ICU and High Dependency Units. System applied to 100 surgical patients to check sensitivity/ over sensitivity. Results not reported in this abstract, but concluded that system suitable for introduction, and that score of 3 or more was an appropriate trigger score leading to earlier referrals to HDU and ICU.

**Conclusion, comments**

Level of evidence- insufficient data. Physiological score that has subsequently been used in many centres across the UK, often in a modified form- evidence of effect on patient outcome not reported in detail here. Include in review as frequently cited in later papers. Quality- poor/ insufficient data to rate quality. Conference abstract- research methodology reported in minimal detail. (Unable to retrieve any more detailed publications on this study at this stage). Method used in score development is not reported in depth. It is not clear if the score validated on a surgical sample is being used across the general ward patient population. Evidence to support earlier referral of patients to HDU and ICU not reported in the abstract. Sensitivity and specificity of score not reported in detail. Core paper.

**Method**

Prospective cohort study.

**Results**

85 deaths (17.5%) of 487 study patients (mortality rates similar in the two hospitals). 309 had negative SA scores, but 21 (7%) of these died. Of the remaining 178 patients (score of 1 or more on the SA) 64 (36%) died ($x^2=64.6$, 1df, $P<0.001$). The Positive SA predicted 3/4 of deaths.

Laparotomy carried a higher number of fatalities and when this was associated with SA positive the mortality was 57% compared to laparotomy and negative SA of 15% ($x^2=33.6$, 1df, $P<0.001$).

**Subject**

Sample of 487 (from total of 498) consecutive surgical emergency admissions aged >65 years, during 10 months, in 2 UK hospitals. Excluded acute urological emergencies.

**Conclusion, comments**

Level 4 evidence. The SA score was a modification of an earlier score used in peptic ulcer patients but added an item on patient independence. Severe chronic disease and compromised immune state were defined according to Knaus et al but the clinician’s assessment of patients’ independence and capacity for self-care was not defined in detail. Formal reliability checks on data collected were not undertaken- study relies on the accuracy of the researcher’s interpretation. The SA score and APACHE II score were not available to clinicians until after the end of the study so that patient management was not affected by these. The Sickness Assessment identified high-risk patients. Positive SA scores should prompt referral of patients to more senior colleagues to plan treatment (suggests this could minimise inappropriate surgery in terminally ill and moribund patients). Hypotension on admission was a strong predictor of mortality- specificity of 77% and sensitivity of 61% (23 out of 38 patients who died and had a positive SA on admission had hypotension on admission. Higher APACHE II scores were associated with increased mortality but sensitivity decreased as specificity increased. The APACHE II score despite being more complex was not more accurate than the SA in this study. Core paper.
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<td>Sample</td>
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**Method**

Prospective cohort study of non-ICU and ICU patients in 5 hospitals. The SUPPORT model included the variables of diagnosis, age, number of days in hospital before study entry, presence of cancer, neurologic function, and 11 physiologic measures all recorded at day 3 and 180 days after study entry. At day 3, physicians also gave their predictions.

**Results**

Statistical analysis of the area under the receiver-operating characteristics (ROC) curve for predicting survival at 180 days was 0.79 in phase I, 0.78 in an independent phase II validation, and 0.78 when the APACHE III replaced the SUPPORT model. When the SUPPORT model was combined with the physicians' judgements the predictive accuracy improved to ROC 0.82. The physiology score calculated on day 3 was the most significant single predictive value in the SUPPORT model and the Glasgow coma scale was the most predictive risk factor for death with a non-linear relationship which was reflected in revised versions of the scale. When the SUPPORT model was compared with APACHE III both performed well, but the former was better in certain chronic conditions as demonstrated by an increased area under the ROC curve.

The Support Prognostic Model study focused on the development and validation of a model for estimating survival in seriously ill hospitalised patients. Predictions from this model were then compared with an established prognostic system and physicians’ independent estimates (SUPPORT phase II).

4301 hospitalised adults with diagnoses associated with 50% mortality at 180 days in phase I; 4028 phase II. Full details of case selection criteria specified in appendix.

**Conclusion, comments**

Level 1b evidence. The objective clinical information used in the SUPPORT model gave as accurate predictions for long term survival as the physicians, and when both were combined the results were even more accurate. Phase I data collection procedures had ongoing reliability checks performed reported as 87% and 82 % for physiological data and morbidities respectively. The physiology score on day 3 was the strongest prognostic factor in the SUPPORT model. The Glasgow coma score was the single most important factor for predicting death. The SUPPORT model performed consistently across the 5 sites and had good calibration in phase II. Prognostic estimates likely to be used more in future treatment decisions and objective estimates may complement physicians judgements. Limitations- model developed from patients in just 5 hospitals who met pre-set criteria. Further testing is required in other locations with other patients. Data collected on day 3 is a further limitation -estimates over time may be more accurate. Acknowledged physicians expertise/accuracy in predictions, and how SUPPORT complements this. Quality rating, good. Core paper.
*Crit Care Med* 25 (7) pp. 1125-1132

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<th>Number</th>
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<tr>
<td>40</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>Sample</td>
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**Method**

Prospective study. Patients admitted to ICU or ward based on Emergency Physician's clinical judgement. Study also categorised as high or low risk using BLEED tool using only information available to emergency physician on admission - 1 hospital did this prospectively, the other retrospectively. Clinical and demographic information also recorded. ICU care was costed.

**Results**

Patients classified as high-risk if any of the following present: ongoing bleeding, low systolic BP(<100mmHg), raised prothrombin time, erratic mental status, unstable comorbid disease. Statistical analysis - significance tests were two-tailed, Student's t-test or Wilcoxon rank-sum for continuous variables, x2 or Fisher's exact test for categorical variables. Logistic regression analysis examined which BLEED criteria were related to prediction of outcome (occurrence of in-hospital complication). Multiple regression analysis examined relationship between ICU admission and hospital location. ROC Curves examined discrimination of the logistic regression model for whole study population. High risk patients at both hospitals significantly greater risks of in-hospital complications compared to low risk patients (both sites, p<0.001). Organ system failure, blood transfusion therapy, longer hospital stays - significantly higher in the high risk group at both sites (p<0.006), compared to low-risk group. BLEED prognostic model calibration good - actual complication rates fell within predicted ranges. Logistic regression model - good discrimination area under ROC = 0.72.

**Conclusion, comments**

Level 2b evidence. Disease specific prediction model for GI haemorrhage on admission to hospital which included both upper and lower sources of haemorrhage without need for information from invasive procedures (endoscopy). Earlier study identified criteria for inclusion in tool by review of the literature and clinical experience, followed by multivariate analysis to derive a final model. The current study represented the independent validation of the final model as a prognostic tool. Defined upper and lower GI haemorrhage using diagnostic procedures or clinical criteria, also specified definition of all items in BLEED tool. Tool could help selection of patients for ICU hospital wards or intermediate care. Limitations- possible differences between the two hospitals - ICU admission for high and low risk patients occurred more often in one of the hospitals. Sample size acknowledged as limitation- further studies planned. Retrospective chart review relies on accuracy of initial recordings. Some definitions rely on subjective assessments rather than objective measures such as *active conditions, change in mental status*. Core paper.

### Method
Development and validation of SAPS II Model

Development (65%) and validation (35%) samples were identified. Outcome measure – status at hospital discharge. Logistic regression analysis used in selection of variables, refining details of points for variables, and translating the SAPS II score into probability of hospital mortality score. The original SAPS had been developed using subjective judgements from an expert panel. Current score – precise definitions for all criteria were given.

### Results
Goodness of fit tests (Hosmer-Lemeshow, expected mortality compared to observed mortality) showed that the model performed well in the development and validation samples (P = 0.883 and p = 0.104 for each). The area under the ROC was 0.88 and 0.86 in the developmental and validation samples respectively.

### Conclusion, comments
Development and validation of new simplified acute physiology score using a large sample to produce a probability of hospital mortality. SAPS II, 17 variables: 12 relate to physiology, age, type of admission (planned surgical, emergency surgical, and medical), and 3 disease items (acquired immunodeficiency syndrome, metastatic cancer, and haematologic malignancy).

Medical and surgical ICU patients (consecutive admissions to 137 units in 12 countries). Each patient followed up for 2 months. 13152 patients randomly divided into development and validation samples (this analysis excluded age<18 years, burns, cardiac surgery, coronary care patients).


### Method
Prospective study. Data collected – standardised form and APACHE II score calculated retrospectively for time just before MET Call.

### Results
MET calling criteria abnormal physiology – temperature <35.5°C or >39.5°C, systolic BP <90 mmHg, >200 mHg, resps/min <10 or >30, pulse rate/min <40 or >120, 24 hour urine output <500 ml, decreased or altered LOC. Abnormal pathology – serum potassium <3 or >6 mmol/l, serum sodium <125 or >155 mmol/l, blood sugar <2 or >20 mmol/l, arterial pH <7.2 or >7.55, blood loss <15 or >10. Specific conditions – cardiac arrest, respiratory arrest, pulmonary oedema, new arrhythmia, acute asthma, acute respiratory failure, upper airway obstruction, all types of shock, metabolic emergencies, poisoning, trauma, obstetric emergencies, neurological and surgical emergencies.

Median APACHE II score immediately prior to MET call was 18. Cardiopulmonary arrest accounted for 148/522 (28%) calls. Specific condition criteria prompted calls in 253/522 (48%) cases, physiological/pathological abnormalities in 121/522 (23%) cases. Acute respiratory failure and status epilepticus were the most frequent conditions for calling the MET. Decreased level of consciousness, abnormal BP were main alerting signs.

### Conclusion, comments
Level 4 evidence. Excluding cardiac arrest, hypotension was found in 101/374 (27%) patients, and hypertension in 20/374 (5%) on MET examination. 130/374 (30%) patients had tachycardia and 30 (8%) had bradycardia but abnormal pulse rates were only used to call the MET in 12 cases. Abnormal respiratory rates were used to call the MET in 14 cases, but 21/374 (6%) were found to be bradypnoeic and 73/374 (20%) were tachypnoeic. There were 36/522 *inappropriate* calls (eg. terminal illness, not for resuscitation, no acute problem). Cardiopulmonary arrest correlated highly with in-hospital mortality (only 29% survived to discharge compared to 76% in other acute illnesses). No reliability checks reported for data collection. Conducted in one site where MET in place already. Severity of illness measured using APACHE II score calculated for period immediately preceding MET call. Normally APACHE II is calculated after 24 hours in ICU. APACHE II prediction of mortalities were not calculated as treatment was already being given and score not validated in such circumstances. Core paper.
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<tr>
<td>43</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
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A "matched nested" case-control study. A matched nested case-control study in 470 bed Australian hospital. Used information collected in audit-patient demographics, past medical history, earlier anaesthetic complications, anaesthetic information, surgery type, and complications either intra-operative or post-operative. Recorded details of patients and treatment received during any MET intervention. Severity of illness in ICU and HDU patients - APACHE III used.

Results

Defined early postoperative emergency as any unexpected, unwanted event occurring within 48 hours after surgery where acute assessment and/or intervention by ICU team needed. High incidence of emergencies outside normal working hours (26 cases). Occurrence -median 15 hours postoperative, 27 cases within first 24 hours. Location of emergencies - majority on general wards (31 cases). 2 cardiac arrests, 3 respiratory arrests treated. 27 cases needed interventions. 6 patients transferred to ICU / HDU after intervention. 2 died immediately, 6 died before discharge (2 of these were treated twice). Univariate analysis: Significant associations between early post operative emergency and time and day of surgery. Differences between 34 cases and controls were non-significant for planned ICU/HDU care. 4 of the 34 cases had "ina-operative events" (low blood pressure, laryngospasm, failed local anaesthetic), compared to 12 of the 126 controls. Complications in recovery were similar for study cases (6/30) and controls(2/105) [X2MHT (Mantel-Haenszel test)=0.03, p=0.88]. Multivariate analysis: Significant risk factors- high ASA status and surgery outside normal hours [p=0.02 and p=0.01 respectively].

Conclusion, comments

Level 4 evidence. Hospital ethics committee waived need for formal ethics' approval for study (audit of care). Main reasons for calling MET were hypotension (<90mmHg systolic blood pressure), and decreased level of consciousness. Type of surgery and priority (emergency or planned) were matched in cases and controls at time of design. Complexity of surgery was controlled at data analysis stage. This strengthened the study design as patient and anaesthetic related factors could be examined closely. Did not assess if any out of hours surgery could have been delayed to normal hours. Postoperative care team visits within 24 hours of surgery should be considered for high-risk patients. ASA physical status not designed as index for operative risk but it predicts postoperative outcome. Incidence of early postoperative emergencies may have been underestimated- calling criteria for MET not always used by nurses. Limitation- small number of cases (34) experienced early postoperative emergencies (i.e. MET called) out of total 15,105 patients and many different types of surgery were represented in the total. It is not known if other patients fell within the MET criteria but the MET was not called- possible underuse of MET. No reported reliability checks for data collection, also data accuracy depends on accuracy of initial recordings in patients' notes. Core paper.

| 15105 patients anaesthetised in study period of 17 months. 34 cases and 126 controls studied. 34 cases (32 patients) had early postoperative emergency 0.21% (95% CI: 0.14-0.30%. Mean SD age of cases 59 (18) years, majority were male (21 cases). ASA physical status: ASA I (9); ASA II (6); ASA III (8); ASA IV (8); ASA V(2); (1 case not ASA rated). Types of surgery: general (17), orthopaedic (6), vascular (6), other (9). 22 "emergency" operations. |

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<th>Method summary</th>
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<tr>
<td>44</td>
<td>Quantitative</td>
<td>Prospective cohort design.</td>
<td>Reasonable</td>
<td>exclude</td>
<td>Development and validation of patient self-report index to measure changes in maximal physical, mental, emotional function - medical and surgical patients.</td>
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Method
Prospective design consisting of a reliability study and a subsequent validation study of a new Functional Status Index. Patients' self-rated their condition in interview at baseline and at 1, 2, 4, and 6 weeks in the two studies.

Results
Study 1 Patients in the baseline assessment reported agreement on responses to questions about physical and mental activities given to two separate interviewers (k = 0.76, p < 0.001), and on the emotion section results for the two interviewers demonstrated agreement (k = 0.5, p < 0.001). The transition index was administered and reliability of patients' responses where checked against the baseline activity - high reliability recorded, 86% for physical transitions and 85% for transitions in mental activity. Data analysis for functional status questionnaire data - analysis of variance for categorical data. Study 2 The Sickness Impact Profile score for the total group (medical and surgical) at 1, 2, 4 and 6 weeks compared to baseline assessments found no significant differences in total scores (F = 0.7, df = 4, p > 0.05) and no differences in the subscales over time. In serial assessments, when the Sickness Impact profile was compared with the study index self-ratings much better, slightly better, the same, slightly worse, and much worse changes identified using one method were also found using the other approach. The overall patterns of change using the two methods were highly correlated - Functional status index valid tool when compared to SIPS.

Conclusion, comments
Level 2b evidence. Novel because it measures change directly within individuals over time. Heterogeneous rather than homogenous population; therefore diagnosis and severity of illness at baseline could have affected the results. Small samples in the two studies and selection tended towards sample of convenience, authors claim some randomisation took place. Construct validity of Functional Status Index (FSI) assessed by comparing score changes with the Sickness Impact Profile score changes. The expected changes in function for surgical post operative and medical patients were compared with the actual scores obtained - supported validity of FSI. Focused on best function in patients' self-report therefore some aspects of function not covered. It was aimed to measure change in function over time, not functional effectiveness in individuals or groups. Limitation - high drop out rate in study 2. Exclude not focused on cues predicting critical illness or cardiac arrest.


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<td>45</td>
<td>Quantitative</td>
<td>Prospective study.</td>
<td>Good</td>
<td>core</td>
<td>Comparison of medical ICU and ward patients in large US hospital.</td>
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</table>

Method
Prospective study. Collected admission, demographic data, resource use, severity of illness and patient outcome. Acute Physiology (APS) and Chronic Health Evaluation (CHE) scores measured severity of illness and health status. Interventions received measured by Therapeutic Intervention Score (TISS). Outcome data hospital and ICU survival. Data collection by 2 research nurses with critical care experience.

Results
Patients had similar demographics and health status (latter using CHE of APACHE at 3-6 mths before), but differed on APACHE score and TISS with MICU patients having higher scores. 28-30% of MICU patients didn't need active therapeutic interventions, and 11% of ward sample needed medical treatment. There was overlap between MICU and ward distributions in both severity of illness and resource use in the lower scores. Hospital survival was higher for ward patients 93% compared to 74% in the total MICU sample (which included coronary care).

Conclusion, comments
Level 1b evidence. Data collection by 2 research nurses with critical care experience, reliability check on 26 patients, excellent agreement reported 0.98 correlation for APS, 0.97 correlation for TISS. Many ward patients could benefit from ICU placement, and some ICU patients had limited prospects of survival. Advocates improved methods for triage of high-risk patients for ICU placement, but due to large variation in severity of illness, and the continuous changes in conditions, this is difficult to achieve. More reliable information on the natural course of in-hospital diseases is needed. (Important implications for my study). Resource use comparison using original APACHE tool (1981). Quality rating - good. Core paper.

Method
Retrospective review (audit) - 6 month period. Patients case notes, observation charts, nursing kardex, physiotherapy notes, laboratory results all reviewed to identify abnormalities reflecting acute deterioration using pre Specified criteria for physiological and biochemical variables. Data recorded by 1 of 3 (intensive care physician, 2 experienced critical care nurses) on predetermined form within 48 hours of death or ICU admission. Care judged as sub optimal using definition:non-recognition of problem, or treatment inadequate.

Results
13 ward deaths judged potentially avoidable; 31 of the 86 ICU admissions were judged to have received sub-optimal care before admission to ICU. When these two groups were compared to well-managed patients the mortality was significantly higher; for ICU 52% vs. 35%, and for hospital mortality 65% vs. 42% (p<0.0001). Cardiac events, pneumonia/sepsis, haemorrhage and pulmonary embolus were the main causes of unexpected deaths in ward patients. Unexpected admissions to ICU - variety factors noted prior to ICU admission such as non recognition of hypotension, tachycardia, bradycardia, hypoxaemia, tachypnoea, oliguria, rising urea and creatinine, hypernatraemia, hyperkalaemia, metabolic acidosis.

Conclusion, comments
Level 4 evidence. General ward patients with clear signs of clinical deterioration often receive poor care- missed or poorly managed. Unexpected ward deaths / unplanned ICU admissions important criteria for evaluation of quality of care on general wards. Within failed resuscitation attempts evidence of deterioration before the event was found- 13 out of 20 cases judged potentially avoidable. Mortality significantly higher in patients transferred to ICU from the wards when care sub optimal. Limitations- relied on quality of notes recorded in retrospective data, possibly incomplete. No reported reliability checks in data extraction. Absence of record of therapy in charts was used to confirm problems had not been recognized-no way to check this as data collected retrospectively. Focused on how recorded abnormalities managed, other elements not studied. No external review of classification of care as sub-optimal, but only definite cases placed in this category. Speculated that recent reduced exposure of nurses and medical students to acutely ill patients in training was possible factor in poorer performance. Quality rating, reasonable. Core paper.

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<tr>
<td>47</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>Quality of care received by adult emergency patients prior to ICU admission in two UK hospitals.</td>
</tr>
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</table>

Method
Prospective study (confidential inquiry). Structured interviews / questionnaires (history, clinical findings, assessment, resuscitation, interventions, outcomes)- noted abnormalities detected, monitoring, management. Interviews of admitting clinical team and ICU team around ICU admission. Data checked by 2 external assessors. Severity of illness recorded - APACHE II worst values < 24 hours ICU admission.

Results
General medical patients constituted 51/100, general surgical 28/100, orthopaedic 8/100, urology 3/100, neurosurgery 2/100, ophthalmology 2/100, and ENT, haematology, thoracic surgery accounted for 1/100 each. The two centres- similar age, sex, inappropriate admissions, late admissions, sub-optimal care and case mix profiles. Severity of illness greater in the Portsmouth centre (APACHE II 21.6 compared to 16, P=0.03 at Southampton). 20 patients (group 1) judged to be well-managed, 54 patients (group 2) had sub-optimal care. Agreement was not reached on a further 26 patients (group 3). APACHE II scores assessed case mix, and severity of illness as comparable across the 3 groups and the two centres. More non-survivors received sub-optimal care prior to ICU admission (26/37, 70%) contrasting with survivors (28/63, 44%) (P=0.04). Improved management of airway, breathing and circulation could have reduced numbers of ICU admissions. 69% of cases in group 2 were judged late admissions to ICU.

Conclusion, comments
Level 4 evidence. Causes of sub-optimal care: organisation failures, knowledge deficits, failure to identify urgent cases, inexperience, inadequate supervision, failure to ask for advice. Quality of care before admission to ICU may affect patient outcomes- something which clinicians could improve when other variables such as severity of illness, and age cannot be manipulated. Provides list of ways to improve quality of care before ICU admission: Greater emphasis of the problem; organisation and structural changes; clinical process; guidelines and audit. Failure of clinicians to recognise that airway, breathing and circulation, the fundamental processes necessary for life, was a major problem. Suggests possible role for medical emergency teams in earlier intervention with severely ill patients before ICU admission. Limitation- sample size (100) and no power analysis conducted to estimate sample size required. Validity checks were undertaken - questionnaire data sent to two external intensive care specialists. The assessors were in moderate agreement- k values 0.42 to 0.53 were reported for assessments of late admissions, appropriateness, sub-optimal care and for classification of patients as receiving excellent, good, adequate or inadequate care. However there were 26 patients where the assessors disagreed on the quality of care given. Scope for using more assessors or having training and feedback to attempt to reach higher level of agreement. Core paper.

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<tr>
<td>48</td>
<td>Qualitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Exploration of processes used by critical care nurses in the early recognition of patient problems.</td>
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</table>

Method
Qualitative study using hermeneutics, interpretive research method. 30 interviews, and 8 of the 30 participants were re-interviewed for additional clarification and expansion on first interview. 2 participants reviewed researcher's interpretations. Participants informed consent was obtained and interviews lasting 20-90 minutes were tape-recorded. Nurses asked to describe their experiences of early recognition of patient problems.

Results
Data analysis - The Ethnograph computer programme used. Stories remained complete as context considered important. Participants' terms were used to code material where possible. All interviews were coded and categorised, themes were identified. 2 key participants confirmed researcher's analysis. In all cases caring came into early recognition of problems and the theme perception of early recognition engendered through caring was identified. Making the connection, recognising the problem, and missing the connection, delay in recognition themes were illustrated by exemplars. Caring about patients reported to be closely related to use of perceptual skills to recognise early warning signs. Nurses rely on subjective assessments, subjective signs or intuition when there are no available objective signs to guide care. Participants also referred to their advocacy role in client care. Combining multiple cues also reported ( cues on their own often not significant but when combined with other information considered more important).

Conclusion, comments
Level - qualitative evidence. Early recognition conceptualised as part of clinical decision making. Limitations of study- results not generalisable as small sample size, sample of convenience, process of recruiting participants not documented, participants from one geographical location, relied on self-report data. Theoretical links limited as concept of care, and caring not analysed in depth. Swanson’s response to this report (which followed the paper) provides a more detailed examination of caring. Research procedures not reported in depth, links between the study and theory were partially described. The first interviews reportedly focused on one question, questions posed in the 8 repeat interviews were not reported. Highlighted importance of nurses' caring stance; assessment comprised of more than observation and knowledge of disease states, some evidence to support this position provided. Criteria for quality assessment partially met. Core paper.
Pompei P, Charlson M E, Ales K et al (1991) Relating patient characteristics at the time of admission to outcomes of hospitalization J Clin Epidemiology 44 (10) pp. 1063-1069

Method
Prospective cohort study. Physicians assessed illness severity or how sick the patient was at the time on a 9 point scale with not ill, mildly ill, moderately ill, severely ill and moribund on the odd points of the scale, and they were asked to rate patients’ function and stability < 24 hours after admission. Comorbidity rated retrospectively using Kaplan and Feinstein (1974) co-morbidity scale; medical conditions graded by severity. Outcomes: in-hospital mortality, morbidity, length of stay, costs, 1 year mortality.

Results
In-hospital mortality and morbidity doubled across the 4 levels of estimated severity of illness (p<0.001). Length of stay increased as severity increased (p<0.001) with the exception of the moribund group. Stepwise linear regression was used to assess which variables were most predictive of in-hospital morbidity and mortality. Severity of illness and functional status were identified as strong predictors, whereas comorbidity was less significant. Physicians’ judgements of severity of illness were strongly correlated with APACHE II scores (r=0.57, p<0.001). Illness severity was important in the prediction of short-term outcomes, but not for long-term outcomes. Comorbidity - less predictive in the short-term, but a better predictor of outcomes at 1 year. Stability estimates predicted morbidity (p<0.001).

Conclusion, comments
Level 4 evidence. Resident physicians made accurate short term predictions about their patients from information within first 24 hours. Function and stability were important in predictions. Acknowledged measurement tools for patient characteristics were not fully examined for validity and reliability. Functional ability at discharge was estimated by physicians and recorded on a 9 point scale with descriptors ranging from fully functional through to not at all. Patients were classified as having excellent to good function or fair to poor depending on the point recorded on the scale. Function was not defined (this could mean mental function, physical function or both). Stability assessed using 9 point scale with descriptions on the odd-points ranging from can take extreme stress, through to trouble without stress and patients who could tolerate extreme and most stress were classified as stable, and the others as unstable. The relationship between the ability to withstand stress and stability of the condition could be construed differently by the respondents and could affect the validity of this rating. This research did not investigate the cues used in the physicians’ judgements in detail, rather it focused on the judgements. Investigation of construct validity of the physicians’ illness severity assessments was possible for patients admitted to ICU as they could be compared with APACHE scores- physicians’ estimates and APACHE scores were highly correlated and significant. Include- core paper.
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<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
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<tbody>
<tr>
<td>50</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Inhospital cardiac arrest - antecedents to cardiac arrest and nursing response.</td>
</tr>
</tbody>
</table>

**Method**
Retrospective, descriptive study.

Retrospective, descriptive study of medical records of patients after cardiac arrest. Investigates: presence of changes in physiological status >8hrs before arrest, effect of nurses' notification times to physicians on outcome of resuscitation, how physiological variables, arrest location, presence of ECG monitoring affect prediction of outcome of resuscitation. 8 preselected variables / complaints measured (Franklin and Mathew, 1994).

**Results**
Frequencies of variables recorded. Logistic regression - physician notification time plotted against resuscitation outcome (no statistically significant effect on outcome), and for the 8 physiologic variables against resuscitation outcome, changes in blood pressure and presence of ECG monitor were predictive of outcome (p=0.05, and p=0.004 respectively). Data collection tool pilot-tested on 12 sets of patients’ records by author and 2 other clinical nurse specialists-reported excellent interrater reliability. An expert critical care nurse assessed that the data collection tool was adequate for the research purposes: face validity. Of 33 successful resuscitations, only 11 survived to discharge. Mean physician notification time 21.4 minutes. 60/100 charts had minimum of 1 physiologic change. In 37 of the 60 cases the registered nurse notified the physician (already present in 3 further cases). Changes in systolic blood pressure (mainly decreases in BP), abnormal laboratory test results (mainly raised potassium) were recorded most frequently.

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<th>Type of study</th>
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<tbody>
<tr>
<td>51</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Investigated relationship between depressed mood, and survival in seriously ill hospitalised adults. Relationship between physical functioning, severity of illness, depressed mood, mortality in high mortality population not previously studied.</td>
</tr>
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</table>

**Method**
Prospective cohort study.

Prospective cohort study. Patients completed a depressed mood assessment 7-11 days after enrolment to study. The Profile of Mood States depression sub scale was used. Used data collected for SUPPORT project - patients were followed up for 6 months after enrolment to study.

**Results**
Commonest diseases - acute respiratory failure, congestive heart failure, chronic obstructive airways disease, lung cancer. Median APS at day 3 was 29.0. Median comorbid illnesses was 2.0, number of disabilities median 0.5. 42% of study patients died within 4.5 years of entering study. Median POMS depressed mood score was 0.37 on scale of 0 to 4. Increase in depressed mood was associated with poorer physical functioning (r=0.151; P<0.001) and severity of illness. Stratified Cox proportional hazards model assessed independent effect of depressed mood on survival time after adjustment for demographic characteristics and health status. After adjusting for demographics and health status depressed mood was associated with reduced survival time (hazards ratio, 1.134;95% confidence interval, 1.071-1.200; P < or equal to .001).

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<th>Type of study</th>
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<tbody>
<tr>
<td>52</td>
<td>Quantitative</td>
<td>Good</td>
<td>exclude</td>
<td>ICU and emergency department (ED) doctors' predictions (of patient outcome for ICU patients admitted from ED) with the admission Mortality Probability Model (MPM).</td>
</tr>
</tbody>
</table>

Method
Prospective observational survey.

Prospective observational survey of all adult non trauma cases admitted to ICU from ED. Compared doctors in ED, and critical care fellows (minimum 3 months critical care experience), and where admission to ICU recommended patient was also independently evaluated by critical care physicians for likelihood to survive to discharge and likelihood of favourable functional outcome at discharge.

Results
Hospital mortality rate was 23% (53). Only one of the 55 deaths was in the group predicted to have a <2% chance of survival by the admission Mortality Probability model (sensitivity 25%) - too insensitive for use as a triage tool. The ED doctors identified 13 of the 55 non survivors compared to ICU doctors who predicted 15 of the 55 non survivors (sensitivities of 24% and 27% for each). False positives were found (3 in the ED doctors and 2 in the ICU doctors, or 81 and 88% positive predictive values). The sensitivity, specificity, and positive predictive value for combined survival and positive functional outcome predictions were calculated. The ED and ICU groups of doctors had sensitivity ratings of 37% and 35% for the <2% cut off value which liked with specificity of 99% and positive predictive value of 96% in both cases. Thus combined subjective assessments of likely function and survival provided the most encouragement for triage away from ICU.

Conclusion, comments
Level 1b evidence. Ethics approval obtained. Advantage of The MPM - it is applicable to patients before admission to ICU- the other scoring systems require patients to have been in ICU for a particular time. Functional outcome defined as ability to do 2 of the following; feed oneself with minimal assistance, walk independently with a walker or minimal assistance, and maintain urinary continence. Discusses difficulty of defining what is "futile" care prospectively-this limits possibility of triaging hopelessly ill patients away from ICU. Advocates further larger studies combining physicians predictions and the MPM model. Quality rating, good. Exclude paper as focuses on ED rather than wards.

Rogers J and Fuller H D (1994) Use of daily acute physiology and chronic health evaluation (APACHE) II scores to predict individual patient survival rate Crit Care Med 22 (9) pp. 1402-1405

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<th>Type of study</th>
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<th>Sample</th>
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<tr>
<td>53</td>
<td>Quantitative</td>
<td>Good</td>
<td>exclude</td>
<td>96% or 236 patients out of the total sample of 253 adult non trauma cases for one year were included in results. Patient demographic data published in table form.</td>
</tr>
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</table>

Method
Prospective study. Calculated daily APACHE II scores for all patients and compared these with ICU and hospital mortality.

Results
APACHE II scores ranged from 0-55 (mean 18). Attempted to replicate Chang et al. (1988)'s findings that hospital mortality could be predicted in 100% of cases using an algorithm based on daily APACHE II scores which predicted mortality for patients in any one of 3 groups (APACHE II score >35 at admission; 30-35 at admission with decrease of < or equal to 3 from day 1-day 2; or >27 on any day with increase of >2 from previous day ). This study found the Chang algorithm overestimated mortality. Increasing the positive predictive value of the criteria reduced the sensitivity so much that few patients could be identified.

Conclusion, comments
Level 1b evidence. Prediction of mortality (rather than transition scale). APACHE II useful for identifying groups of patients at high risk of mortality as higher scores are generally found in non-survivors, but within this group there may still be a number of potential survivors. APACHE II is unsuitable for predicting mortality in individuals. (As a transition scale it shows trends for groups of patients only - higher APACHE II scores indicate greater risk of mortality ). Quality rating, good (exclude as ICU patients are the focus).

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<tr>
<th>Number</th>
<th>Type of study</th>
<th>Method summary</th>
<th>Quality rating</th>
<th>category</th>
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<tbody>
<tr>
<td>54</td>
<td>Quantitative</td>
<td>Prospective evaluation study.</td>
<td>Reasonable</td>
<td>core</td>
<td>Therapeutic efficacy of critical care units for patients admitted for observation. Case-control design.</td>
</tr>
</tbody>
</table>

**Method**
Prospective evaluation study. Admitting doctor rated severity of illness, stability (using Charlson (1986b) rating scales for clinical judgments rather than scales with precise variables) and reason for admission, from which 4 prognostic groups identified. Case control design with principles of randomised controlled trial applied- useful if RCTs cannot be done for ethical reasons. Direct admission to ICU was the exposure agent or treatment, and survival was the outcome.

**Results**
14% admitted directly to critical care, 85% admitted to wards initially, 1% to telemetry. Stable not ill, 47% (n=903); stable moderately ill, 41% (n=774); 3% (n=65) unstable moderately ill; 9% (n=163) unstable, severely ill. After exclusions 88% of original cohort was included in analysis to assess efficacy of critical care admission compared to ward admission. 3 survivors (controls) were matched to each fatality. Unit care was given to 144 survivors and 184 fatalities (odds ratio calculated - no overall reduction in mortality with direct admission to critical care. The 4 prognostic groups had odds ratios calculated (ratio >1 represented protective effect of critical care admission). The unstable, moderately ill sub group was the only one to achieve odds ratio >1 (1.3). However small samples in sub groups limits power of the analysis (500 more cases needed to reach significance if Bonferroni correction used). Mortality decreased in unstable moderately ill sub group with direct critical care admission.  

**Conclusion, comments**
Level 4 evidence. Reliability and severity ratings based on judgement, not objective measures, therefore possibility of personal biases in assessments (previous study demonstrated good predictive validity for such judgements). Power of study affected by larger number of unstable moderately ill admitted directly to critical care than in previous study (possible change in admission practices as result of earlier research). Also more patients designated not for aggressive care/ critical care admission than previous study. Conducted at large teaching hospital and may not be applicable in other types of hospitals. Patients not stratified by diagnosis, larger samples would be needed. Findings support position that selective admissions to ICU may not be detrimental to outcomes. Quality reasonable. Core paper.


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<th>Method summary</th>
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<tbody>
<tr>
<td>55</td>
<td>Quantitative</td>
<td>Secondary analysis of a prospective cohort study.</td>
<td>Good</td>
<td>core</td>
<td>Prediction of intensive care unit readmission by physiological and other predictors.  Are readmissions due to failure to respond to treatment and unrelated to discharge timing, therefore unavoidable?</td>
</tr>
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</table>

**Method**
Secondary analysis of a prospective cohort study. Examined influence of changes in acute physiology scores (APS from APACHE III), and measures reflecting clinical instability or patient characteristics (including admission diagnosis, treatment e.g., active ICU treatment or monitoring, admission location) in prediction of readmission to ICU. Trained reviewers collected data from patient records. Logistic regression analysis performed.

**Results**
Patient characteristics- descriptive analysis performed. Patient outcomes (ICU readmission, ICU or hospital mortality) were identified by admission source. Variables were analysed by chi-square statistic, Students t-test, one-way analysis of variance, and simple logistic regression as appropriate for type of variables. Multiple linear regression was used in further analysis of data. 317 (9.6%) of 3,110 alive at first ICU discharge were readmitted. Readmitted patients had significantly more hospital mortality than the rest of the study sample (43% vs. 8%; p<.0001), and longer lengths of stay. Mean APS at discharge was significantly higher in the readmitted compared to the not readmitted group (34.19 vs. 34.18; p<.01). Discharged APS >40 was a significant independent predictor of ICU readmission (odds ratio [OR] 2.1; 95% confidence interval [CI] 1.6-2.7; p<.001). Admission from general medical wards and transfer to ICU from other hospitals were also significant predictors of readmission.

**Conclusion, comments**
Level 1b evidence. Need for informed consent waived. Data quality measures explicitly stated. Sampling method and how data derived, also described. Gastro intestinal bleeding, respiratory diseases and higher APS were associated with readmission- similar to other studies. Overall model discrimination moderate ( Hosmer-Lemeshow goodness-of-fit x2=3.8, df=8, p=.85 and receiver operating curve = 0.67). Physiologically based systems could be improved by inclusion of clinical instability, likely response to further treatment. By focusing on medical ICUs overcame limitations of earlier studies due to small samples, different types of ICUs, heterogeneity patients. Patient characteristics at time of first ICU discharge (discharge status) performed here, but absent in many other studies, relevant to subsequent readmission - enables comparison with control group. Organisational factors affecting discharge decisions e.g. bed census not studied. Limited generalisability to medical ICUs. Study quality, good. Core paper.

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<tbody>
<tr>
<td>56</td>
<td>Systematic review</td>
<td>Good</td>
<td>core</td>
<td>Patients readmitted to medical and surgical ICUs. Systematic review of causes, risk factors and outcomes (mortality rates).</td>
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</table>

Method: Systematic review. MEDLINE review of primary articles on ICU readmission or ICU outcomes from January 1996- June 1999, and authors of primary studies contacted. Data abstracted on methodology and design: rates, causes, predictors, outcomes, and measures of quality of care associated with ICU readmission. Search strategy was reported.

Results: Overall ICU readmission rate in North America and Europe is 7% (range 4 to 14%). ICU readmission occurred most frequently in respiratory and cardiac conditions (30 to 70%). Length of hospital stay doubled for patients readmitted to ICU compared to non-readmissions. Hospital mortality was 2 to 10 times higher for readmitted patients compared to former ICU patients not readmitted. Prediction of ICU readmission has received minimal attention in the literature. Unstable vital signs in patients at discharge from ICU frequently predicted ICU readmission. The relationship between ICU readmission and quality of care requires further exploration and use of consistent methods of reporting such data.

Conclusion, comments: Level 2a evidence. Quality assessment rating for review- good. Future research directions were indicated. Core paper.


Method: Prospective cohort study: Residents' admission assessments of severity of illness (compared with APACHE II scores), classification as stable or unstable, TISS score (correlated with stability assessments). Physicians' reviewed post discharge hospital records (blinded to residents earlier predictions).

Results: Morbid event defined as "clear deterioration in the patient's status or a complication". In-hospital morbidity-specified deterioration of pre-existing condition or new complication. Multivariate analysis- logistic regression. 4% (20/466) patients experienced a morbid event, just 15% (3) of those survived to discharge. Only 2 admission variables, unstable and acute dyspnoea, were significant predictors of arrest (p<.001; p<.005). Study did not compare incidence of raised respiratory rate as a predictor of cardiopulmonary arrest with a control group who did not arrest. For acute dyspnoea and chronic pulmonary disease, arrest occurred in 25% (4/14). Excluding acute dyspnoea, 0.9% stable patients and 11% unstable experienced arrest. Only 0.3% experienced arrest without new complications or deterioration.

Conclusion, comments: Level 4 evidence. Clinical course in hospital very important- arrest occurred after onset of new complications or deterioration of pre-existing problem. Usually there are some warning signs of deterioration before the catastrophic events. Unstable patients experienced more deterioration and comorbid disease also important. Concluded that patients unstable on admission or who become unstable (due to admitting diagnosis or comorbidity) are at very high risk of arrest and require critical care for close observation. Patients admitted to critical care in this study had less deterioration than ward based patients, but lack of randomisation limits conclusions which should be made. Deterioration in non-cardiac cases seems to be less well recognised by clinicians. Study related to series of studies on similar theme. Limitations- does not list all the variables examined initially before those with univariate predictive ability were identified and included in regression analysis. There is no way to account for variables that have predictive ability in combination with other variables. No independent assessment of patients to check the validity of the resident doctors assessments. No reported reliability checks on data extracted. Core paper.

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<tbody>
<tr>
<td>58</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Identification of medical patients likely to be admitted to ICU based on doctors’ predictions compared to patient outcome (same research project as Sax et al., 1987a).</td>
</tr>
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</table>

**Method**
Prospective study and retrospective review.

**Results**
No statistical difference between demographic characteristics or comorbid diseases of patients admitted directly to critical care or the medical wards. 62% of admissions to critical care had cardiac condition, only 13% of cardiac conditions were admitted to the wards. Preference for full intervention was greater for critical care patients 95% compared to 77% ward patients. The clinical and demographic characteristics predictive of admission to critical care unit or medical wards were derived from multiple regression analysis. Preference for intervention (P<0.0001), illness severity (P<0.0001), and reason for admission, cardiac or non cardiac (P=0.0001) were most significant predictors of critical care admission. Acute neurologic (P<0.02), and acute pulmonary (P<0.02) problems also more likely to gain direct critical care unit admission. Cardiac cases gained admission more readily (P<0.005) than non cardiac when analysed by level of severity. The threshold for admission of cardiac cases was low (most were admitted), and threshold for non cardiac cases was high (many high risk were excluded). Overall mortality cardiac and non cardiac similar.

**Conclusion, comments**
Level 4 evidence. Late transfers from ward to critical care had significantly higher mortality than early transfers (x2=8.1; P<0.02). *Precipitous deterioration* (cardiac, respiratory, and near arrest patients) was more prevalent in the unstable, severely ill or moribund (P<0.001). Non cardiac, unstable, and moderately ill patients were also at greater risk of precipitous deterioration (P<0.05). Admissions compared to who should be admitted -examined using receiver operator characteristic curves. True positive rates for precipitous deterioration plotted against false-positive rates for patients cardiac and non cardiac admissions - optimum strategy in cardiac group would be to admit all unstable, severely ill or moribund patients , and for non cardiac the same patients plus unstable moderately ill should be admitted. ROC curves (all patients) indicated moribund, unstable and severely ill cardiac patients, and non cardiac moribund, unstable severely ill should be admitted (better than current practice). Limitation- investigates residents preferences only, not checked independently, and omits the patients and relatives’ perspectives. Core paper.


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<tbody>
<tr>
<td>59</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Clinical antecedents to in-hospital cardiopulmonary arrest.</td>
</tr>
</tbody>
</table>

**Method**
Retrospective review using predetermined definitions of pathophysiology, severity of disease, patient complaints, and clinical observations to identify critical features. Data collected within 24 hours of arrest, patients followed up to discharge or death. Cardiac arrest was defined, and clinical events leading up to the arrest were described and categorised as cardiac, respiratory, neurological, metabolic, multiple and unclassified. How items were selected was not stated, likely method clinical judgement.

**Results**
Changes in pathophysiology prior to arrest were categorised as respiratory in 24 (38%), metabolic in 17 (11%), cardiac in 6 (9%), neurologic in 4 (6%), multiple in 17 (27%), and 6 (9%) were unclassified. In the multiple category respiratory and metabolic problems predominated. 54 or 84% of patients had documented evidence of clinical deterioration or new problems within 8 hours of cardiac arrest- suggests underlying pulmonary and metabolic problems are significant. Respiratory or mental function deterioration was recorded in 70% of all patients in the 8 hours prior to arrest. Changes in vital signs provided more consistent evidence of problems than routine laboratory tests with elevated respiratory rate noted (mean respiratory rate 29±1 breaths per minute).

**Conclusion, comments**
Level 4 evidence. Information on deterioration is available to clinicians but their response to this is not optimal whether due to communication problems, physicians’ failure to recognise significance of features e.g. high respiratory rate, or failure to commence the correct treatment to avoid arrest. Earlier appropriate intervention could prevent cardiac arrest as many of these events could be predicted from the clinical antecedents. Sample relatively small, but the consecutive method of deriving the sample increases confidence in the results. 2 investigators independently classified the patients’ underlying diseases seeking advice where required- interrater reliability tests not reported. Clinical antecedents such as underlying pathophysiology, changes in vital signs and patient behaviour prior to arrest are reported clearly. Core paper.

Method
Retrospective study. Medical records reviewed for gender, age, co-morbidity, duration of resuscitation, initial pH and P02, location and outcome of resuscitation. Arrests on wards specified as witnessed unless witnessed recorded. Other locations- arrest noted as witnessed. X2 analysis and analysis of variance (ANOVA) used to calculate significance for data according to location of arrest. Reliability checks in data collection were reported. Cardiac arrest was defined.

Results
Return of spontaneous circulation (ROSC) in 75/266 arrests (28%). Only 9% (n=24) survived to discharge. Variety of admitting diagnoses (myocardial infarction, congestive heart failure etc.), some had >1 illness. Survival not related to gender, or location. Age <60 years was associated with increased survival (15% rather than 6.2%, P=0.02). Age >60 years, no survivors. Survival greater in patients with <2 co-morbid conditions (13% compared to 4.2%, P=0.04). Only 1 unwitnessed ward arrest survived to discharge. When resuscitation lasted >10 minutes only 5 (2%) survived to discharge. P02 or equal to 50 was associated with increased survival (13% compared to 1.3%, p=0.004). Initial pH and survival- no difference found between survivors and non-survivors.

Conclusion, comments
Identification of objective predictors of patient outcome after in-hospital cardiopulmonary resuscitation (CPR)- may be useful in decisions about who should be resuscitated and when to cease CPR attempts.

266 (out of 500 consecutive CPR patients) in a 3 year period in a US hospital. The remaining 234 of the 500 had Do Not Resuscitate (DNR) orders.

Shoemaker W C (1996a) Temporal physiologic patterns of shock and circulatory dysfunction based on early descriptions by invasive and non invasive monitoring New Horizons 4 (2) pp. 300-18

Method
Theoretical paper.

Results
Earlier research on shock did not analyze time in relation to the development of circulatory problems. Many studies of early period were not early in the physiological sense as shock was often already established by ICU admission or onset of a hypotensive problem. The "hypotensive episode represents decompenstation of protective circulatory mechanisms, not the beginning of circulatory dysfunction" p.300. With early monitoring changes in the circulation can be seen at the time of the precipitating event (e.g. trauma, haemorrhage), monitoring after onset of hypotension misses the first part of the problem. Invasive methods - gold standard in ICU, but newer non invasive methods open up possibilities for picking up problems early, and at the time they are occurring. Describes temporal patterns in shock using both invasive and non invasive methods.

Conclusion, comments
Temporal aspects of shock and physiological patterns. Recognition of shock in the early stages makes early intervention possible and treatment is likely to be more effective. Examined invasive and non invasive monitoring.

Level 5 evidence. Refers to the early subjective, non-specific signs and symptoms which are used to recognise shock- cold clammy skin, pallor, weak and thready pulse, unstable vital signs, cyanosis, mottled skin, restlessness, and altered level of consciousness. These signs only indirectly linked to the pathophysiology, therefore difficult to use these to guide therapy. Shock is involved in all fatal illnesses- circulatory failure a component of the final common pathway. Shock seen in primary circulatory illnesses as well as complication in other illnesses. Shock and circulatory dysfunction feature in life-threatening critical illnesses. Suggests that medical and surgical shock may have similar circulatory mechanisms. Quality review- good theoretical paper. Include as background literature.
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<td></td>
<td>Sample</td>
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<tr>
<td>62</td>
<td>Quantitative</td>
<td>Good</td>
<td>background</td>
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</table>

**Method**

Prospective study of physiologic patterns - cardiac, pulmonary and perfusion characteristics in survivors / non survivors. Time sequence circulatory events- critical to description of survivor and non survivor patterns. Haemodynamic and oxygen transport patterns evaluated by non invasive (Bioimpedance, pulse oximetry, transcutaneous oxygen and carbon dioxide tensions), and invasive techniques (PA catheter).

**Results**

76 (29%) died, 71% survived and discharged from hospital. Statistical Analyses of variance and Newman-Keuls test to compare all data collected in sequence. Two-tailed student’s t test (significance at probability values<0.05) compared data under the different conditions. Hypotensive shock often preceded by periods of high flow then low flow and inadequate tissue perfusion (reduced transcutaneous oxygen tension). Early on values often normal ranges- 64% had normal or elevated arterial pressures in the early stages which masked problems of low blood flow and inadequate tissue perfusion. Changes in non invasive variables; transcutaneous oxygen tension decreased first in 52% monitored cases, Cardiac Index decreased first in 26%, both together decreased in 15%, remainder not possible to determine. Described events sequence- range of trauma and non trauma cases. Common circulatory patterns - early baseline control followed by quick deterioration to low point nadir partial/ complete reversal.

**Conclusion, comments**

Level 4 evidence. Uses detailed description of cases advocated by Feinstein in development of science of clinimetrics. One of series of papers arising from this study, methods reported in greater detail elsewhere. Survivors and non survivors characterised by amount of deficiencies. Latter had larger drop in pressure, flow, and tissue oxygenation at the nadir and less resolution after resuscitation. Conceptual statements made require further research investigation to confirm. Hypotension, low flow, amnesia and collapse-late shock treatment less effective. Early shock- non specific signs and subjective symptoms- cold clammy skin, changed mental status, weak thready pulse, unstable vital signs. Bringing values into normal ranges does not treat underlying shock problems (perfusion deficits) and can result in reperfusion injury, inflammatory response and failing organs. Non-invasive/continuous/on-line monitoring approaches -increased understanding trends, titration of therapy then possible. Background paper.
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<td>Prediction and prevention of in-hospital cardio-respiratory arrests.</td>
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</table>

**Method**

Prospective study. Surveyed cardio-respiratory arrests on medical and surgical wards of a UK teaching hospital. Details of cardiac arrest calls obtained from switchboard, data collected within 72 hours using an agreed protocol (demographic details, previous health status, arrest details, vital signs in the 24 hours before event, other clinical signs, laboratory test results, interventions, outcome).

**Results**

Successful resuscitations occurred in 9/47 (19%), but only 5 of these survived to discharge from hospital (10.5%). Abnormal vital signs, and at least one abnormal laboratory result, were recorded in preceding 24 hours in medical or nursing notes in 24 (51%) patients. In 3 cases of documented abnormal signs in nursing notes there was no record of doctors being informed. Small number of patients therefore statistical analysis to rank signs and test results for predictive index not undertaken.

**Conclusion, comments**

Level 4 evidence. Many patients have abnormal vital signs and abnormal laboratory test results in the 24 hours before cardiac arrest calls made. Tachyphoe, altered mental state, oliguria, abnormal arterial blood gases were highlighted. (Statistical analysis not done). Resuscitation after cardiac arrest in general wards yields poor results (3/24 with abnormal signs were resuscitated, but none survived to discharge). Limitations- Small sample size, 51 excluded from sample. Switchboard information incomplete (patient names not recorded–6 cases not traced). Documentation of vital signs often incomplete. Urine output records may be inaccurate. No comparative data were used–analysed 16% of total deaths on medical and surgical wards during this period, did not study others where cardiac arrest call was made. (Hospital policy states that resuscitation must take place unless DNR status documented in patients’ notes, but this was not investigated here). Do not know how many patients had abnormal vital signs but did not arrest. No reliability checks in data collection reported. Core paper.

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<td></td>
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<td>Explored critical care nurses’ perspective on phenomenon of deterioration in critically ill patients using qualitative research methodology.</td>
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</table>

**Method**

Qualitative research study (In-depth interviews).

Qualitative research study. In-depth interviews using a 2 part instrument; the first was a 34-item open-ended questionnaire, the second part consisted of an 18-item tool to validate characteristics of deterioration with responses made using a 3-point scale. All items in part 2 were based on investigators’ experience and thoughts on concept of deterioration.

**Results**

Interviews were transcribed and labelled with descriptors and themes. Grounded Theory Analysis was used (Glaser and Strauss, 1978). 13 thematic descriptors were developed from interview responses in part 1, initial period of stability, subjective certainty (that something was going on), non specific- felt changes, reliance on gut feelings, search for confirming evidence, gradual pattern of recognition, sudden onset of crisis, difficulty communicating with doctors, intervening factors, importance of context, preventive role of nurse, sense of involvement with spiritual realm, ethical decision making. In part 2 nurses rated possible characteristics of deterioration from 1, most essential to 3, a part of the phenomenon and these were then given overall ranking from 1 to 23. Included perceptual cues, and physiological indicators of change in state. Areas of agreement parts 1 and 2, initial sense that something was wrong, awareness of change in state - worsening, need to closely observe.

**Conclusion, comments**

Level - qualitative evidence. No information about how participants were recruited. Minimal information on how data was analysed, or how threats to validity, reliability minimised. Quotations cannot be traced to particular participants (no codes reported). No predefined theoretical framework, but study used a grounded theory approach. Items with the same average group score in part 2 were not ranked equally, no explanation of how the items were ranked separately e.g. sense that something is wrong and feeling of concern ranked 1 and 2 respectively, but they had the same average group score. Small sample size limits generalisability of findings, types of ICUs/patient population not fully described, no independent analysis by second person reported. Highlights context very important to understanding phenomenon of deterioration and refers to the transitional nature of the process of deterioration. Criteria quality assessment of qualitative research (Khan, ter Riet et al 2001) partially met. Core paper - refers to deterioration in ICU, but include in review as one of few qualitative studies.

**Method**
Prospective cohort study.

**Results**
190 medical admissions - 14.1% all critical care admissions in 1 year. 93.7% medical admissions referred from A&E, Medical Assessment Unit and general medical wards. Respiratory disease, self-poisoning/overdose, and central nervous system disorders accounted for 66.8% medical admissions. Renal failure, multiple organ failure, cardiac disease - highest mortalities. APACHE II risk of hospital death noted for 119 patients (39 admitted to HDU, and further 29 ICU cases had no APACHE II score). Observed to predicted deaths in 119 patients was 48 to 44.7 (observed to expected ratio: 1.07; 95% confidence interval 0.79-1.33). Of the 186 patients 54 (28.4%) died on ICU, 16 (11.8%) died after ICU but in hospital, 6 (5.2%) died after hospital discharge. 12 of the 16 who died on the ward had new medical problems, but on ICU admission - were expected to survive. DNR orders on 7 of the 12 with new problems was surprising finding; not explored.

**Conclusion, comments**
Level 1b evidence. Kaplan-Meier survival curve at 1 year for discharged patients not significantly different from age and sex- matched population (6 died compared to 3 expected to die). Where admission and discharge diagnosis with mortality were different mortality was doubled (p=0.05). Binary logistic regression analysis at 100 days after ICU admission found APACHE II score (p=0.001) and admission from general ward (p=0.03) had negative effects on outcome. Readmission to ICU almost achieved significance. Lead time bias may account for higher mortality in patients admitted from general wards compared to A&E and Medical Assessment Unit. Earlier admission to ICU was related to improved outcomes. New problems when identified should be treated quickly and effectively. Problem noted in high number of DNR orders on post ICU ward patients who had been expected to survive- perhaps reflecting reluctance to readmit to ICU. MET- early intervention strategies advocated. No reliability checks reported for data collection/ extraction, but used data collected routinely ICUs. Quality rating of research- reasonable. Core paper.


**Method**
Prospective multi-centre study.

**Results**
417 of the 3765 were identified as survivors at one year, but 214 could not be followed-up. Life table analysis was used to take account of missing data and percentage survival was reported for 4 different time periods. Initial resuscitation survival was 38.7%, and 62.7% of these were alive at discharge or 6 week follow-up. Initial survivors alive at one year - 32.4%. Overall survival was 12.5% (including out of hospital cases), and 15.0% for only in hospital cases. In hospital survival was best in accident and emergency, cardiac and other specialised units. Arrests recorded as primarily cardiac (56%), respiratory (11%), both (18%), other or unknown. Patients aged <65 years, with arrests in specialised areas had better than study average with initial success (57%), and 1 year survival (31%). Better outcomes were reported in arrests managed by smaller teams of 2-3 people; arrests lasting longer give more time for help to arrive, these are likely to be the more difficult cases

**Conclusion, comments**
Level 4 evidence. Missing data may have affected results. Results may not be generalisable as participating hospitals were not selected randomly. Comparisons between hospitals is complicated by the possibility of selection biases existing locally. Differences in how arrests are recorded and reported has prompted development of uniform criteria (Utstein style) but these are difficult to apply retrospectively. Age was found to affect immediate and subsequent outcome, and combined cardiac and respiratory arrest results in higher mortality than either one of these. Location in a specialised area was also important in arrest survival. Important study as it was one of the first to describe the extent of the problem in the British society (most studies had been conducted in the US). No reliability checks were reported for data collection/ extraction. Under or over reporting of cardiac cases was a possibility but could not be investigated. Exclude paper - focuses on survival after CPR.
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<tr>
<td></td>
<td>Method summary</td>
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<td>Sample</td>
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<tr>
<td>67</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Low risk patients admitted to medical - surgical ICUs</td>
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<td></td>
<td>Prospective cohort study.</td>
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<td>Prospective cohort study as part of larger study to develop better prognostic information. Phase 1: Prospective data collection <em>estimation phase</em> in 1 hospital extended in phase II to another 12 hospitals -validation phase. Diagnosis, demographic data, reason for ICU admission, severity of illness (APACHE II), ICU therapy collected. Main hypothesis- Low risk monitor patients can be identified by assessment of physiologic stability (APS of APACHE II was used). Active treatments were any of the 31 items identified in the TISS scale.</td>
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<td><strong>Results</strong> Phases 1: Of 778 monitor patients 509 (65%) were predicted to be &lt;10% risk of needing active therapy (logistic regression analysis) and just 4.1% (21/509) of these low-risk cases went on to receive active therapy. Therefore 95.9% predicted as low-risk did not require active therapy. Phase 2: In the validation sample 73% were identified as low-risk, and 4.4% (37/849) received active therapy. The predicted value negative was 95.6% in this data set. Of the 37 low risk admissions 31 were judged to be unsuitable for non-ICU care (for the remaining 6 insufficient data was available to make any comment). The threshold to establish low or high risk patients was decided by clinical judgement- a 10% predicted risk. Analysis of the total data set (5,790 ICU admissions) categorised as low, high risk monitor and initially actively treated at p level of 0.05, there were significant differences in mean APS day 1, mean total TISS, cost, % actively treated, length of stay, ICU and hosp death rates across the low/ high/ initially actively treated groups.</td>
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<td><strong>Conclusion, comments</strong> Level 4 evidence. Low risk thresholds using the Acute Physiology Score from APACHE II may identify patients who could be treated in other areas such as high dependency units but this should inform rather than replace clinical judgment for individual patients. It is not possible to recommend a particular threshold for physiological abnormality when ICU admission or discharge is appropriate based in this evidence. Review of patient records concluded that &lt;1% of low-risk patients would have had problems due to delay in treatment resulting from non ICU care. This requires analysis of the potential costs and benefits. Limitation- missing data for 6 low-risk admissions. No report of reliability testing for review of clinical records however the validity of the study depends on the accuracy of this data. It also relies on active interventions being appropriate- the study did not investigate how decisions were made nor if clinicians varied in their use of the identified active interventions. Core paper.</td>
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<tr>
<td>68</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>To identify causes of death in general hospital ward patients after ICU discharge. Do patients die from potentially treatable complications?</td>
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<td>Retrospective study.</td>
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<td>Retrospective study of patients admitted to ICU in a 5 year period. Data extracted by two clinicians (main researchers) retrospectively-they knew the outcome in each case. Medical records and discharge summaries were used. No report of independent reliability checks for classifying patients where death was expected, or considered a risk or where survival was expected. The latter categories were described and illustrated with examples, but assigning patients to categories relies on clinical judgement.</td>
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<td><strong>Results</strong> Patients who died on the wards were older than the others, males predominated in all groups, ICU deaths had the highest APACHE II score on admission compared to ward deaths and survivors but patients who died did not all have high APACHE II scores. Post-cardiac arrest patients accounted for 20% of deaths on the wards. Ward deaths’ patients spent longer in ICU. 54.2% ward deaths were judged at risk of death, 25.5% death was expected, 20.3% died when survival was expected.</td>
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<td><strong>Conclusion, comments</strong> Level 4 evidence. 20.3% of patients who died on the wards would have been predicted to survive on discharge from ICU. Deaths were due to pneumonia, sepsis, malignancy, myocardial infarction, thromboembolism, and cerebrovascular accident. Some of these deaths may have been avoided through better ICU care and improved ward care. Raises issue of bed shortages and premature discharge from ICU. Elderly ICU patients appeared to be at greatest risk of ward death. Possible criticism of study - use of data from death certificates which may be inaccurate. Core paper.</td>
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<tr>
<td>69</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>Incidence of antecedents to cardiac arrests in hospital.</td>
</tr>
</tbody>
</table>

Method
Review of medical notes on 5 randomly selected occasions using pre-set criteria to define patients predicted to be at high risk of major deterioration/cardiorespiratory arrest: respiration <5 or > 36 per min., pulse rate <40 or >140 bpm, systolic BP <90 mmHg, decreased LOC with fall in GCS > 2 points. 5 research assistants collected data using the above criteria applied to previous 24 hours, age, sex and admission category. Recorded frequency tabulations of variables.

Results
Abnormal physiological variables for the 9 cases were resp rates >36 breaths/min. in 4, resp rate <5 in 1 case, pulse rate >140 bpm in 1 case, systolic BP <90 mmHg in 3 cases, no cases of decreased LOC. Rate of antecedent events over the 5 days of the study = 0.88%. No patients went on to cardiac arrest during the study.

Conclusion, comments
Level 4 evidence. The MET is activated using these study criteria in the study site. MET can intervene and minimise risk of further deterioration. No reported reliability checks during data collection. Study relies on accuracy of written documentation—did not attempt to observe patients in real time. Incidence of recording antecedent factors and patient outcomes may not be typical of other general hospitals as MET in situ and staff here may be more diligent in recording abnormal signs and may refer to MET earlier (Further study underway to examine case fatality rates and morbidity in different hospitals). Core paper.
Fieselmann JF, Hendryx MS, Helms CM et al 1993 Respiratory rate predicts cardiopulmonary arrest for internal medicine inpatients J Gen Intern Med 8: pp 354-360

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<tbody>
<tr>
<td>70</td>
<td>Quantitative.</td>
<td>Good</td>
<td>Core</td>
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</table>

**Method**

Retrospective case-control study

Retrospective case-control compared vital sign measurements for 72 hours before arrest with 72 hours of measures for patients in the same locations who didn’t arrest.

**Results**

Mean age of cardiac arrest cases (61.9 years; SD=16.2, range 18-88) significantly greater than controls (53.9 years; SD=17.3, range 17-92) (t=2.85, p<0.01). Patients excluded from study due to arrests < 72 hours of admission were not statistically different in mean age, gender or survival rates to the study sample. Incidence of cardiac arrests greatest in bone marrow transplantation (17.9/1,000) cardiology (6.6/1,000), renal (6.2/1,000), GI (4.3/1,000) and pulmonary (4.3/1,000).

Respiratory rate within the 72 hour period was a significant predictor of cardiopulmonary arrest across a broad range of thresholds. For one or more records of resp rate > 27 there was a sensitivity of 0.54, specificity 0.83 (OR = 5.56, 95% CI (confidence limit) = 2.67-11.49 predictive of cardiac arrest. Abnormal resp rate also predictive at other levels e.g. rate > 23 occurred in 83% cardiac arrest cases but this also included 54% controls. For resp. rates > 31, 42% arrests were captured and only 7% controls. Generally pulse and BP did not predict arrest; a pulse of >110 was the only one to achieve significant OR (OR = 2.83, 95% CI = 1.35-5.90, sensitivity 0.41, specificity 0.75). Systolic BP > 149 mmHg reached sig. OR (OR = 2.34, 95%CI = 1.13-4.86, sensitivity 0.42, specificity 0.69).

**Conclusion, comments**

Level 2b evidence. Elevated respiratory rates strong predictor of cardiopulmonary arrest in general medical patients. Core paper-include in review.

All 59 inpatients with cardiac arrest (excluded patients with DNR or < 72 hours vital signs records. 91 inpatients without cardiac arrest formed the control group matched for units and availability of 72 hours vital signs records.
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<tr>
<td>71</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
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</table>

**Method**

Retrospective review of patient records after all in-hospital deaths plus data on cardiorespiratory arrests and admissions to ICU. Deaths in the *not for resuscitation* (DNR) group were analysed separately. A data collection tool was refined during the initial 2 week pilot phase. Rationale for inclusion of items based on clinical judgement and previous research on MET calling criteria by the authors. Demographics, antecedent factors within 0-8 and 8-48 hours of events were recorded.

**Results**

Of the total 778 deaths, 549 (71%) deaths were in the DNR group; 171 (22%) deaths presented initially with cardiac arrest, 53 (31%) of the latter went on to have DNR orders; 160 (21%) deaths occurred in patients admitted to ICU and 111 were planned or expected admissions, of the remaining 49 unexpectedly admitted from the wards 31 (66%) went on to have DNR orders. 29% of the remaining group of 447 patients (after excluding cardiac arrest and ICU-linked deaths) had severe physiological abnormalities documented within 8 hours of death (up to 50% in the DNR group). Many also had the same serious physiological signs for the whole 48 hours before death. Nurse or doctor *concern* about the patient’s condition was documented in 1/3 of the non-DNR group. In non-DNR patients, hypotension (30%) defined as systolic BP < 90 mmHg, and tachypnoea (17%) defined as resp rate > 36 per min. were the most frequent antecedent cues. 519 (67%) of deaths occurred on general wards. Pulse rate > 140 beats per min. was the next most frequent antecedent.

**Conclusion, comments**

Level 2b evidence. Indicators of physiological dysfunction used in this study represent marked abnormal organ function. Hypotension, tachypnoea and tachycardia where the most common antecedents. Presence of abnormalities for prolonged periods without appropriate corrective action was an important finding. Limitations - retrospective review so relied on documentation of factors. Authors attempted data collection as early as possible to minimise the risk of missing patients or data. Focuses on MET signs, presence of earlier signs were not analysed. No reported reliability checks for initial data collection, although data entry was checked for typographical errors by one data collector. Quality - reasonable. Core paper.

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<td>72</td>
<td>Quantitative</td>
<td>Reasonable/</td>
<td>core</td>
<td>Effects of MET on mortality in unexpected cardiac arrests in hospital.</td>
</tr>
</tbody>
</table>

Method
Non-randomised population study with historical control.

Non-randomised population study before and after introduction of medical emergency team (intervention). MET activated by nurse or doctor at bedside using simplified MET calling criteria. Data from the 2 study periods was analysed. Incidence of cardiac arrest calls was calculated per 1000 patients at risk. Descriptive statistical techniques were used for univariate association of risk factors. Logistic regression model used for probability of call according to age, sex, type admission, DRG. Presence/ absence of MET analysed. Stepwise and backward elimination algorithms used to identify potential predictors of mortality.

Results
Differences in numbers and types of admissions over the 2 time periods were noted. Unexpected cardiac arrest calls 73 vs. 47 before and after MET intervention - incidence of 3.77 vs. 2.05 per 1000 (P=0.001). Mortality 56/73 vs. 26/47 before and after the MET (P=0.001). Presence of MET (OR 0.52; 95% CI 0.36-0.74), age > or equal to 65 years (OR 8.07; 95% CI 5.32-12.2), admission to emerg. dept. rather than planned/ other admissions (OR 2.73; 95% CI 1.65-4.54), male patients (OR 1.51; 95% CI 1.05-2.16) and same day admission (OR 0.36 (0.23-0.56) all significantly related to risk of cardiac arrest. 50% calls in 1999 were from general medical wards, 25% from general surgery, and most were made by nurses (86%) or junior doctors (15%).

Conclusion, comments
Level 2b evidence. 2 separate time periods studied as implementation of the new system took > 2 years may have affected results. Cardiac arrest calls were checked against telephone switchboard records to minimise errors/ omissions. Cardiac arrest working definition- any cardiac arrest call made by a member of staff regardless of whether the patient actually had cardiac arrest was a broad definition of cardiac arrest which could affect the results. Limited to data from one hospital. Altered case-mix noted in the two time periods, may have affected results. Not able to say that the MET was the cause of reduced mortality - improved management of patients on wards may have been due to the educational input that accompanied the introduction of MET, or changes in the application of DNR orders alters the numbers of unexpected cardiac arrests- the statistics for the latter were not reported. Core paper.


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<tr>
<td>73</td>
<td>Quantitative</td>
<td>Poor</td>
<td>exclude</td>
<td>Describes use of MET model in a district general hospital in Australia.</td>
</tr>
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Method
Descriptive prospective study.

Prospective study of all MET activations in 12 months- data collected using a predetermined form. Activation was based on a simplified version of the MET calling criteria.

Results
48% MET calls were made between 8.00-18.00 hours. 40 calls (58.8%) were for medical patients, 21 (30.9%) for surgical patients, 4 (5.9%) for neonatal or paediatric patients, 1 (1.5%) for an obstetric patient. Most common conditions leading to MET call: chest pain 13, respiratory distress 11, seizures 10, cardiopulmonary arrest 8, Decrease in LOC 6, and a range of other conditions including collapse, hypotension, syncope, neonatal and obstetric emergencies, drug reaction. None of the cardiopulmonary arrest patients survived to discharge, and two other patients also died (one with ruptured abdominal aortic aneurysm, the other with dementia and bronchitis). 9 (13.2%) MET calls were judged inappropriate. 60 MET activations were immediate upon recognition of problems by ward staff, in 6 cases inappropriate delays were found.

Conclusion, comments
Level 4 evidence- descriptive study. No reliability checks reported in data collection. States that process of care was improved due to early activation of MET but no comparison made with situation before introduction of MET. Small sample - not possible to test the hypothesis that the MET led to improved outcomes for patients with antecedents to cardiac arrest present. Did not include patients for whom MET was not called. Simplified MET calling criteria could lead to error as some staff may interpret the criteria differently e.g. severe respiratory distress might identify at risk patients late in the deterioration. Quality-poor- exclude.
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<td>74</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>core</td>
<td>The pattern of transfers into ICU from the wards, and hospital survival rates after the introduction of the MET.</td>
</tr>
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</table>

**Method**  
Prospective study collected using standard form over period of 3 years after introduction of MET. Data collected on all patients for whom MET activated (included data <24 hours of call) and on all unanticipated admissions to ICU from the wards (patients meeting at least one MET criterion < 24 hours of admission, but ward staff did not activate team). Data analysis undertaken using SPSS- descriptive analyses for sample characteristics and $\chi^2$ to compare categorical data. Statistical significance set at $P<0.05$, and two-tailed tests were used.

**Results**  
71% patients seen by MET survived to discharge. Reasons for MET activation changed over the 3 years- cardiopulmonary arrest calls dropped from 30% year 1 to 12% in year 3 ($\chi^2=6.628$, df=6, $P=0.357$). Transfers to ICU via MET system decreased from 44% in year 1 to 31% in year 3 ($\chi^2=3.590$, df=2, $P=0.166$). Incidence of patients needing advanced life support did not change. Survival rate after introduction of MET did not change over the three years (26% patients who died met at least one MET criterion in the 24 hours before the MET call). Overall hospital admissions increased slightly (numbers reported), and in-hospital deaths decreased slightly (numbers reported, but not statistically significant). Unanticipated ICU admissions from wards (not via MET system) decreased from 58 in year 1, to 46 in year 2 and 36 in year 3 ($\chi^2=9.969$, df=2, $P=0.007$).

**Conclusion, comments**  
Level 4 evidence. Reduced hospital mortality over the three years could not be attributed to the MET - other factors such as case-mix changes may have affected this, but numbers of unanticipated ICU transfers was reduced. Ward staff underscoring MET criteria- indicates scope for more educational interventions. Quality- reasonable. Core paper.

Method
Prospective cohort study. Data collected in routine care by nursing staff (after training). Methods of recording vital signs (Critikon and IVAC equipment) and conscious level described. On adm. demographic data, systolic BP, pulse rate, temperature, respiratory rate and AVPU (Alert, reacting to vocal stimuli, reacting to pain, unconscious) recorded, twice daily (am, p.m.) on a pre-determined sheet for 5 days. The modified Early Warning Score (MEWS) was calculated - score of 5 or more defined as critical. Highest score during admission - ScoreMax. Endpoints - HDU, ICU admission, cardiac arrest team called, death at 60 days. SPSS (version 10.0) used for statistical analysis and relative risk ratios calculated.

Results
673 complete patient records were available for inclusion in analysis (remaining 36 were excluded). 7 patients were admitted to ICU, 23 to HDU, 4 resuscitated by cardiac arrest team, 56 died. On admission the majority of patients scored 0 for BP, pulse rate, temperature, and AVPU score. The median score for resp rate was 1 (55% admissions). Admission scores ranged from 0-9 (median 1). More critical scores (>4) recorded on admission day, falling over the next 3 days. The mean of the highest average score reached was 2.29 (SD 1.51). Outcomes: Increased risk of death found in cases of ScoreMax of 5 or more (OR 5.4, 95% CI 2.8-10.7), ICU admission (OR 10.9, 95% CI 2.2-55.6), HDU admission (OR 3.3, 95% CI 1.2-9.2). Endpoints occurred at median of 4 days (0-45 days). 7.9% with ScoreMax 0-2 reached endpoints, 12.7% reached endpoints with ScoreMax 3-4, and 30% reached endpoints with ScoreMax 5-9. Patients reaching endpoints were significantly older (p<0.0001), had lower systolic BP (p<0.0001), higher pulse rate (p<0.0001), and higher respiratory rate (p<0.0001). Endpoints in single parameters such as systolic BP or raised temperature were not associated with increased risk for reaching endpoints. However age>70 placed patients at significantly more risk than age <50 years (OR 6.5, 95% CI 2.5-16.7). Addition of age score to EWS increased area under the ROC from 0.67 to 0.72 when admission and endpoints were analysed.

Conclusion, comments
Level 1b evidence. Advantage - uses physiological data routinely recorded at the bedside. Other scores (APACHE II, MPM, SAPS) require more detailed data for their calculation. Criteria included in MEWS and EWS based on clinical judgement. Sample included patients with DNR orders. Demonstrated higher MEWS scores associated with increased mortality in study group. Suggests scores >4 in this patient group could be used to triage patients for increased ward treatment, HDU or ICU. Limitations - restricted to one study centre- generalisability unknown. Restricted period of data collection to 5 days within the MAU. Quality good- core paper- include paper in review.

Method
Prospective observational study. After inclusion patients were followed up to discharge or in-hospital death. Serious adverse events (SAEs) -defined as acute myocardial infarction, pulmonary embolism, acute pulmonary oedema, unscheduled tracheostomy, respiratory failure, cardiac arrest, cerebrovascular accident, severe sepsis, acute renal failure, emergency admission to ICU, death. Descriptive statistical analysis - reported as means with 95% CI. Student's t- test used to compare continuous variables, ordinal data compared using Fishers exact test or X^2. Multivariate logistic regression used to identify variables that might predict SAEs.

Results
SAEs selected based on clinical judgement of ICU staff. All SAEs were recorded on an Excel database. 414 SAEs were recorded in 190 patients (16.9%). 80 (7.1%) patients died. Incidence of SAEs not significantly related to type of surgery. In the 934 patients for whom ICU support was not requested 138 had 309 SAEs (14.9%), and 62 (6.7%) died. Results of multivariate logistic regression found that age affected the incidence of SAEs (OR 1.02; 95% CI, 1.01-1.03), and so did unscheduled surgery (OR 2.28; 95% CI, 1.63- 3.19). Age over 75 was associated with particularly high incidence of SAEs- when the surgery was unscheduled 27 (20%) died. Unscheduled surgery independently associated with more SAEs (22.5% v 13.4%, p=0.0001). Unscheduled surgery, no planned ICU adm., and age >75 accounted for 24 (18.8%) deaths. SAEs were associated with increased lengths of stay.

Conclusion, comments
Level 4 evidence. Did not investigate cause of SAEs nor if they could have been avoided. No reported reliability checks on data collection. Demonstrates SAEs common especially in the elderly, and suggests their preventability requires further research. Quality- reasonable. Core paper.
Durbin C G, Kopel R F 1993 A case-control study of patients readmitted to the ICU. Critical Care Medicine 21, 10 pp 1547-1553.

Method
Retrospective case-control chart review study.
Surgical ICU - multiple specialties (general, neuro, cardiothoracic, and other subspecialties). Medical ICU included all medical patients except acute myocardial infarction and bone marrow transplants. Predefined list of items were extracted from patient records. Some variables were missing. Details on readmission recorded and judgement made about cause of readm.- either new problem or deterioration of original problem. Linear regression analysis performed on variables organised by organ system or functional group - principal components. Chi-square and Student t-tests compared variables in study and control groups.

Results
APACHE II score at first discharge in readmitted group was 10.6 vs. 8.8, p=0.031 (readmitted patients may have been more seriously ill than control group patients). Outcome- 34 (41.5%) readm. patients died. Matched control group 6(7.3%) patients died. No difference in mortality rates between readm. medical ICU or surgical ICU patients and controls (p=0.436). Length of stay- Initial ICU and length of hospital stay (LOS) were different in study cases and controls. Control cases ave. ICU stay 4.0±5.0, and 20.8±14.3 days in hospital. Readm. patients stayed in ICU (initial stay) 8.3±16 days and 47.8±41.7 days in hospital. Difference in ICU LOS was statistically significant p=0.004, and hospital LOS was significant p=0.0009. Risk of readmission- Linear analysis found weak correlations between variables (except BUN and creatinine, haematocrit and haemoglobin, base excess and bicarbonate conc.). Principle component analysis actually increased the number of variables. Paired t-tests were analysed for each individual variable. Respiratory rate was one of two continuous variables to achieve significance when study and controls were compared 24.2 vs. 21 breaths/min, p<0.002, the other being haematoctrit at discharge (31.9 vs. 34.4%, p=0.01). Risk of death- Age, APACHE II score, BUN were higher in patients who died. Also creatinine conc. and use of dialysis were higher and GCS was lower in non-survivors in the control group compared to non survivors in readm group. Readmission Group characteristics- Respiratory problems accounted for readm in more than 50%. 1/3 were readm. for deterioration in original problem. Mortality was lower in patients readm with new problems (p=0.349).

Study population- 1803 patients discharged from 2 ICUs (6-bed medical, 16-bed surgical ICUs in 1 US hospital) in 18 months period. 83 (4.6%) readmitted. Excluded planned readmissions, and patients who died during first ICU adm. not used as controls. Matched controls were matched (age, sex, primary diagnosis and location - surgical or medical ICU) were found and agreed for 82 of the 83 readmitted patients. Readmitted group - 43 males, 39 females. Control group - 49 males, 33 females (p=0.875). Average age study group 59.5 vs 59.1 years in control group (p=0.715).

Conclusion, comments
Level 2b evidence. Some controls could not be matched in all main characteristics. Provides evidence on importance of raised respiratory rate as significant predictor of readmission. Mortality 5 times higher in readmitted patients compared to matched controls. Did not investigate reasons for non-readmission of the control group patients. Extremes of variables such as respiratory rate may assist clinical decision making - need for additional continuing care in raised respiratory rate cases after discharge. Patients readmitted with same problem had higher mortality rate - may point to premature discharge. Advanced age affected outcome in control and study cases factor in APACHE II. Did not report reliability ratings for initial data extraction process. Quality - good. Core paper.

Method
Prospective inception cohort analysis. Analysis part of APACHE III evaluation study. Demographic, clinical and physiologic data collected on consecutive cases or on every 2nd or 3rd case. Data collected on first ICU day, and every day for 7 days- used APACHE III (APS), discharge location, ICU and hosp LOS, ICU readm., survival at ICU or hosp discharge. TISS recorded daily up to 7 days. Defined ICU monitor patients as patients not requiring pre- specified active treatments. Predictor variables selected based on earlier research. Logistic regression equation was developed- probability of active treatment after first ICU day. ROC used to test equation. 10% predicted risk for needing active treatment used as risk threshold. Also used 2x2 tables to calculate sensitivity and specificity, false classification, positive predictions.

Results
9,400 (54%) of total 17,440 ICU adm. received one or more active treatments. 8,040 (46%) had monitoring only. Reason for ICU admission and first day APS make up 88.7% of the equation’s explanatory power. Characteristics of low risk monitor patients- there were more postoperative cases (54.7% vs. 45.3%), younger p<0.0001, lower mean APS score (p<0.0001) and shorter ICU LOS, lower death rate than active treatment or high-risk monitor patients. Predictive accuracy of equation for high and low risk monitor patients needing active treatment - ROC area 0.74. Low risk patients who needed active treatment 274 (4.4%)- false positives. Low risk cases accounted for 35.4% ICU admissions in this study- major savings could be made if they were not located in ICU- argument for intermediate care beds. Predictors of need for active treatment are diagnosis, age and physiological items in APACHE III, operative status, patient’s location and hospital LOS before ICU adm. Equation not designed to be used prospectively in decisions for individual patients- e.g. admit, don’t admit- used retrospectively to assess ICU utilisation.

Conclusion, comments
Level 1b evidence. Limitations-not for application to guide management of individual patients. Did not study patients outside ICU including possible prevention of adverse events, or effectiveness of intermediate care. Differences between hospitals- some already have < 20% low-risk monitor admissions- substantial improvements may not be possible. Quality- good. Background paper- characteristics of patients admitted to ICU - low risk monitor patients making up substantial proportion.
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<tr>
<td></td>
<td>Method summary</td>
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<td></td>
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<tr>
<td>79</td>
<td>Prospective randomized trial</td>
<td>Quantitative</td>
<td>Reasonable</td>
<td>exclude</td>
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<tr>
<td></td>
<td>Method</td>
<td>Prospective randomized trial. Inclusion criteria for frail patients based on Winograd et al (had to meet at least one of the following): chronic disability, acute impairment of one ADL, mild/ mod. dementia, confusion, depression, imbalance/ dizziness, falls, impaired mobility, urinary incontinence, malnutrition, polypharmacy, vision or hearing impairment, social problems or prolonged bed rest. Screening of patients, random allocation-90% by experienced study nurse, 10% by project leader. Randomization after informed consent gained-method explained. GEMU- interdisciplinary approach. Medical wards(MW)- usual care, more fragmented medical and allied professional team across several wards.</td>
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<td></td>
<td>Results</td>
<td>Baseline characteristics- groups comparable on demographic and clinical characteristics. Total LOS in GEMU median- 19 days (inter quartile range 13-30), MW 13 days (inter quartile range 7-18) p&lt;0.001. 38% GEMU had psychiastic diagnoses at discharge compared to 7% MW patients P&lt;0.001. Mortality during 1st year follow-up was less in GEMU group than MW group (greatest reduction was in the first 3 months). After 2 years 50% patients in both groups were dead. Heart disease main cause of death in both groups at 3 and 12 months.</td>
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<td></td>
<td>Conclusion, comments</td>
<td>Level 1b evidence. Reduction in early mortality in GEMU patients. Inclusion criteria- possible bias could be introduced as many of these criteria rely on subjective assessment. Quality- reasonable. Exclude-topic not within current review.</td>
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Smith L, Orts C M, O'Neill I et al 1999 TISS and mortality after discharge from intensive care Intensive Care Medicine 25 pp 1061-1065

<table>
<thead>
<tr>
<th>80</th>
<th>quantitative</th>
<th>reasonable</th>
<th>core</th>
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<tr>
<td></td>
<td>Method</td>
<td>Prospective observational study. No HDU facilities available at time of study. Data on age, sex, LOS, APACHE II on adm, TISS 76 and 28 score in=24 hrs discharge all collected. Bed occupancy and staffing details recorded. TISS data collected before and after discharge by two trained ICU nurses- good agreement. Post ICU complications were recorded using terms in predefined list.</td>
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<td></td>
<td>Results</td>
<td>Of the 283 discharges 31 (11%) died in hospital, most deaths happened soon after ICU discharge (median 3.5 days, range 1-46 days), 7 within 24 hours of discharge. 6 were discharged for terminal care (not included in analysis). 22 were readmitted to ICU and 4 of these died in hospital. Morbidity after ICU discharge occurred in 129(46%) patients, a median of 2 events per patient. TISS &gt; 20 on ICU discharge- 21.4% died in hospital vs. 3.7% in patients with TISS less than 10 (Pearson's x² 12.371, p=0.002. Significant predictors of post- ICU death were increasing age, non survivors vs. survivors 70±13 vs. 52±20; higher AP5 score on Adm. 17±7 vs. 14±7; higher TISS on day of ICU discharge 20±8 vs 14±8; and being male. Stepwise multiple logistic regression indicated age accounted for 9% variation in outcome, TISS 8%, being male 2% and APS 1%.</td>
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<td></td>
<td>Conclusion, comments</td>
<td>Level 4 evidence. Details of reliability checks in data collection not reported. Quality reasonable. Core paper.</td>
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Patients aged 75 and over admitted to Department of Internal Medicine in Norway were randomly assigned to GEMU (n=127) or general medical wards (n=127). Study period 1994-1995. Patients had to be suitable for transfer to the GEMU (i.e. not needing a particular treatment specific to Adm. location). Acute stroke patients only included if no beds available in stroke unit. Fully independent nursing home patients were excluded, as where patients with metastases or estimated survival <6 months, and known severe dementia.
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<td></td>
<td>Method summary</td>
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Method  
Systematic review of the literature on admission criteria for ICU and CCU for years 1966-1991. Search strategy described and summary of results reported, Criteria for inclusion stated and examples of reasons for exclusion were given.

Results  
Two papers met review inclusion criteria: Charlson and Sax (1987), and Ron and Aronne et al (1989). Unstable, moderately ill patients benefited most from ICU admission. Both studies were low in statistical power (large confidence intervals). Further studies used indirect methods to identify patients least likely to gain from ICU treatment- found overlap in APACHE scores for patients admitted to ICU and remaining on wards. Diagnosis specific scores may be more accurate than APACHE II in the future. Concludes that few studies were available to determine patients likely to benefit form ICU- predictive values need to be identified for patients at upper and lower margins of the moderately ill category. The *too ill, or not ill enough* patients would benefit from placement elsewhere.

Conclusion, comments  
Level 2a evidence, but very small number of papers met inclusion criteria. Possibly an argument for reviewing the inclusion criteria and the systematic review methods used - an example of a complex health care system (see Fulop et al 2001). Background paper.

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<td></td>
<td>Selective literature review</td>
<td>Reasonable</td>
<td>core</td>
<td>Implementation of in-hospital CPR has not resulted in major improvements in survival in cardiac arrest. In serious illness, the MET can intervene earlier than the traditional cardiac arrest team, and may improve patient outcomes.</td>
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Method  
Selective review of the literature by prominent research clinicians in this field. A systematic search was not undertaken. Included some major studies on CPR outcome, failure to detect serious illness in ward patients and antecedents to cardiac arrest, factors preceding unplanned admission to ICU, development of MET system based on trauma system model, argues importance of MET in overall resuscitation system.

Results  
This paper reviews various *system failures* such as evidence of deterioration in the hours before cardiac arrest in ward patients, personel issues- ineffective responses to deterioration (nurses and junior doctors), hierarchical medical system leading to a delayed response in serious illness, and the future research effort focused on pharmacological solutions to prevent tissue damage that are unlikely to effect outcome- need to detect ischaemia as soon as possible. MET presented as a strategy for earlier intervention in seriously ill patients that may improve patient outcomes.

Conclusion, comments  
Level 5 evidence. Quality- reasonable. Core-include in review.
Coombs M, Dillon A 2002 Crossing boundaries, re-defining care: the role of the critical care outreach team *Journal of Clinical Nursing* 11 pp 387-393

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<th>Number</th>
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<th>Method summary</th>
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<th>Subject</th>
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<tbody>
<tr>
<td>83</td>
<td>Quantitative</td>
<td>Poor/ insufficient information</td>
<td><strong>exclude</strong></td>
<td>The delivery of critical care services and the role of the critical care outreach team.</td>
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</table>

**Method**

Evaluation of 2 critical care outreach teams during the first 6 months of implementation. Review of selected policy and clinical papers related to the development of critical care outreach teams.

**Results**

Description of the planning phase prior to the introduction of the critical care outreach teams. Aim was to supplemented rather than replace services already in place- educational initiative implemented across the 2 trusts prior to introduction of outreach. Reported audit of outreach activity for first 6 months. More referrals to outreach in hospital with more acute beds (hospital B). One site (although it is not clear which one) used an early warning score but it was not clear if this was a score already in use elsewhere, and the system for the other site (not identified specifically) was not reported in detail. The two sites were dissimilar as one provided 24 hour cover immediately whilst the other operated a restricted service between 0700- 21.30 hours (did not report on any increase in the provision of latter service). Insufficient information given to identify which site was which. Significantly in the 24 hour service 43.7% referrals occurred between 20.00 hours and 08.00 hours and 50 % of these were for follow-up of recently discharged ICU patients. Descriptive statistics reported for combined figures for 2 outreach teams - main users were surgery, medicine, orthopaedics and trauma. Outreach teams also followed up patients after ICU discharge (accounted for 35.7-45% of all outreach visits per month). Main patient problems referred to outreach- respiratory, cardiovascular (hypotension and low urinary output), intravenous drug therapy (beyond current role of outreach team), neurological (often relating to airway management) and pain management (advised re- respiratory management and referred to pain specialists). Most patients were seen 2-3 times by outreach staff, 7% were transferred to HDU/ICU.

**Conclusion, comments**

Level 5 evidence. Results not clearly reported for each site. The two outreach services had important differences. Areas for future educational input- undertaking patient observations, management of respiratory problems, management of hypotension. Rates of cardiac arrest, unplanned admissions to ICU before and after implementation of outreach were not reported. Quality- poor. Exclude.
Bion J F 2000 Susceptibility to critical illness: reserve, response and therapy Intensive Care Med 26 S57-S 63

Method summary

84

Good

core

Improved cost-effectiveness for ICU through earlier recognition and prophylactic management of patients at high risk of critical illness. Early recognition of critical illness requires nursing and medical staff to assess patients’ physiological reserve (prior risk) as well as the acute illness. Physiologically-based scoring systems do not measure prior risk as they do not measure physiological reserve separately.

Method
Review/theoretical paper

Selective review, theoretical position paper.

Results
Physiological scoring systems predict mortality for large cohorts of patients but are less useful in clinical management of individuals. Methodological comment: Group mortality risk is a continuous variable, whereas individual patient outcomes are dichotomous. Further explanations for differences can also be found. Patients with the same severity of illness have the same risk of death, but when one survives and the other dies the possible explanations relate to the quality of care received, or to factors such as prior risk. A model of factors influencing outcome from critical illness identified the major elements as physiologic reserve, stressor event and therapy. According to Bion the physiological presentation of the patient with developing critical illness results from combination of underlying physiological reserve and the acute disease itself, the interplay being measured in the current scoring systems rather than the disease per se. To identify patients at risk of critical illness early attempts should be made to measure their physiological reserve - preventive therapy can then be used. Thus risk of critical illness can be identified according to physiological derangements (tachypnoea, hypotension) but these often identified late (if at all), or according to background health, physiological reserve and genetic susceptibility. The latter are assessed intuitively using biological rather than chronological age, by physical and social dependence, co-morbid disease and immunocompression. Bion highlights cardiovascular fitness and the type inflammatory response as the most important issues. Cardiovascular fitness and physical exercise are associated with reduced risk of death due to genetic factors [mechanism - angiotensin converting enzyme ACE and gene responsible for how it manifests]. Individuals differ in response to inflammation- possibly due to genetic factors (TNF gene). Treatment of impaired tissue oxygenation and critical illness most effective when given early to non-septic patients. Dietary/social/economic factors including smoking, diet, exercise, alcohol, employment status also be related to inflammatory response.

Conclusion, comments
Level 5 evidence. Genetic profiling may in future identify patients at prior risk of critical illness. Cardiac reserve- cardiac function assessment may be used. History of moderate exercise protects from cardiac events. Optimisation of cardiac output- basic principles of resuscitation, prophylactic use of modulators - dopexamine or dobutamine in high risk patients (major surgery), ACE, and prevention focused on healthy lifestyle may help. The MCT, or US concept of hospitalist -medical practitioner who acts as trouble-shooter, intermediate/ HDU care are presented as possible solutions. Quality good. Core paper- include.
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<tr>
<td></td>
<td></td>
<td>Prospective study</td>
<td>Quantitative</td>
<td>insufficient detail</td>
<td>core</td>
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Stenhouse C, Coates S et al 2000 Prospective evaluation of a modified Early Warning Score to aid earlier detection of patients developing critical illness on a general surgical ward *British Journal of Anaesthesia* 84, 5 p663

Prospective study over 10 months in 2 general surgical wards. After 1 month the EWS was modified by adding urine output, temperature changes were made less sensitive and a category for the patient’s normal blood pressure was included. [Limited information on method in research abstract].

Results

26/206 patients were admitted to ICU. Of these 26, APACHE II scores were 16.6 (±7.3). A further 11 patients not on the scoring system were admitted to ICU from the surgical wards - APACHE II scores on admission in this group were 22.3 (±5.5). In the 9 months before introduction of scoring system 43 were admitted to ICU from the surgical wards (possibly the same 2 as in the study?), and the APACHE II scores were 22.3 (±5.5). Conclusion- the modified EWS may result in earlier referral to ICU.

Conclusion, comments

Unable to rank level of evidence- research abstract. Criteria for placing patients on the scoring system in the first instance are not reported. The comparisons across the two time periods did not specify if the same two wards were being compared on both occasions. Future research could use a larger sample, undertake reliability checks in data extraction, specify how the staff were prepared for using the score. The prospective study could take place over a longer time period to measure the effect of using the scoring system. The criteria/cues included in the scoring system are based on clinical judgement; the original EWS was modified based on clinical judgement and research evidence from the first month of the study. The criteria included in the modified EWS were accessible to ward nurses: heart rate, respiratory rate, temperature, CNS, urine output, systolic BP, graded from 0-3. The threshold for triggering the ward medical staff was a score of 4 or greater. The ward medical staff called the ICU team as necessary. However 11 patients not in modified EWS group required admission to ICU. Study does not report cardiac arrest rates, DNR orders, ward mortality rates before and after introduction of system- therefore it is not possible to draw firm conclusions about efficacy of system. Include as frequently cited research- quality rating insufficient detail. Core paper.
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<tr>
<td>86</td>
<td>Quantitative</td>
<td>reasonable</td>
<td>core</td>
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</table>

**Method**

Prospective study

Surgical wards - pilot site. Used modified EWS (Morgan et al 1997)- omitted temperature, added urinary output/24 hours, reviewed values assigned to grades for heart rate (rationale behind modifications not stated). Score included in patient observation charts- score 0= normal, score 3=very abnormal. Score 3= trigger threshold for referral to medical and critical care outreach teams. Preparation of nursing and medical staff for MEWS undertaken (not described in detail). Data collected by outreach team- demographic data, MEWS score, level of care (DoH, 2000), presenting symptoms, diagnosis, location, interventions, outreach outcome. Compared to data on referrals to outreach before MEWS.

**Results**

Outreach service operates 0800-1600 hours, outside these hours bleed held in ICU -cover provided to wards from there. Outreach outcomes: discharge stable, admitted to critical care, not for resuscitation, death. Latter 3 categories defined as adverse events. During first 7 months of outreach 432 patients seen (total visits 976). In the 3 months pilot of MEWS 231 patients seen in 546 visits. Activity of outreach increased over this period. In 49% referrals patients scored MEWS 3 or greater. Most patients had 1 visit (range 1-17), some admitted to outreach multiple times- this group often had scores 3-5, MEWS >5 had less outreach activity due to transfer to ICU, death or NFR. Outreach activity limited by nurse resource. Most referrals to outreach were made through MEWS system after its introduction. Cues used most frequently - respiratory rate (52%), heart rate (24%). Most frequent interventions- advice re fluid administration, oxygen, types of observations and parameters to use, medication advice, nursing care and patient positioning. Increased MEWS tended to require more interventions. 920 interventions in 546 visits- 59% of outreach visits resulted in intervention. Most patients were discharged from outreach stable, but hospital outcome data not available. During MEWS pilot 4/231 (2%) patients seen by outreach died, 16/231 (7%) categorised not for resus, 23/231 (10%) admitted to critical care. Respiratory rates were recorded more frequently after MEWS introduced (13.6% before, 82% after). Staff perceptions of outreach service were positive.

**Conclusion, comments**

Level 4 evidence. Referrals can be made by medical staff and nursing staff and through post ICU transfer reviews. Small sample - conclusions about effect of MEWS on outcome cannot be made, generalisability to specific patients e.g. pancreatitis cannot be made. Not possible to separate out effect of MEWS outreach team, or pre-implementation education on the results. Hospital outcome data not included - not able to assess effect of system on patient outcome. Quality reasonable. Core paper.
Sterling C, Barrera Groba C 2002 An audit of a patient-at-risk trigger scoring system for identifying seriously ill ward patients *Nursing in Critical Care* 7 (5) pp 215-218

**Method**

Audit prospective study

PAT system - criteria previously tested in two separate audits of medical and surgical patients and current study reports on a larger trial of this system. Criteria included HR, BP, RR, Oxygen saturation, SpO2 <60%, FiO2, core temp., LOC, Urine output/2 hours, pain rating 0-4 from normal to severely abnormal. *Trigger score* >5 or more nurses completed audit chart. Uses existing referral systems- patients at risk being referred to med/surgical medical team who assess, treat and refer patients. Audit team- *outreach interest group*. Data collected prospectively using pre-specified chart for audit when score 3 or more reached: observations, PAT score, time of call to doctor, time doctor attended, outcome on the day, demographics and hospital number -accessed hospital outcome later. Data collected on ICU admissions, cardiac arrest calls from wards in study.

**Results**

278 medical Adm. (60 triggered-21%), 341 surgical patients (10 triggered-3%) -total 70. Of these 12 ICU admissions, 1 cardiac arrest for study period. 53% patients with scores >5 died. Study extended in 2 wards and 21 more triggered patients were included in analysis. Reasons for triggering -most common were respiratory failure, heart failure and sepsis. Time interval to being seen- 6% seen <1 hour, 8% were not seen within 1 hour. Patients who triggered -9% admitted to HDU/same day, 6.6% adm. same day to ICU, 16% had DNR order made. 43% of triggered patients improved, 2.5% deteriorated on same day (excluding DNR patients). Results for total patients who triggered- 51% died, 11% discharged home, 3% transferred, 21% still in same hospital by end of audit period. There were 14 ICU adm. from study wards during audit period, and 1 cardiac arrest on the ward for a patient who had triggered earlier.

55 observation charts were randomly selected and analysed- 40% had no observations/ PAT scores documented. In other cases parameters were omitted, notably respiratory rate (17%). For the 14 ICU admissions, 67% had no documented PAT scores- charts either not completed or no observation charts in notes.

**Conclusion, comments**

Level 4 evidence. Limitation small study, and large numbers of patients observation records either not completed or incomplete. High mortality in patients who triggered (51%) could suggest that patients were being identified too late. Medical patients triggered more often than surgical patients. Some chronically ill patients triggered frequently - resulted in negative comments from junior doctors and nurses as calls for senior help deemed unnecessary. Further work needed- acute change in score appropriate reason to summon senior help in chronically ill patients. Large numbers of observations undertaken by HCAs further complicated the implementation of the PAR-T audit area for further work in development of Alert zones and referral to registered nurse. Quality- reasonable, core- include in review.
Carberry M 2002 Implementing the modified early warning system: our experiences Nursing in Critical Care 7 (5) pp 220- 226

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<th>Number</th>
<th>Type of study</th>
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<th>Subject</th>
<th>Sample</th>
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<tr>
<td>88</td>
<td>quantitative</td>
<td>reasonable</td>
<td>core</td>
<td>Modifications of the early warning system, preparation of medical, nursing and paramedical staff, results of pilot study.</td>
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**Method**

Prospective observational study

Modifications to EWS score were: patients appropriate for inclusion (those receiving active treatment and not categorised as not for resuscitation), systolic BP changed to reflect range of values rather than changes from patient’s normal BP; urine output measured in ml/ hr; and an algorithm detailing process to be followed according to score values trigger score ≈ 4 or more. Data collected prospectively by ward nurses during trial period.

**Results**

Returned completed MEWS forms -290 (87%) of trial population. 26 forms excluded as illegible or incomplete, and 16 not returned. Of 2,216 sets of observations 218 (9%) resulted in trigger score of 4 or higher. Of 332 patients in the audit 14 (4%) were Adm. to ICU (n=10), HDU (n=4). In the group of 14 transferred patients 11 were scored on MEWS and 3 had no score. ICU and HDU admissions range between scores of 4-11 (median 8), 13 calls had delayed response by medical staff (>10 mins). Anuria >2 hours in non- catheterised patients noted for future amendment.

**Conclusion, comments**

934 total surgical admissions to 5 study wards during trial. 332 (35%) patients were placed on the MEWS trial.

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Robson W 2002 An evaluation of the evidence base related to critical care outreach teams- 2 years on from Comprehensive Critical Care Intensive and Critical Care Nursing 18 pp 211-218.

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<th>Sample</th>
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<tr>
<td>89</td>
<td>Review</td>
<td>Reasonable</td>
<td>background</td>
<td>Limited evidence that EWS and critical care outreach teams have reduced cardiac arrests on wards, reduced unplanned critical care admissions, or resulted in earlier referrals to critical care.</td>
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</table>

**Method**

Review (not systematic)

Selective review of the literature on health policy documents and critical care outreach.

**Results**

Research evidence for recommendation to establish critical care outreach was not made explicit in the DoH (2000) Comprehensive Critical Care document. Many of the studies influencing current developments are based on observational studies that would not rank high in a hierarchy of evidence- outreach was introduced without thorough evaluation. Educational initiatives have focused on key skills in the recognition and treatment of critical illness (e.g. ALERT 2000 a multidisciplinary course in acute life threatening events- recognition and treatment by medical consultant Gary Smith, in Portsmouth). If support workers and nursing auxiliaries are undertaking vital signs monitoring they need to know when clinical observations indicate that a patient is deteriorating and the qualified nurse should be informed. The organisation of medical teams may also require review- junior doctors often have an excessive work load and supervision may be inadequate. Physiological scoring systems have been introduced but the evidence underpinning them is weak. Outreach teams could potentially reduce the availability of experienced nurses in ICU. Potential for closer outreach team collaboration with pain teams- may lead to improved ward care. To date there is limited evidence that outreach has improved patient outcomes, or that the money spent has been worthwhile- a challenge for future research.

**Conclusion, comments**

Level 5 evidence. Evidence that outreach has improved patient outcomes has yet to be demonstrated. Not a systematic review, but useful commentary on current practice. Does not analyse contribution of particular cues to the prediction of critical illness and cardiac arrest in detail. Include as background.
Results
Findings reported under context and 3 categories from the literature- compatibility, relative advantage and practical applicability. Verbatim quotes supported the categories. Context described medical and nursing staffing including long term sickness of G grade sister and recent departure of F grade sister- ward managed by G grade sister from neighbouring ward. Nurses reported that many of their patients were highly dependent or seriously ill. Staffing problems perceived inadequate for needs of patients. DoH (2000) and Audit commission (1999) studies focused on education and training needs of ward staff rather than workload and inadequate staffing-nurses in current study reported having inadequate time to care for patients effectively. Research on recognition of seriously ill patients on the wards has not acknowledged impact of nursing in this area or their capacity to pick up deterioration if they are too busy. Compatibility referred to how learning equipped the nurse for the demands of the organisation. Assessment skills important, both in picking up new problems through formal monitoring or by chance informal methods. Role boundaries between medical and nursing staff were a source of conflict. Collaboration - with medical staff was not optimal, nurse reported knowledge deficits in junior doctors and how nurses shared knowledge for the benefit of the patient. Lack of collaboration - doctors didn’t always review patients the nurses were concerned about. Relative advantage refers to how knowledge empowered the nurses- physiology enabled them to make accurate clinical judgements and take action. Contrasts cognitive skills required in clinical judgement with behavioural competencies foci in DoH (2000). Knowledge of oxygenation, fluid management important areas.

Conclusion, comments
Level - qualitative study. Study set out to describe the context of ward-based critical care nursing in one surgical ward. Findings relate to one surgical ward and 7 participants at particular time therefore limiting generalisability. Cues involved in clinical judgements were not examined in detail. Categories were supported with relevant verbatim quotes. Validity checks were undertaken with respondents. Subsequent developments- EIDU and outreach service introduced since study was completed. Quality- reasonable. Include as core paper.

Method
Focused ethnographic case study
A focused ethnographic case study according to Morse (1990). Data collection- semi-structured in depth interviews with 7 qualified nurses. Local staffing situation was reported. Data analysis- interviews transcribed verbatim by the researcher. Nurses validated that each transcript was accurate and permitted its use in analysis. Descriptive names rather than codes were used in the analysis of text. Selected participants checked the suitability of the names- part of validity checking. Results of analysis were related to literature. Permission to undertake study gained from Director of Nursing and surgical ward manager (not hospital ethics committee).

Judgemental sampling technique (after Fetterman, 1998) - individuals were approached by the researcher if he considered they would be able to contribute information relevant to the research question and convenience sampling was used. Total-7 participants in a 34 bed surgical ward.

Cutler L R 2002 From ward-based critical care to educational curriculum 2: a focussed ethnographic case study Intensive and Critical Care Nursing 18 pp 280-291

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Method summary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Focus</td>
<td>qualitative</td>
<td>reasonable</td>
<td>core</td>
</tr>
</tbody>
</table>

The culture and context of ward-based critical care nursing in one surgical ward.
Lawrence A, Havill JH 1999 An audit of deaths occurring in hospital after discharge from the intensive care unit *Anaesth Intensive Care* 27 pp 185- 189

Method

Retrospective review. Patients divided into survivors, ICU deaths and ward deaths. Demographic, APACHE II scores assessed for all patients. Sample- ward deaths examined in depth- divided into expected to die at ICU discharge group 1, and patients who died on the ward group 2- inclusion criteria defined. Group 2 patients divided into 1) death not expected, 2) death likely within 1 year of discharge. Cause of death recorded.

Results

Of 6741 admissions, 825 were repeats (therefore 5,916 patients). 5,283 (89%) survived hospital, 525 (9%) ICU deaths, 108 (2%) ward deaths (but 9 missing data sets in latter group). Ward death patients were older than other groups. APACHE II scores highest for ICU deaths, next highest were expected deaths on wards, then unexpected ward deaths, lastly, survivors had lowest scores. Ward deaths mean length of stay in ICU -138 hours- a longer ICU stay than ICU deaths or survivors. Of ward deaths expected deaths mean hospital stay was 12 days compared to 24 days for other ward deaths. Main causes of death in ward patients were cardiac arrest or failure, hypoxic brain damage, CVA, renal failure, and respiratory failure. 22 of the 99 ward death patients had previous admission to ICU and 8 of these (36%) had potentially avoidable events that resulted in ICU admission and later death. Results generally reflect deaths due to ongoing organ failure rather than deficient post-ICU ward management.


Conclusion, comments

Level 4 evidence. Patients were prospectively judged as expected to die by ICU staff, but other groups were classified retrospectively. Findings do not support poor ward care contributing to death found in Wallis et al (1997). Limitations- conducted in one site, and potential for bias associated with retrospective studies (9 missing patient records). Quality reasonable. Background paper.

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Method summary</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>quantitative</td>
<td>prospective cohort study</td>
<td>reasonable</td>
<td>core</td>
<td>Investigated if patients' activity of daily living (ADL) function contributed information for prognosis and case mix taking into account routine physiologic measures and comorbid diagnoses.</td>
</tr>
</tbody>
</table>

**Method**
Analysis draws on 2 longitudinal studies of changes in functional status (inclusion/exclusion criteria reported earlier). Within 48 hours of adm, primary nurse provided data on capacity to independently perform 6 ADLs [bathing, dressing, grooming, transferring, eating and toileting]. Also Adm. Apache II APS score, Charlson comorbidity score, demographic data collected and discharge data, admission to nursing home after discharge. Patients divided into 4 groups by dependency in ADLs (0, 1-3, 4-5, or 6). Outcome measures - hospital and 1 year mortality, nursing home< 90 days after discharge, costs of hospital treatment.

**Results**
Study based on research evidence that functional status is related to mortality. X² test for bivariable associations, logistic regression to examine functional status as independent predictor of mortality, nursing home Adm., costs. ROC curves compared if ADL function improved model of mortality (hospital and at 1 year) based on APS, Charlson scores, and on both APS and Charlson scores. ADL category differentiated between levels of mortality and costs. No ADL dependencies on adm. contributed 0.9% hospital mortality, dependency in all ADLs resulted in 17.4% hosp mortality (p<0.001). 1 year mortality increased with dependency in ADLs (range from 17.5% to 54.9%; p<0.001). Nursing home use also increased with full ADL dependencies (35% vs 33%; p=0.001). Multivariate analysis (APS, Charlson scores, demographic details controlled) compared patients with no dependencies with group that had dependencies in all ADLs. All dependencies group were at > risk of hospital death (OR 13.7; 95% CI 3.1-58.8), mortality at 1 year (OR 4.4; 2.7-7.4), nursing home adm. (OR 14.9; 6.0-37.0). Costs of hospitalisation were 50% greater in all ADLs dependencies group.

**Conclusion, comments**
Level 1b evidence. ADL assessment- interrater reliability was not assessed. Supports functional status as factor that contributes information to mortality prediction in this group of elderly patients. Requires validation in other settings. Quality reasonable. Subjective assessments of patient ADL activity were required, but not checked. Include. Core paper.
**Number** | **Type of study** | **Method summary** | **Quality rating** | **Category** | **Subject** |
--- | --- | --- | --- | --- | --- |
93 | Quantitative | reasonable | background | Investigated hospital deaths to identify if some were preventable. |

**Method**

Method consisted of 4 phases. **Phase 1**: Development of a sampling method for selection of medical records. **Phase 2**: Used pre-specified forms to summarise hospital course for patients who died and expert panel decided if deaths were probably preventable. **Phase 3**: Comparison of demographic and severity of illness data for patients in probably preventable and non preventable groups. **Phase 4**: Development of screening tool to identify preventable deaths in high risk patients, and to review hospital deaths retrospectively to identify probably preventable ones.

**Results**

The 377 medical records included CVA (105), pneumonia (132), myocardial infarction (140). 182 deaths were reviewed. Deaths were more common in older patients (77.6 vs. 73.6, p < 0.001), nursing home residents before hospital admission (29% vs. 18%, p < 0.01), and in patients with dementia (22% vs. 12%, p < 0.01). APACHE II scores on admission were greater in patients who died (19.7 vs. 12.9, p < 0.001). 3 judges reviewed the deaths - 27% were preventable based on agreement of at least 2 of the 3 judges, all 3 judges agreed that 14% were probably preventable. 9 factors captured most of the reasons for preventable deaths: inadequate treatment of angina, fluid management, control of arrhythmias, haemodynamic monitoring, incorrect antibiotics, airway or oxygen management problems, diagnosis, treatment of cerebral oedema, management of sepsis, and other reasons. In MI patients management of care was at fault (inadequate treatment of angina), whereas diagnostic errors were present in CVA cases. DNR orders were more frequent in non preventable deaths group (54% vs. 35%, p < 0.05). Not able to state particular cues that predicted preventable deaths. Disagreement between reviewers in study- low inter-rater correlation coefficient agreement in pneumonia cases (0.11), high agreement in CVA cases (0.55). Depending on the threshold used, between 14% and 27% deaths were judged preventable and there was no significant difference in preventable deaths between conditions.

**Conclusion, comments**

Level 4 evidence. Generalisability limited as study hospitals all owned by same investor, non-teaching, and study hospitals were at the extremes of high and low death rates. Focused on 3 conditions making up 36% of hospital deaths - results for other conditions unknown. Disagreement between reviewers was common. Background paper.

Method
Prediction model and validation in separate data set.

Using logistic regression analyses and developed triage model based on patients discharged from ICU at Guy's hospital. Outcome measures: mortality after ICU discharge, and predictive power of model. Candidate variables for model were identified by univariate analysis and significant variables for survival were inserted into logistic regression model. Complex method of model development was reported - ROC used to identify the optimum model. Validation of triage model undertaken with a separate data set from later period at Guy's and 19 other ICUs. SPSS version 9.0 used in data analysis. X² used for analysis categorical data.

Results
Mortality after ICU discharge - 12.4%. Patients assigned to 1 of 4 groups depending on patients prediction of risk for a particular day - group 0 denoted patients at risk on day of discharge through to group 3 patients not at risk in 48 hours before discharge from ICU. Variables included in models were APS, LOS in ICU, TISS score, duration of mechanical ventilation, dialysis, age, chronic ill health, failing organs, ± cardiothoracic surgery. Forward stepwise regression on 20 data sets identified 5 variables: age, chronic health points, APS points at ICU discharge, LOS in ICU, ± cardiothoracic surgery. The model with the best sensitivity (65.5%) and specificity (87.6%) cut-off at 0.6 was selected for the validation study (ROC 0.86). In validation phase 34% at risk patients had discharge mortality 25%, whereas not at risk had a 4% mortality. ROC 0.8 in validation data set. Relative risk of mortality calculated for the 4 groups. If at risk patients remain in ICU a further 48 hours discharge mortality could be reduced by 39%.

Conclusion, comments
Level 1b study. Model for identification of ICU patients prediction of risk at time of discharge-staying in ICU a further 48 hours substantially reduced mortality. This has implications for numbers of ICU beds- 16% increase in beds needed to cover additional 48 hours in ICU. Riyadh ICU program enabled information about patients to be accessed daily. Quality- good. Include in review.

<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
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<tbody>
<tr>
<td>95</td>
<td>Quantitative</td>
<td>reasonable</td>
<td>core</td>
<td>Sample</td>
</tr>
</tbody>
</table>

Description of reasons for summoning the MET and outcome of MET activation.

Method

Retrospective review

Retrospective analysis of MET calls for 12 month period in 1998. Data collected using predesigned form completed by MET leader after each MET activation, entered into a database missing data followed up weekly. Included all MET calls in 12 month period; n=800. 87 calls were excluded from study. Excluded calls for non- inpatients, and patients in emergency department. Total included in study: 713 calls to 559 patients; 55.5% male, mean age 64.5 years (range 38-98 years). Location: Liverpool hospital, Sydney, Australia.

Results

252 (45%) patients were admitted to ICU, 49 (6.9%) died during MET session. 102 patients had >1 MET call made. Reasons cases for summoning MET - most common was a drop in GCS >2 (n=115); next most common was fall in systolic BP <90 mmHg, and respiratory rate >35 (n=109) was the third most common reason. Worried category was used alone in 83 (12%) MET calls and 13 (16%) of these patients were transferred to ICU where none died. Total number cardiac arrests 61 (8.6%) and 35 (59%) died. 20% patients with respiratory arrest or HR <40 died. Patients with NFR orders did not have MET activation, but 130 patients were judged appropriate for NFR by MET during the MET activation. MET criteria: Airway threatened: Breathing - respiratory arrest, or rate <5, or respiratory rate >36; Circulation all cardiac arrests, pulse <40, pulse >140, systolic BP <90 mmHg: Neurological sudden drop in LOC, fall in GCS > 2 points, repeated or continuing fits: Other patients causing concern who do not fit in the above.

Conclusion, comments

Level 4 evidence. The worried category requires further research - patients may benefit from earlier intervention and nurses who make most MET calls draw on their subjective assessments of patients using this category. Worried category was used alone in cases of bleeding, cardiovascular problems, neurological abnormalities, respiratory deterioration, rigors, febrile, hypoglycaemia, and the largest number had no reason stated. The PART (Goldhill et al 1999) criteria do not have a worried category. More difficult to draw conclusions about overall cardiac arrests rate of 61 in the study period (other developments may have affected this rate which was lower than previously).


<table>
<thead>
<tr>
<th>Number</th>
<th>Type of study</th>
<th>Quality rating</th>
<th>category</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>Literature review.</td>
<td>reasonable</td>
<td>core</td>
<td>Exploratory review of the literature on critical care outreach and early warning scoring systems.</td>
</tr>
</tbody>
</table>

33 potential papers for inclusion were identified and 9 were selected for inclusion due to their relevance.

Results

Criteria for inclusion and exclusion were not stated explicitly. Theoretical framework for review not presented in depth and specific review questions not stated exploratory review. Presented critiques of papers selected for inclusion in review. Argued that some scores are too precise e.g. PART where patients have to fulfil three criteria to be referred, and sensitivity, specificity and utility of others such as the EWS have yet to be shown. Evidence for effectiveness of outreach not yet available, limitations of introducing nurse-led teams in terms of their acceptance by ward medical staff, and potential depletion of critical care staff in HDU/ICU.

Conclusion, comments

Level 5 evidence. Raises many points in discussion - potential deskilling of ward staff, importance of educational initiatives in MET outreach activities, potential fragmentation of care, assessment skills should be developed rather than encouraging reliance on particular physiological parameters, need for 24 hour outreach service to support staff on wards caring for these patients, need to identify ward staff educational requirements in critical care skills, need to have staff on wards able to recognise and care for patients with early signs of developing critical illness. Further research required on how nurses make decision to call a doctor and elements underpinning these decisions. Include paper.
## Appendix 6

### Inter-rater reliability coding checks

<table>
<thead>
<tr>
<th>Category</th>
<th>APACHE III</th>
<th>APACHE APS</th>
<th>APS</th>
<th>MET</th>
<th>ASA</th>
<th>Pulse</th>
<th>BP</th>
<th>RR</th>
<th>ABGs</th>
<th>O2therapy LOC/GCS</th>
<th>LOC/GCS</th>
<th>Temporal Administered</th>
<th>Delayed response</th>
<th>New Comps</th>
<th>Urine output</th>
<th>Biochem</th>
<th>Clinical states</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apac 1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>Apac 5</td>
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<td>1</td>
</tr>
</tbody>
</table>

**Note:**
- The table above represents the inter-rater reliability coding checks.
- The numbers indicate the number of agreements for each category.
- The columns represent various parameters such as APACHE III, APACHE APS, APS, MET, ASA, Pulse, BP, RR, ABGs, O2therapy LOC/GCS, LOC/GCS, Temporal Administered, Delayed response, New Comps, Urine output, Biochem, and Clinical states.
- The total number of agreements is calculated by summing all the rows.
- The percentage of reliability is calculated by dividing the sum of agreements by the total number of agreements and multiplying by 100.
### Appendix 7.

**Definition of fields used in the content analysis of cues**

for predictors of cardiopulmonary arrest, critical illness, post-operative complications, readmission to ICU and mortality/ outcome

<table>
<thead>
<tr>
<th>Field name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>All references to age</td>
</tr>
<tr>
<td>Demographic</td>
<td>All references to gender</td>
</tr>
<tr>
<td>Admission disease process</td>
<td>All references to admission disease, illnesses, reasons for admission</td>
</tr>
<tr>
<td>Type of admission</td>
<td>All references to planned, unplanned, medical, surgical admission</td>
</tr>
<tr>
<td>Medical history</td>
<td>All references to medical history and chronic conditions</td>
</tr>
<tr>
<td>Haematology</td>
<td>All references to haematological values</td>
</tr>
<tr>
<td>Respiratory</td>
<td>All references to respiratory conditions</td>
</tr>
<tr>
<td>Cancer</td>
<td>All references to cancer</td>
</tr>
<tr>
<td>Neurological</td>
<td>All references to neurological conditions</td>
</tr>
<tr>
<td>Cardiac</td>
<td>All references to cardiac conditions</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>All references to haemorrhage</td>
</tr>
<tr>
<td>Renal</td>
<td>All references to renal conditions</td>
</tr>
<tr>
<td>Medication</td>
<td>All references to medications, drugs</td>
</tr>
<tr>
<td>Intuition</td>
<td>All references to the terms intuition or intuitive judgements</td>
</tr>
<tr>
<td>Clinical state</td>
<td>Study focus as cardiopulmonary arrest, critical illness, early post operative complications, ICU readmission, mortality/ outcome</td>
</tr>
<tr>
<td>Predictors of cardiopulmonary arrest/ critical illness/ early post operative complications/ ICU readmission/ mortality/ outcome</td>
<td>Cues according to study focus</td>
</tr>
<tr>
<td>Scores</td>
<td>All references to scores* Apache II, Apache III, APS, EWS, PAR, MET, SAS, ASA, TISS, SAPS II, PAM</td>
</tr>
<tr>
<td>Physiological cues</td>
<td>All references to pulse, blood pressure (BP), respiratory rate, temperature, urine output, electrocardiograph (ECG), chest x-ray (CXR), Body mass index (BMI), arterial blood gases (ABGs), oxygen (O₂) treatment, biochemical indicators, blood sugar, peripheral oxygen saturation or arterial blood (SPO₂), fluid balance</td>
</tr>
<tr>
<td>Field name</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Behavioural cues</td>
<td>All references to colour, level of consciousness, muscle tone, dyspnoea, chest pain, nausea/vomiting, patient distress, restlessness, patient position, rambling, thirst, clammy, fits, cold, airway obstruction, lethargy.</td>
</tr>
<tr>
<td>Judgement</td>
<td>All references to clinicians’ estimation of severity of illness, functional status, seriously worried (about a patient), stability.</td>
</tr>
<tr>
<td>Functional status</td>
<td>All references to patients’ functional status and includes ability to perform activities of living such as mobilising, personal hygiene care and eating and drinking.</td>
</tr>
<tr>
<td>Patient self-report</td>
<td>All references to patients’ reports of symptoms.</td>
</tr>
<tr>
<td>Psychological</td>
<td>All references to psychological state such as anxiety, mood, and fear.</td>
</tr>
<tr>
<td>Temporal</td>
<td>All references to clinical course over time and change in condition within a specified time. Also change in practice e.g. comparison pre and post introduction of medical emergency team (MET.)</td>
</tr>
<tr>
<td>New complications</td>
<td>All references to new diseases, illnesses, conditions (including consequences of procedures).</td>
</tr>
<tr>
<td>Original condition worse</td>
<td>All references to deterioration in original condition.</td>
</tr>
<tr>
<td>Administrative</td>
<td>All references to patients’ location (ward), length of stay (in ward, ICU, or hospital).</td>
</tr>
<tr>
<td>Delayed response</td>
<td>All references to delays in response, delays in treatment, inadequate response, organisational failures.</td>
</tr>
<tr>
<td>Strength of evidence for cues</td>
<td>Judgement of strength of evidence for predictors based on level of study in hierarchy of evidence by study type, quality appraisal of study, method of statistical analysis used. Minimal criteria used for each category:─  &lt;br&gt;  <em>Strong</em>- Study quality good, sample size good, inferential statistics. &lt;br&gt;  <em>Moderate</em>- Study quality reasonable, sample size reasonable, inferential or good descriptive statistical analysis. &lt;br&gt;  <em>Weak</em>- Study quality reasonable, sample size limited. &lt;br&gt;  <em>Other</em>- Background paper, exclude paper, qualitative paper (for qualitative studies the alternative quality criteria for qualitative studies were applied – see Appendix 1).</td>
</tr>
</tbody>
</table>

**Key**  
* see Appendix 12 for scores
Appendix 8
Data entry sheet for predictor cues
Three completed example sheets are shown.
<table>
<thead>
<tr>
<th>Author Year</th>
<th>Smith A F, Wood J (1998)</th>
<th>number</th>
<th>63</th>
<th>category</th>
<th>core</th>
</tr>
</thead>
</table>

- age
- physiological reserve
- Adm disease process
- Medical history
- type of admission

- demographic
- respiratory
- cancer

- haematology
- sepsis
- neurological
- haemorrhage

- Medication
- renal
- medication
- intuition

### Clinical State

#### Antecedents to in-hospital

- Predictors of cardiopulmonary arrest
- Most frequent signs: Tachypnoea (RR > 25)
- Predictors of critical illness
- Predictors of early post op comp
- Predictors of ICU readmit
- Predictors of mortality/outcome

### Scores

- APACHE II score
- APACHE III score
- APS score
- EWS score
- PAR score
- MET score
- SAS score
- ASA score
- TISS
- SAPS II score
- PAM index

### Physiol. Cues

- pulse
- BP
- Resp.Rate
- temperature
- urine output
- ECG
- CXR
- BMI
- ABG
- O2 Rx
- biochem
- blood sugar
- GI bleeding
- SPO2

### Behaviour

- colour
- LOC
- muscle tone
- dyspnoea
- chest pain
- nausea vomiting
- pt distress
- restlessness
- pt position
- rambling
- thirst
- clammy
- fits
- cold
- airway obstruct
- lethargy

### Judgement

- severity of illness
- functional st
- seriously worried
- stability
- pt self report
- psychological
- temporal
- new complications
- admin
- original condition worse
- delayed response

**strength of evidence**

- strong
- moderate
- weak
- Other..
Predictors of cardiopulmonary arrest
- Raised respiratory rates <72 hours

Predictors of critical illness

Predictors of early post op comp

Predictors of ICU readmit

Predictors of mortality/outcome

Scores
- APACHE II score
- APACHE III score
- APS score
- EWS score
- PAR score
- MET score
- SAS score
- ASA score
- TISS
- SAPS II score
- PAM index

Physiol. Cues
- pulse
- BP
- Resp.Rate
- temperature
- urine output
- ECG
- CXR
- BMI
- ABG
- O2 Rx
- biochem
- blood sugar
- GI bleeding
- SPO2

Behaviour
- colour
- LOC
- muscle tone
- dyspnoea
- chest pain
- nausea vomiting
- pt distress
- restlessness
- pt position
- rambling
- thirst
- clammy
- fits
- cold
- airway obstruct
- lethargy

Judgement
- severity of illness
- functional st.
- seriously worried
- stability
- pt self report
- psychological
- temporal
- new complications
- admin
- original condition worse
- delayed response

strength of evidence
○ strong
○ moderate
○ weak
○ Other..
Appendix 9.

Sample size summary core quantitative papers by clinical states.

<table>
<thead>
<tr>
<th></th>
<th># of papers</th>
<th>Sample Size</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>std deviation</td>
<td>minimum</td>
<td>maximum</td>
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<tr>
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<td>Cardiopulmonary arrest</td>
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<td>263</td>
<td>271</td>
<td>47</td>
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<tr>
<td>Critical illness</td>
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<td>675</td>
<td>1270</td>
<td>63</td>
<td>5790</td>
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<td>804</td>
<td>739</td>
<td>160</td>
<td>2153</td>
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<tr>
<td>ICU readmission</td>
<td>4</td>
<td>4938</td>
<td>6390</td>
<td>295</td>
<td>14344</td>
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<tr>
<td>Mortality/ outcome</td>
<td>29</td>
<td>2037</td>
<td>3589</td>
<td>63</td>
<td>13924</td>
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<td><strong>By Strength of Evidence</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>strong evidence</td>
<td>4</td>
<td>9829</td>
<td>4404</td>
<td>4301</td>
<td>13924</td>
</tr>
<tr>
<td>moderate evidence</td>
<td>23</td>
<td>1686</td>
<td>3103</td>
<td>63</td>
<td>14344</td>
</tr>
<tr>
<td>weak evidence</td>
<td>29</td>
<td>484</td>
<td>521</td>
<td>47</td>
<td>1905</td>
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<tr>
<td><strong>Overall</strong></td>
<td>all papers</td>
<td>56</td>
<td>1711</td>
<td>3338</td>
<td>47</td>
</tr>
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</table>

Table A9-i Sample size for core quantitative papers by clinical states and strength of evidence.
Appendix 10.

Sample size summary core quantitative papers by strength of evidence.

<table>
<thead>
<tr>
<th># of papers</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>Average</td>
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<tr>
<td><strong>Strong evidence</strong></td>
<td></td>
</tr>
<tr>
<td>disease process</td>
<td>4</td>
</tr>
<tr>
<td>medical history</td>
<td>4</td>
</tr>
<tr>
<td>type of admission</td>
<td>3</td>
</tr>
<tr>
<td>age demographic</td>
<td>3</td>
</tr>
<tr>
<td>admin</td>
<td>2</td>
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<tr>
<td><strong>Moderate evidence</strong></td>
<td></td>
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<tr>
<td>type of admission</td>
<td>10</td>
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<tr>
<td>admin</td>
<td>10</td>
</tr>
<tr>
<td>temporal</td>
<td>9</td>
</tr>
<tr>
<td>new complications</td>
<td>8</td>
</tr>
<tr>
<td>BP</td>
<td>8</td>
</tr>
<tr>
<td><strong>Weak evidence</strong></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>17</td>
</tr>
<tr>
<td>RR</td>
<td>15</td>
</tr>
<tr>
<td>temporal</td>
<td>13</td>
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<tr>
<td>pulse</td>
<td>13</td>
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<tr>
<td>LOC</td>
<td>13</td>
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</tbody>
</table>

Table A10-i Statistics for core quantitative papers. Sample size for the five most frequently reported cues in papers categorised as; strong, moderate, or weak.
Appendix 11.

Figures for calculation of applicability of Central Limit Theorem

To check that central limit theorem was applicable the boundary of Altman (1991) was used, where “p and 1-p are both greater than 5/n where p is the proportion and n is the sample size” (cited in Jordan et al., 1998, p.112).

The boundary on p is given in Table A11.1 for each set and for over all the papers. For three sets, “post op comp”, “ICU readmit” and “strong” the sample size is too small and the boundary is greater than 50%.

Table A11.1 The portion boundary, 5/n, for which central limit theorem is applicable for each set (from Altman, 1991). Sets were the theorem can never be applicable are marked in italic.

<table>
<thead>
<tr>
<th></th>
<th>overall</th>
<th>cardio</th>
<th>critical</th>
<th>post op comp</th>
<th>ICU readmit</th>
<th>mortality outcome</th>
<th>strong</th>
<th>moderate</th>
<th>weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size, n</td>
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<td>14</td>
<td>23</td>
<td>6</td>
<td>4</td>
<td>29</td>
<td>4</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>5/n (%)</td>
<td>8.9</td>
<td>35.7</td>
<td>21.7</td>
<td>83.3</td>
<td>125</td>
<td>17.2</td>
<td>125</td>
<td>21.7</td>
<td>17.2</td>
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</table>

The p values for each cue are tabulated for each set with boundary less than 50% in Table A11.2. When p and p - 1 are within the boundary for that set the value is highlighted in bold text and underlined.

Table A11.2 Portion, p (%), per cue for each set. Where central limit theorem is applicable the table entry is underlined in bold.

<table>
<thead>
<tr>
<th>cues</th>
<th>overall</th>
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<th>critical</th>
<th>mortality outcome</th>
<th>moderate</th>
<th>weak</th>
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<tbody>
<tr>
<td>BP</td>
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<td>57</td>
<td>57</td>
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<td>22</td>
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<td>0</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>7</td>
</tr>
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</table>
Appendix 12.

Cue composition of indexes identified in systematic review papers.

<table>
<thead>
<tr>
<th>Index</th>
<th>Source</th>
<th>Items</th>
<th>Weighting</th>
<th>Time calc.</th>
<th>Variables</th>
<th>Score calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apache II</td>
<td>Clinical judgement and multivariate analysis</td>
<td>12 physiological variables, age and chronic health.</td>
<td>0-4 for variables in APS, increased weight given to GCS and serum creatinine.</td>
<td>Most abnormal measures in first 24 hours after ICU admission.</td>
<td>APS- Temperature, Mean arterial BP, Heart rate (HR), respiratory rate (RR), oxygenation, arterial PH, serum sodium, potassium, and creatinine, haematocrit, WBC, GCS. Age- 5 groups Chronic health- long term organ problems (defined), operative status</td>
<td>Sum of APS (higher score with increased severity), Age 5 groups (points increasing with age) and Chronic Health points - 2 points for elective post operative, 5 points for non-op or emergency post op).</td>
</tr>
<tr>
<td>Apache III</td>
<td>Clinical judgement and multiple regression analyses</td>
<td>17 physiological variables, age and chronic health.</td>
<td>Adjusted weights for extreme physiological measures, added 5 new variables, excluded serum potassium and bicarbonate, modified and simplified application of GCS. Missing values- 0 weight.</td>
<td>As above- APACHE II.</td>
<td>Physiology score- pulse, mean BP, temperature, RR, PaO₂, or A-aDO₂ (intubated and FI O₂ &gt; or equal to 0.5), haematocrit, WBC, creatinine ARF, urine output, BUN, sodium, albumin, bilirubin, glucose. Used equation to establish weights for chronic health (0-23) and age (0-24).</td>
<td>APACHE III score produces a number between 0- 299 based on sum of physiological score (0-252), age (0-24), chronic health (0-23).</td>
</tr>
<tr>
<td>Early warning score (EWS)</td>
<td>Clinical judgement.</td>
<td>5 physiological variables.</td>
<td>Normal values score 0, abnormal values score 1-3 points.</td>
<td>Routine observation.</td>
<td>HR, BP, RR, Temperature, CNS.</td>
<td>Score trigger threshold 3.</td>
</tr>
<tr>
<td>Modified EWS (Subbe C P et al., 2001)</td>
<td>Clinical judgement.</td>
<td>5 physiological variables.</td>
<td>Normal values score 0, abnormal values score 1-3 points.</td>
<td>Routine observation</td>
<td>Systolic BP, HR, RR, Temp., Alert, verbal, pain, unconscious (AVPU) score.</td>
<td>Score 5 or more- critical.</td>
</tr>
<tr>
<td>Index</td>
<td>Source</td>
<td>Items</td>
<td>Weighting</td>
<td>Time calc.</td>
<td>Variables</td>
<td>Score calculation</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>-------</td>
<td>-----------</td>
<td>------------</td>
<td>-----------</td>
<td>------------------</td>
</tr>
<tr>
<td>The Patient at Risk Score Goldhill D R, Worthington L et al., (1999)</td>
<td>Clinical judgement.</td>
<td>6 Physiological variables and doctor seriously worried.</td>
<td>A. Senior nurse criteria for calling doctor- any 3 or more abnormal variables, or decreased LOC and RR &gt; or equal to 35 breaths/min. B. registrar and above can call patient at risk team directly.</td>
<td>Routine use.</td>
<td>RR, arterial systolic BP, HR, decreased level of consciousness (LOC), oxygen saturation, urine output, decreased LOC combined with raised RR, or raised HR;</td>
<td>Score- 3 or more abnormal variables, or senior doctor concern, or when patient's condition fails to improve doctor or senior nurse (in emergencies) may call team.</td>
</tr>
<tr>
<td>The MET score. Lee A, Bishop G, Hillman K M et al., (1995). The MET score in Hourihan Bishop et al., (1995)</td>
<td>Clinical judgement.</td>
<td>6 physiology variables, 5 biochemistry variables, list of med. conditions. Hourihan et al., 1995 added the criterion other for any patient causing concern not covered in above criteria.</td>
<td>Any of the abnormal variables/ conditions could be used to call the MET.</td>
<td>Routine use.</td>
<td>Abnormal physiology-temperature, systolic BP, RR, pulse rate, urine output, decreased/altered LOC. Abnormal Pathology: serum potassium, sodium, blood sugar, arterial pH, base excess. Specific conditions e.g. cardiorpulmonary arrest, respiratory and all other emergencies.</td>
<td>Presence of any abnormal signs considered sufficient to summon MET.</td>
</tr>
<tr>
<td>The Sickness Assessment (SA) Index/ score. Kennedy R H, Al-Mufti R A M, Brewster S F (1994)</td>
<td>Clinical judgement.</td>
<td>3 variables.</td>
<td>Presence of any parameter indicated a positive SA score.</td>
<td>Pre-operative assessment.</td>
<td>Systolic BP &lt; 100 mmHg; severe chronic disease or compromised immune state; not independent and self-caring.</td>
<td>Patients could score a total of 3 points, but presence of any parameter was interpreted as a positive SA score.</td>
</tr>
<tr>
<td>Index</td>
<td>Source</td>
<td>Items</td>
<td>Weighting</td>
<td>Time calc.</td>
<td>Variables</td>
<td>Score calculation</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------</td>
<td>------------------------------------------------</td>
<td>----------------------------------------</td>
<td>----------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>The TISS score (Keene et al., 1983)</td>
<td>Clinical judgement.</td>
<td>76 therapeutic interventions</td>
<td>4 points most severe to 1 point least severe.</td>
<td>Same time each day</td>
<td>Items included the full range of interventions available in ICU.</td>
<td>Increased score corresponded to increased severity of illness.</td>
</tr>
<tr>
<td>The SAPS II (Le Gall et al., 1993)</td>
<td>Logistic regression analysis - Statistically derived variables (13,152 randomly allocated to development or validation samples.</td>
<td>17 variables.</td>
<td>Points ranged from 0-3 for temperature through to 0 to 26 for GCS.</td>
<td>Physiological data- worst values in first 24 hours of ICU admission.</td>
<td>12 physiologic variables: HR, systolic BP, Temp., PaO_2/ FiO_2, urine output, serum urea or urea nitrogen, WBC, serum potassium, sodium, bicarbonate, bilirubin, GCS, and 5 other variables: age, type of admission, AIDS, metastatic cancer or haematologic cancer.</td>
<td>SAPS II score a good predictor of risk of death ROC 0.88 in development sample, and ROC 0.86 in validation sample.</td>
</tr>
<tr>
<td>The Pre-Arrest Morbidity (PAM) Index.</td>
<td>Multivariate analysis.</td>
<td>15 variables.</td>
<td>1 point assigned to 10 variables and 3 points assigned to 5 variables (hypotension, azotemia, malignancy, pneumonia and home bound before admission).</td>
<td>Pre-arrest variables applied to patients with in-hospital cardiac arrest &amp; cardiopulmonary resuscitation.</td>
<td>Systolic BP, Blood Urea Nitrogen, malignancy, pneumonia, homebound lifestyle, angina, acute myocardial infarct, heart failure, S_3 gallop, oliguria, sepsis, mech. Ventilation, CVA, coma, cirrhosis.</td>
<td>PAM index inversely correlated with successful resuscitation and long term survival.</td>
</tr>
</tbody>
</table>

**Key**

ABGs Arterial blood gases  
APS Acute Physiology Score  
ARF Acute renal failure  
BP Blood pressure  
BUN Blood urea nitrogen  
CNS Central nervous system  
FiO_2 fraction of inspired oxygen  
GCS Glasgow Coma Score  
HR Heart rate  
PaO_2 partial pressure of arterial oxygen  
RR Respiratory rate  
WBC White blood count
Appendix 13.
Draft Preliminary Coding Framework for data analysis in study 2.

<table>
<thead>
<tr>
<th>Field name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
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<td>Biological Severity [Severity of illness dimension]</td>
<td>All references to age</td>
</tr>
<tr>
<td>Age</td>
<td>All references to age</td>
</tr>
<tr>
<td>Gender</td>
<td>All references to gender</td>
</tr>
<tr>
<td>Physiological reserve</td>
<td>All references to physiological reserve</td>
</tr>
<tr>
<td>Demographic</td>
<td>All references to gender</td>
</tr>
<tr>
<td>Physiological Severity [Severity of illness dimension]</td>
<td>All references to admission disease, illnesses, reasons for admission</td>
</tr>
<tr>
<td>Admission disease process</td>
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<tr>
<td>Type of admission</td>
<td>All references to planned, unplanned, medical, surgical admission</td>
</tr>
<tr>
<td>Medical history</td>
<td>All references to medical history and chronic conditions</td>
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<tr>
<td>Haematology</td>
<td>All references to haematological values</td>
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<td>All references to respiratory conditions</td>
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<tr>
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<tr>
<td>Cardiac</td>
<td>All references to cardiac conditions</td>
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<tr>
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<td>All references to haemorrhage (including GI haemorrhage)</td>
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<td>All references to renal conditions</td>
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<tr>
<td>Medication</td>
<td>All references to medications, drugs</td>
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<tr>
<td>Intuition</td>
<td>All references to intuition, intuitive judgements</td>
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<tr>
<td>Clinical state</td>
<td>All references to clinical state being diagnosed, potential clinical state.</td>
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<tr>
<td>Scores</td>
<td>All references to scores* Apache II, Apache III, APS, EWS, PAR, MET, SAS, ASA, TISS, SAPS II PAM</td>
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<td>Physiological cues</td>
<td>All references to pulse, BP, respiratory rate, temperature, urine output, ECG, CXR, BMI, ABGs, O₂ treatment, biochemical indicators, blood sugar, SPO₂, fluid balance</td>
</tr>
<tr>
<td>Behavioural cues</td>
<td>All references to colour, level of consciousness, muscle tone, dyspnoea, chest pain, nausea/ vomiting, patient distress, restlessness, patient position, rambling, thirst, clammy, fits, cold, airway obstruction, lethargy.</td>
</tr>
<tr>
<td>Field name</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Clinician’s judgement of patient’s severity of illness, concern for patient’s condition</td>
<td>All references to clinicians’ estimation of severity of illness, seriously worried (about a patient), stability.</td>
</tr>
<tr>
<td>Patient self-report</td>
<td>All references to patients’ reports of symptoms.</td>
</tr>
<tr>
<td><em>Functional Severity [Severity of illness dimension]</em> Functional status</td>
<td>All references to the patient’s functional status, before or during current hospitalisation. Includes capacity to perform activities of living such as mobilising, personal hygiene, eating and drinking</td>
</tr>
<tr>
<td><em>Psychological Factors [Severity of illness factors]</em> Psychological</td>
<td>All references to psychological state/patient distress. Includes references to anxiety, mood, and fear.</td>
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<tr>
<td><em>Temporal Factors [Severity of illness factors]</em> Temporal</td>
<td>All references to clinical course over time and change in condition within a specified time. Also change in practice e.g. comparison pre and post introduction of MET.</td>
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<tr>
<td>New complications</td>
<td>All references to new diseases, illnesses, conditions (including consequences of procedures).</td>
</tr>
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<td>Original condition worse</td>
<td>All references to deterioration in original condition.</td>
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<td><em>Administrative/ organisational factors [Severity of illness factors]</em> Administrative</td>
<td>All references to patients’ location (ward), length of stay (in ward, ICU, or hospital).</td>
</tr>
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<td>Delayed response</td>
<td>All references to delays in response, delays in treatment, inadequate response, organisational failures.</td>
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<tr>
<td>Types of judgements- categories</td>
<td>All references to medical diagnosis, diagnosis of the current state of the patient, problem identification, change in state, prognostic judgement, causal judgement, judgement re- timing of interventions/ agenda judgements as defined in section 3.3.2, pp. 54-56.</td>
</tr>
<tr>
<td>Interventions</td>
<td>All references to interventions</td>
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<tr>
<td>Outcome</td>
<td>All references to patient outcomes</td>
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<tr>
<td><strong>Key</strong></td>
<td>* see Appendix 12- scores</td>
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Appendix 14
Letters of support for the study from
the Director of Nursing & a Medical Consultant

Written Nurse Manager Consent To Invite Nurses To Participate In A Research Study

Title of the project: Nurses' Early Recognition of Transition from Acute to Critical Illness in Hospitalised Adult Patients - A Clinical Judgement Analysis

Name of Investigator: Margaret A. Coulter

To be signed by the Nurse Manager

I declare that the purpose and nature of the above research study has been explained to me in writing. This explanation included a description of the procedures involved, possible benefits to patients, how ethical issues would be addressed, and the anticipated duration of the study. I give my consent for the above investigator to invite nursing staff to participate in the above study.

Signature of Nurse Manager: ____________________________
Date: 18/10/02

Director of Nursing

448
ETHICS COMMITTEE SUBMISSION

Reference:
A. MA Coulter, Nurses’ early recognition of transition from acute to critical illness in hospitalised adult patients – a clinical judgement analysis

1. Reference A is a research proposal submission to NW Surrey Research Ethics Committee (NWSREC) for Oct 00.

2. Reference A is complementary to the In-hospital Cardiac Arrest Prevention Project currently running at [redacted] and approved by NWSREC.

3. The 1-year retrospective audit of in-hospital cardiac arrests at [redacted] where resuscitation was attempted has identified an avoidable/potentially avoidable arrest rate of 61%. This is a reflection of a national and an international problem. Reference A seeks to determine a clinicometric score that will support clinical decisions for early intervention to prevent in-hospital cardiac arrest.

4. This office fully supports the research application, and will provide practical support for the undertaking of the study.

T J HODGETTS
Professor, Emergency Medicine and Trauma

Distribution:
External:
Action:
Mrs MA Coulter, Lecturer Nursing Studies, EIHMS
Dear Margaret

PRO/109/00 – (Please use this reference in all correspondence)
Nurses’ early recognition of transition from acute to critical illness in hospitalised adult patients – a clinical judgement analysis

Thank you for submitting the above protocol, which was formally reviewed by the ethics committee on the 1st December 2000. I am pleased to confirm that the committee have granted your study and application full ethical approval.

For your information, the following documentation was reviewed:
- Written Nurse Manager Consent
- Proposal (October 2000)
- Hospital Medical Consultant Consent for Access to Patients’ Medical and Nursing Notes
- Consent Form to Participate in a Research Study (October 2000)
- Consent Form for the Use of Interview Data following Interview (October 2000)
- CV for Margaret Coulter

Please notify the committee in advance of any significant proposed deviation from the original protocol. Would you also report any unusual or unexpected results, which raise questions about the safety of the research once the study is under way. The committee would be interested in the final results of your study and wish you every success in carrying it out.

Yours sincerely,

[Signature]

Chairperson

Date: 6th December 2000
12 February 2001

Ms Margaret A Coulter  
Lecturer Nursing Studies  
European Institute of Health & Medical Sciences  
University of Surrey

Dear Ms Coulter

Nurses' early recognition of transition from acute to critical illness in hospitalised adult patients - A clinical judgement analysis  
ACE/2001/07/EIHMS) – FAST TRACK

I am writing to inform you that the Advisory Committee on Ethics has considered the above protocol under its 'Fast Track' procedure, and has approved it on the understanding that the Ethics Guidelines are observed and the following condition is met:-

• That private addresses and telephone numbers will not be used for communication with the volunteers.

This letter of approval relates only to the study specified in your research protocol (ACE/2001/07/EIHMS) - Fast Track. The Committee should be notified of any changes to the proposal, any adverse reactions and if the study is terminated earlier than expected (with reasons). I enclose a copy of the Ethics Guidelines for your information.

I should be grateful if you would confirm in writing your acceptance of the condition above, enclosing copies of relevant documentation.

Date of approval by the Advisory Committee on Ethics: 12 February 2001
Date of expiry of the Advisory Committee on Ethics approval: 11 February 2006

Please inform me when the research has been completed.

Yours sincerely

Catherine Ashbee (Mrs)
Secretary, University Advisory Committee on Ethics

cc: Professor L J King, Chairman, ACE
Professor R A Crow, Principal Investigator, EIHMS
Dr M C Murphy, Principal Investigator, EIHMS
Appendix 16
Researcher’s letter of introduction to potential participants

Registered Nurses (General)
Hospital Name
Hospital Address

Ext. Number 2964
E-mail: m.coulter@surrey.ac.uk

April 2001

Invitation to Participate in a Research Study

Dear Registered Nurse

Project Title: Nurses’ Early Recognition of Transition from Acute to Critical Illness in Hospitalised Adult Patients- A Clinical Judgement Analysis

I wish to invite you to participate in the above study. I am a registered general nurse, and this study should provide valuable insights into nurses’ expertise in the early recognition of patients with seriously deteriorating conditions who are at high risk of critical illness and cardiac arrest. Information gained in this study may help less experienced staff in the early recognition of such patients and enable prompt referral for emergency medical intervention.

The study uses in-depth interviews to investigate the signs and symptoms important in the prediction of developing critical illness and cardiac arrest. I wish to invite nurses with 3 years experience, or more, in their clinical speciality to participate. Within the interviews I would be asking nurses to recall cases of patients whose condition deteriorated seriously, and I would use these examples to help to identify the signs and symptoms which experienced nurses recognise as significant predictors of developing critical illness. To maintain confidentiality and anonymity of patients, personal identification would not be requested and would not be recorded by the investigator. Nurse confidentiality and anonymity would be maintained by using...
codes rather than personal identification.

The interview would not exceed one hour, and the time and venue would be arranged according to your availability and to avoid disruption to clinical care. I would involve both your clinical manager and yourself in the joint negotiation of the most convenient time and place for the interview.

Prior to data collection your informed consent to participate would be requested, and I would guarantee your confidentiality and anonymity by using codes to protect identities. You would be free to withdraw from the study at any stage without being asked to give a reason. I would like to use a tape-recorder to assist with data collection, and would ask for your informed consent for this. During the study, information collected shall be coded and stored in a locked cupboard, and at the end of the study this will be destroyed by the investigator.

The study and the procedures involved were approved by the North West Surrey Local Research Ethics Committee in December 2000. If you would like further information about the study and are interested in participating I would be very pleased to hear from you. I enclose a reply slip for you to complete and place in an envelope which I would then hope to collect from a large brown envelope marked Nursing Study Replies for Margaret Coulter placed in your ward office. My contact details can also be found at the top of this letter (my telephone extension is connected to the voicemail system - if I am unavailable you could leave your contact details and I would be very happy to return your call).

Thank you for your time and interest in reading this letter of introduction.

Yours sincerely

Margaret A. Coulter.
Written Nurse Consent To Participate In A Research Study

Title of the project: Nurses’ Early Recognition of Transition from Acute to Critical Illness in Hospitalised Adult Patients - A Clinical Judgement Analysis

Name of Investigator: Margaret A. Coulter

SECTION 1 - To be signed by the nurse

I ................................................................consent to take part in the above study.

The purpose and nature of the procedures have been explained to me by
..........................................................................................

I have been given time to decide on my participation in the study and I understand that my participation in this study is entirely voluntary and that I may withdraw from it at any time without giving reason and without jeopardy to my future career.
If I have any further questions regarding this study I should contact
..........................................................................................

Signature of Nurse..................................

Date..................................

SECTION 2 - To be signed by the Investigator

I.................................................................declare that the purpose and nature of the above research study has been explained to the above person in writing and verbally.
This explanation included a description of the procedures involved, possible benefits, and assurances of confidentiality and anonymity.

Signature of Investigator.................................

Date......................................................

SECTION 3- To be signed by the Witness

I................................................................ declare that in my opinion the nurse has understood the purpose and nature of the above study. He/She was given the opportunity to ask relevant questions and his/her consent was freely given.

Signature of Witness....................................................

Date......................................................

_____________________________________

Written Nurse Consent For The Use Of Interview Data Following Interview

Title of the project: Nurses' Early Recognition of Transition from Acute to Critical Illness in Hospitalised Adult Patients - A Clinical Judgement Analysis

Name of Investigator: Margaret A. Coulter

SECTION 1 - To be signed by the nurse
I ............................................................................. consent to the use of information obtained in interview for the above study.

Signature of Nurse............................................

Date......................................................

455 App.16
SECTION 2 - To be signed by the Investigator

I................................................................. declare that the information obtained during interview shall be used for the purposes of the above investigation only. Individual participants will not be identifiable to others in any report arising from this study. No records bearing individual participants' names will be given to anyone else.

Signature of Investigator..............................
Date.................................................

Reply Slip for Margaret A Coulter Re: Research Project.

Project Title: Nurses' Early Recognition of Transition from Acute to Critical Illness in Hospitalised Adult Patients- A Clinical Judgement Analysis

Please reply by ticking the relevant box below:

☐ I would like to know more about the above study and may be interested in taking part.

My contact details are:
Name ............................................................................................................
Contact number/ location ...........................................................................

☐ I do not wish to participate in the above study.

Thank you for taking the time to complete and return this form.

M.A.Coulter April 2001

---

456 App.16
## Appendix 17

### MET calling criteria

Front face of chart, observations

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<th>MET SCORE:</th>
<th>Nurse concerned</th>
<th>Chest pain</th>
<th>AAA Pain</th>
<th>SOB</th>
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<th>Nurse concerned</th>
<th>Score</th>
<th>Action</th>
<th>Bleep patient's SHO</th>
<th>All other patients</th>
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<td>Confirm with Senior Nurse then 333 SHO of patient's speciality</td>
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<td>3</td>
<td>Repeat TPR, BP, SpO2, GCS, calculate urine output last 2 hours if known</td>
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<th>Temperature core temperature</th>
<th>Respiratory Rate (adult)</th>
<th>SpO2 (O2)</th>
<th>SpO2 (Air)</th>
<th>SBP jump or falls</th>
<th>GCS changes</th>
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<td>9 - 29</td>
<td>66 - 91</td>
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Appendix 18
Inter-rater reliability checks on interview data

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Reliability = 93.1%
Agrees = 67
Disagrees = 5
Appendix 19: Interview guide
(After pilot study with three clinicians)
(Semi-structured/lightly structured depth interviews)

The Purpose of the Study

1. To identify the cues experienced nurses consider important in the prediction of critical illness and cardiac arrest in adult patients in general wards in hospital.
2. Using a conceptual framework based on the severity of illness concept and the clinical states of critical illness and cardiac arrest, what can an analysis of nurses clinical judgements in acute through to critical illness and cardiac arrest show?

Central Research Questions

1. What cues do clinicians consider important in judgements of patient condition in critical illness and cardiac arrest?
   • What are the sources of cues considered important in judgements of patient condition?
   • Which cues do clinicians consider to be important in the prediction of critical illness and cardiac arrest?
2. What is the time sequence in which cues are considered important in judgements of patient condition and prediction of critical illness or cardiac arrest?
   • 2a. Do clinicians consider any cues to be early predictors of critical illness or cardiac arrest?
   • 2b. Which cues are considered to be late predictors of critical illness or cardiac arrest?
3. How accurate were the clinicians’ reports of their predictions compared to their reports of patient outcomes?
4. What cues do clinicians consider important in judgements of patient condition in acutely ill patients, and patients who are acutely ill and vulnerable to physiological instability and deterioration to critical illness or cardiac arrest?

Definitions

Early cues in this study are defined as cues that are available to the clinician in the time period leading up to making a referral to medical staff, specialist nurses, and/or nurse intervention.
Late cues in this study are defined as cues considered important that are available after the initial referral to medical staff, specialist nurses and/or nurse intervention.
Research Question 1: What cues do nurses consider important in judgements of patient condition and prediction of critical illness or cardiac arrest in general ward patients?

I am interested in situations where patients’ conditions change from being acutely ill to being at either high risk of critical illness or cardiac arrest, or actual critical illness or cardiac arrest.

1. Can you recall two or three examples of patients with conditions that changed from acute illness to being at either high risk of critical illness or cardiac arrest, or actual critical illness or cardiac arrest?

2. Taking the first example, can you summarize the main details relating to the patient’s personal, medical and nursing history, including the reasons for admission to hospital?

3. Could you describe the details of the patient’s medical and nursing care during this admission to hospital?

4. At what stage did you think that the patient’s condition was becoming more serious? Why did you think that the patient’s condition was becoming more serious?

5. What did you think the patient’s future condition would be?[If not already stated by informant]

6. Can you recall any notable features relating to this patient’s condition in the days and hours leading up to when you judged his/ her condition was becoming more serious?

7. Which features did you consider to be the most important as you judged that the patient’s condition was becoming more serious?

Research Question 2: What is the time sequence in which cues are considered important in judgements of patient condition and prediction of critical illness or cardiac arrest?

9. In what order did you notice these features?

9a. What was/ were the initial feature(s) that you considered important in the judgement of the patient’s condition? [If not stated explicitly in answer to question 9]
Research Question 3: How accurate were the clinicians’ reports of their predictions compared to their reports of patient outcome conditions?

10. What happened in this patient’s situation? [Should get patient outcome here, ask if this not given].
10a How did the patient’s actual outcome compare with your earlier estimation of the patient’s future condition? [If not explicitly stated earlier]

Repeat above for other examples participant may wish to discuss.

Research Question 4: What cues do nurses consider important in judgements of patient condition in acutely ill patients, and patients who are acutely ill and vulnerable to physiological instability and deterioration?

11. Would you be able to recall examples of patients with acute illness who did not develop critical illness or cardiac arrest?

12. Taking the first case could you summarize the main details relating to his/her personal, medical and nursing history, including the reasons for admission to hospital?

13. Can you describe the details of the patient’s medical and nursing care during this admission to hospital?

14. Can you describe the factors you considered important when judging his/her clinical condition and clinical progress?

15. In what ways did this patient differ from the patients whose condition deteriorated to critical illness or cardiac arrest?

Repeat questions 11-15 for patients who are acutely ill and vulnerable to physiological instability and deterioration [If not already included in the above acute illness cases].

Additional topics to explore if they come up in informants responses:

Change in condition over time- trajectory of patient’s deterioration in condition (increasing in severity), or improvement in condition

Interventions- purposes, nature of interventions, and any comments on quality of interventions.
Factors that assist or interfere with accuracy in making judgements of patients’ current conditions

Any other cues or features considered important
Closure of interview

16. As the interview is drawing to a close are there any questions which you would like to ask me?

Thank you for your participation in this interview. May I now ask for your consent to use the information you have given in interview within the current research study?

**Prompt** on the following if they come up:

Within accounts of clinical cases:
Ask *sensory* questions about what the informant saw, heard, touched, or smelled in relation to the cues considered important in judgements of patient condition, and prediction of future condition?

Ask how the informant felt about the situation he/she found himself/herself in.

Ask for any factual clarification of clinical cases as required.

More generally:
Ask for further clarification of the following terms if they come up in descriptions of patients' conditions:
Descriptors of illness - ill, not ill, mild, moderate, severe to moribund.
Nature of onset of illness – acute/ sudden, or chronic/ gradual.
Physiological stability or instability
Severity of illness
Functional status
Emotional status/ mood

*Margaret A Coulter March 2001*
Appendix 20
Summary contact sheet for interviews

Documentation Sheet: Semi-structured/ lightly structured depth interviews.

Information about the Interview and the Interviewee

Date of the interview: ..........................................
Place of the interview ..........................................
Duration of the interview ..........................................
Interviewer ...........................................
Identifier for the interviewee ..........................
Specialty of the interviewee ..........................................
Years working in specialty ..........................................
Years of working experience since qualification ..........................................
Current grade ..........................................
Highest academic qualification held ..........................................

Age range of interviewee, please circle as appropriate:
20-29 years, 30-39 years, 40-49 years, 50-59 years, 60 years and over.

Significant information relating to the interview/ context

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M. Coulter 2001
Appendix 21
Coding framework and definitions for category membership

Q.S.R. NUD*IST Power version, revision 4.0.
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PROJECT: Finalmaster asNov5master26/11,

(1) /Interviewees
*** Definition:
Social demographic characteristics of
research participants

(1 1) /Interviewees/interviewee's
gender
*** Definition:
Copy of node (1) and its subtree.

(1 1 1) /Interviewees/interviewee's
gender/male
*** Definition:
Male interviewees

(1 1 2) /Interviewees/interviewee's
gender/female
*** Definition:
Female interviewees

(1 2) /Interviewees/interviewee's
age
*** Definition:
Definition
Interviewees age identified within a range of
ages

(1 2 1) /Interviewees/interviewee's
age/20s
*** Definition:
Ages 20-29 inclusive

(1 2 2) /Interviewees/interviewee's
age/30s
*** Definition:
Ages 30-39 inclusive

(1 2 3) /Interviewees/interviewee's
age/40s
*** Definition:
Ages 40-49 inclusive

(1 2 4) /Interviewees/interviewee's
age/50s
*** Definition:
Ages 50-50 inclusive

(1 2 5) /Interviewees/interviewee's
age/60s
*** Definition:
Ages 60-69 inclusive

(1 3) /Interviewees/years
experience
*** Definition:
Years of experience since qualification

(1 3 1) /Interviewees/years
experience/<5yrs
*** Definition:
Less than 5 years experience

(1 3 2) /Interviewees/years
experience/5-10 yrs
*** Definition:
5-10 years experience

(1 3 3) /Interviewees/years
experience/>10 yrs
*** Definition:
More than 10 years experience

(1 4) /Interviewees/years in
speciality
*** Definition:
Years of experience in current speciality.

(1 4 1) /Interviewees/years in
speciality/<5yrs
*** Definition:
Less than 5 years experience in current
speciality

(1 4 2) /Interviewees/years in
speciality/5-10 yrs
*** Definition:
5-10 years experience in speciality

(1 4 3) /Interviewees/years in
speciality/>10 yrs
*** Definition:
More than 10 years experience in speciality

466
(1 5) /Interviewees/Current speciality
*** Definition:
Type of ward or unit where interviewee is currently based

(1 5 1) /Interviewees/Current speciality/medical
*** Definition:
All medical specialties excluding coronary care

(1 5 2) /Interviewees/Current speciality/surgical
*** Definition:
All general surgical specialties excluding orthopaedic surgery

(1 5 3) /Interviewees/Current speciality/orthopaedic
*** Definition:
Orthopaedic surgery

(1 5 4) /Interviewees/Current speciality/ICU or HDU
*** Definition:
Intensive care or high dependency specialities

(1 5 5) /Interviewees/Current speciality/CCU
*** Definition:
Coronary care

(1 5 6) /Interviewees/Current speciality/elderly care
*** Definition:
Elderly care

(1 5 7) /Interviewees/Current speciality/recovery
*** Definition:
Post operative recovery

(2) /Case data
*** Definition:
All data relating to specific cases

(2 1) /Case data/Case Biog data
*** Definition:
All references to the biographical details relating to cases presented

(2 1 1) /Case data/Case Biog data/gender
*** Definition:
Gender of patient

(2 1 1 1) /Case data/Case Biog data/gender/male patient
*** Definition:
Male patient

(2 1 1 2) /Case data/Case Biog data/gender/female patient
*** Definition:
Female patient

(2 1 2) /Case data/Case Biog data/Age
*** Definition:
Patient's age identified within a range of ages

(2 1 2 1) /Case data/Case Biog data/Age/20s
*** Definition:
Age 20-29 years inclusive

(2 1 2 2) /Case data/Case Biog data/Age/30s
*** Definition:
Age 30-39 years

(2 1 2 3) /Case data/Case Biog data/Age/40s
*** Definition:
Age 40-49 years

(2 1 2 4) /Case data/Case Biog data/Age/50s
*** Definition:
Age 50-59 years

(2 1 2 5) /Case data/Case Biog data/Age/60s
*** Definition:
Age 60-69 years

(2 1 2 6) /Case data/Case Biog data/Age/70s
*** Definition:
Age 70-79 years

(2 1 2 7) /Case data/Case Biog data/Age/80s
*** Definition:
Age 80-89 years

(2 1 2 8) /Case data/Case Biog data/Age/90s
*** Definition:
Age 90-99 years
(2 1 2 9) /Case data/Case Biog data/Age/unknown
*** Definition:
Age unknown or not reported
*******************************************************************************
(2 1 2 10)/Case data/Case Biog data/Age/14-19 years
*** Definition:
Ages 14-19 years
*******************************************************************************
(2 2)/Case data/Case medical condition
*** Definition:
Major medical condition(s) according to body system affected such as cardiac,
cardiovascular, respiratory, neurological, renal underpinning patient outcome state or condition
*******************************************************************************
(2 2 1)/Case data/Case med condition/cardiac & cardiovascular
*** Definition:
All references to cardiac or cardiovascular conditions as main medical conditions contributing to patient state
*******************************************************************************
(2 2 2)/Case data/Case med condition/respiratory
*** Definition:
All references to respiratory conditions as main medical condition contributing to patient state
*******************************************************************************
(2 2 3)/Case data/Case med condition/neurological
*** Definition:
All references to neurological condition as main medical condition contributing to patient state
*******************************************************************************
(2 2 4)/Case data/Case med condition/gastrointestinal
*** Definition:
All references to gastrointestinal condition as main medical condition contributing to patient state gastrointestinal problems
*******************************************************************************
(2 2 5)/Case data/Case med condition/renal
***Definition
All references to renal condition as main medical condition contributing to patient state
*******************************************************************************
(2 2 6)/Case data/Case med condition/immune system
*** Definition
All references to immune system disorder as main medical condition contributing to patient state
*******************************************************************************
(2 2 7)/Case data/Case med condition/metabolic
*** Definition
All references to metabolic system disorder as main medical condition contributing to patient state
*******************************************************************************
(2 2 8)/Case data/Case med condition/malignancy
*** Definition
All references to malignancy as main medical condition contributing to patient state
*******************************************************************************
(2 2 9)/Case data/Case med condition/sepsis
*** Definition
All references to sepsis as main medical condition contributing to patient state
*******************************************************************************
(2 2 10)/Case data/Case med condition/post operative
*** Definition
All references to post operative condition as main medical condition contributing to patient state
*******************************************************************************
(2 2 11)/Case data/Case med condition/haematologic
*** Definition:
All references to haematological problems as main medical condition contributing to patient state
*******************************************************************************
(2 2 12)/Case data/Case med condition/psychiatric
*** Definition
All references to psychiatric condition as main medical condition contributing to patient state
*******************************************************************************
(2 2 13)/Case data/Case med condition/medical condition unknown
*** Definition:
Main medical condition not specified
*******************************************************************************
(2 2 14)/Case data/Case med condition/Liver
*** Definition
All references to liver condition as main medical condition contributing to patient state
*******************************************************************************
(3) /Change in patient condition
*** Definition:
All references to the stage at which the patient's condition changed, and if change was acute and sudden or chronic and gradual

(3 1) /Change in patient condition/Acute or sudden
*** Definition:
All references to acute or sudden changes, or changes within the last 48 hours

(3 2) /Change in patient condition/Chronic or gradual
*** Definition:
All references to chronic or gradual changes occurring over period of 48 hours or more

(4) /Cues considered important
*** Definition:
Cues the clinician generally rated as important, also includes absence of pre-warning cues

(4 1) /Cues considered important/Early cues
*** Definition:
Cues considered important in advance of event and before referral to medical team or nurse intervention

(4 2) /Cues considered important/Late cues
*** Definition:
Cues considered important after the initial referral to medical team or nurse intervention / not early cues

(4 3) /Cues considered important/No pre-warning early cues
*** Definition:
All references to situations where patient collapses without early warning cues being noticed

(5) /Clin signs & symptoms- cues/objective measures
*** Definition:
measures that can be witnessed/ measured independently- age, temperature, pulse, fluid balance and output, respiratory rate, BP, oxygen saturation level, pulse, CVP, weight, MET score

(5 1) /Clin signs & symptoms- cues/paraclinical or lab
*** Definition:
All references to laboratory results and clinical investigations (blood, biochemistry, pathology, microbiology, ECGs, X rays (descriptive) ABGS etc

(5 2) /Clin signs & symptoms- cues/subjective clinician data
*** Definition:
All data obtained by clinician through observation or palpation. Also behavioural cues of patient such as withdrawn, lethargic, restless where there is a physical response to external or internal stimuli, and psychological state such as anxious, frightened

(5 4) /Clin signs & symptoms- cues/subjective patient self report
*** Definition:
Patient self- report of symptoms- sensations reported by person experiencing them. Includes pain, shortness of breath, feelings, mood or beliefs (Wulff & Gotzsche, 2000)

(5 5) /Clin signs & symptoms- cues/Patient history
*** Definition:
All references to patient's medical and nursing history including prior functional independence up to current condition

(5 6) /Clin signs & symptoms- cues/response to treatment
*** Definition:
Situations where patient is not responding to treatment as expected or response is slower than expected, and more general references to response to response to treatment

(6) /Interventions required
*** Definition:
All references to specific therapeutic interventions and treatments and referrals to other specialists
(6.1) /Interventions required/Related actions or treatment
*** Definition:
The clinician's actions relating to a particular patient state

(6.2) /Interventions required/Patient condition support needed
*** Definition:
The clinician's judgement of the type of interventions the patient requires - emergency medical intervention, medical review, specialist practitioner - categorise according to most severe relevant category where more than one applies

(6.2.1) /Interventions required/Patient condition support needed/Requires emergency medical intervention
*** Definition:
Requires resuscitation or emergency interventions such as Cardiac Arrest Team and Medical Emergency Team

(6.2.2) /Interventions required/Patient condition support needed/Requires medical review
*** Definition:
Patient's condition requires medical review

(6.2.3) /Interventions required/Patient condition support needed/Requires specialist clinician input
*** Definition:
Patient's condition would benefit from input from critical care outreach or equivalent, or other specialist clinician such as Speech Therapist, Urology Nurse Specialist

(6.2.4) /Interventions required/Patient condition support needed/Requires close monitoring of physiological state
*** Definition:
Condition requires close monitoring of physiological state

(6.2.5) /Interventions required/Patient condition support needed/Requires physical interventions adjusted
*** Definition:
Condition requires adjustments to physical interventions from nurse

(6.2.6) /Interventions required/Patient condition support needed/Requires psychological interventions
*** Definition:
Requires specific psychological interventions from nurse, psychological support

(6.3) /Interventions required/Quality of intervention
*** Definition:
References to delayed reactive treatment or earlier pro-active treatment (after Bion, 1999)

(6.3.1) /Interventions required/Quality of intervention/Delayed reactive
*** Definition:
Delayed reactive intervention

(6.3.2) /Interventions required/Quality of intervention/Earlier pro-active
*** Definition:
Earlier pro-active intervention

(7) /Consequences (cases)
*** Definition:
The specific case or patient outcomes relating to the period of time described - critical illness, cardiac arrest, acute and vulnerable etc

(7.1) /Consequences (cases)/Cardiac arrest
*** Definition:
Outcomes of cardiac or respiratory arrest, includes patients who died. Cardiac arrest defined as absent pulse, loss of blood pressure, no spontaneous respirations. Respiratory arrest defined as no spontaneous respirations.

(7.2) /Consequences (cases)/Critical illness
*** Definition:
Outcome patient critically ill. Defined as level 2 or 3 critical illness in the DoH (2000) guidelines.

(7.3) /Consequences (cases)/Acute illness and vulnerable to physiological instability or deterioration to critical illness/cardiac arrest (Acute +)
*** Definition:
(7 4) /Consequences
(cases)/Acute illness
*** Definition:
Acutely ill and physiologically stable or improving or recovering. Defined as level 0 in the DoH (2000) guidelines on levels of critical illness.

(7 5) /Consequences
(cases)/chronic illness
*** Definition:
All references to patients with chronic illnesses and patients where chronic illness is resulting in a deteriorating condition

(7 7) /Consequences
(cases)/Palliative or terminal
*** Definition:
Patients with advanced disease that are not expected to recover in whom death is predicted

(8) /What changes in judgements
*** Definition:
In judgement situation is it the cues changing or cues becoming more significant as patient condition or context changes- Conceptual Code

(8 1) /What changes in judgements/Context
*** Definition:
All references to how the context affects how particular cues are viewed, cues may not have changed but are more significant as time goes on

(8 2) /What changes in judgements/Cues changing
*** Definition:
All references to situations where cues are changing

(F 2) /Free Nodes/Physiological reserve
*** Definition:
All references to factors that contribute to patient’s capacity to recover from illness such as age, chronic illnesses, pre-admission functional ability

(F 3) /Free Nodes/Linking physiological and pathophysiological data
*** Definition:
All references to nurses making links between patients’ physical presentation and underlying pathophysiology in physical assessment

(F 4) /Free Nodes/Organisation of care
*** Definition:
All references to organisation of care, care context, skill mix and doctor-nurse communication
First interview (interview 6, cases 1 & 3) before coding:

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+++ ON-LINE DOCUMENT: Int 6
+++ Document Header:
*Interview 06/MED/WIF
*2345678901234567890123456789012345678901234567890123456789

+++ Retrieval for this document: 787 units out of 787, = 100%
++ Text units 1-787:
012

*INTERVIEWER

Em (name) thank you very much for agreeing to talk to me about my project it's a huge help and em it's greatly appreciated. I've given you a little bit of background into the study and em basically er I just just to recap I'm particularly interested in patients who are becoming more seriously ill and you're working on an acute medical ward here and I would think that it's possible you see quite a lot of that kind of condition. And I was wondering if you could perhaps er think about patients that you're currently nursing or have nursed in the past who have come in perhaps in an acute illness state and you were then subsequently more concerned about

*No 6

Ya

*INTERVIEWER

Is that a useful place to just begin to talk?

*No 6.

Ya ya that's fine

*INTERVIEWER

And then I can ask some more questions as we go along

*No 6

Ya. Em right it's em we had a gentleman a couple of months ago now and he was feeling quite nauseated em during the night and then on the early shift he had his breakfast and promptly collapsed. And that was quite an acute situation however a nurse was with him at the time a health care assistant actually who got him onto the bed and shouted for help. The gentleman by the time I got there was actually pretty unresponsive but breathing and his pulse was good so at that point that's when we put out the MET call simply because his condition had suddenly deteriorated

*INTERVIEWER
Right em

*No 6

Em we needed assistance by we didn’t need a full crash team. He was breathing OK in actual fact em a few minutes after we put the MET call out he stopped breathing and he had a respiratory arrest. And at that point we put a crash call out and to this day I don’t know whether the doctors responded to the MET or the crash call.

*INTERVIEWER

Right

*No 6

But I know that we got assistance quickly. Em basically we needed help and we needed it there and then so that’s why I put the MET call out for that gentleman.

*INTERVIEWER

Can you recall some of the circumstances about that man’s em medical history?

*No 6

Em he ya I’m trying to think he was actually he had an MI but it wasn’t a confirmed at that stage and I believe they were actually querying a PE with this gentleman. That’s right because that was actually the concern at the time if I was thinking that you know he’d had another PE. Em so he was a fairly fairly new admission probably on the ward a couple of days and no real confirmed diagnosis lots of queries.

*INTERVIEWER

Was he having any treatment at the time for any of those things, although he was he being observed was there anything else being done?

*No 6

I would thinking back I would say that he was probably having Clexane em he wouldn’t be having any other anti coagulants until they confirmed. He would have been planned to have a V/Q scan I’m sure of that but he hadn’t had that at that stage.

*INTERVIEWER

Was the resuscitation attempt successful?

*No 6

Yeah yeah it was. Em he actually his I mean to he honest his breathing returned before the doctors arrived I mean he stopped breathing and em we started resusc. but we didn’t need to do CPR

*INTERVIEWER

Right uhhuh.

*No 6

Because he still had a good output and when we em attempted to put in a normal airway that stimulated his breathing
*INTERVIEWER
Right ah ah
*No 6
Excellently and he had a gag reflex and em he was transferred to high
dependency
*INTERVIEWER
Ahah
*No 6
Immediately afterwards
*INTERVIEWER
Did he come back to you then
*No 6
Not as far as I'm aware he didn't no.
*INTERVIEWER
So was there anything in the sort of the hours leading up to that
event that made you more concerned?
*No 6
Yeah, the vomiting, it was completely unexplained. Em and when he
vomited he became vague. Now it had only been overnight em and so he
had been seen by the on call doctor but no action had been taken. And
he was in bed at the time so there was no major concern. But when we
came on duty in the morning I was concerned about the fact that he
was you know becoming vague with the vomiting and the query with the
PE I was concerned that you know he might be throwing off clots or
whatever. But he was recovering very quickly so er . So em so . That's really why
*INTERVIEWER
That's a very good example isn't it
*No 6
Yeah
*INTERVIEWER
Have you any other patients now that you’ve em talked about that man?
*INTERVIEWER
That’s very helpful. Em obviously your intervention at that stage
you know was important. Have you got any other patients that you can
recall at the moment em em that you noticed a change in their
condition over maybe a period of hours or days?
*No 6
Yeah we had when I was on night duty there was a patient in the team
next door. Staff Nurse who was in charge there was very new to the
job and she came up and told me that this gentlemen she was a bit
concerned about him because his urine output had dropped off and I asked her about him and she really couldn’t tell me a great deal about his condition. He was on em CPAP I think. I think it was CPAP as opposed to BIPAP and em but she just wasn’t happy and the MET call had only just been brought in at that time and I didn’t know the gentleman in anyway whatsoever and by reading the notes and things I wasn’t being informed. So we made a decision at that point to em to get the MET score down and put that on the desk and we scored him for MET and he was just outside of the range. So we actually observed him continuously over probably a couple of hours and his output dropped and his respirations increased and it was at that point that we decided to put the MET call out because em because we really didn’t know. We felt, we knew this gentlemen wasn’t right but we didn’t know what was happening

*INTERVIEWER
Was he conscious this chap?

*No 6
He was yeah he was conscious. Em and the gentlemen was transferred to the High Dependency Unit er but it was I mean it was a classic call em you know MET because it was it was a call for help really in that the patient was deteriorating but quite slowly and we couldn’t put our finger on it but we knew he wasn’t right and we knew we couldn’t cope with it. It was getting to the point where we were thinking this patient is unsafe on the ward and em we need assistance especially during the night you feel quite isolated

*INTERVIEWER
Uhuh.

*No 6
In the night

*INTERVIEWER
Certainly em you’re thinking about his condition how would you describe it?

*No 6
Emm he was definitely unstable definitely unstable. Em yeah again you see it wouldn’t have been a situation where I would have chosen to fast bleep a doctor because it wasn’t acute in such a way because it was a slow deterioration so we scored him regularly

*INTERVIEWER
What about in that sense, I know it was night- time, would the on call Medical Registrar medical cover be an option

*No 6
The yeah

*INTERVIEWER
Is that an option or

*No 6
It is an option but not always and they won’t always come up. It depends on the time of night and this was actually in the early hours
Second interview (interview 28, case 2) before coding:

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+++ ON-LINE DOCUMENT: Int 28
+++ Document Header:
*Interview No 28/m/wf

+++ Retrieval for this document: 632 units out of 632, = 100%
++ Text units 1-632:

INTERVIEWER
What do you think is going into your gut instinct?

No 28
I'll tell you, we have got one case now, a gentleman who doesn't look right at all. He's come in with a right pleural effusion. He's umm, he did have a pig-tail drain in about a week ago, they took it out, they think everything's fine, then they did a chest x-ray and he's started building up again, he's got more fluid, pleural effusion. They wanted to tap it but meanwhile he dropped his haemoglobin down to 8.8 or something, 8.7 I think it was. And he was passing out blood in his stool. So they transfused him and sent him up to endoscopy and he's got a bleeding DU.

INTERVIEWER
Oh...

No 28
They couldn't do umm the chest drain now so they cancelled that. They said they will put him on iron tablets, stabilise his anaemic state, send him home, and bring him back as an out-patient and do the chest drain. That was the plan. But something about this guy, his previous history, you always check out the previous history. He's got AVR, aortic valve replacement, and he's got a permanent pacemaker in there which we weren't aware of until he went for his umm echo cardiogram which showed it and umm now he's back and his colour's not right. I go a lot by colour. And his colour is ashen. He's got a really grey, ashen looking colour on his face and it's not like him. He's normally, previously he was admitted with the same pleural effusion problems on the other side. And he was independent he walked with a stick to the toilet up and down. His mobility is totally down now. He just about manages to get to the chair. That tells us overall that something is not right. And then his umm, like I said, you can't put your finger on it, something's not right. The doctors came round last week, they said right he can be discharged home, send him home tomorrow, and bring him back as an outpatient for a chest drain, right. Then I said to them, he needs, his mobility is not good, he's not good in himself, generally he's not feeling well, so we need to really fast-track re-hab him before he goes home because he lives alone. So they said fair enough, let's fast-track. So we got through to [ward] and we found a bed for him. And they said they'd have him next day down in [ward] for fast-tracking. Then what happens, that evening before I went home, 3 o'clock I just went into that bay and I looked at him. I thought something's not right here, look at the colour of...
him, he looks grey and he was breathless, his breathing was getting worse. So I came back and I said to the registrar who happens to be on the ward, I said to him "(Name), I think um Mr so and so is not well, he's got an awful colour, and I can't put my finger to it." And he turned round and he said "Don't send him for rehabilitation, keep him here. I'd rather have him here in a medical ward than send him to the care of the elderly ward." The doctor phoned [ward], and because of that we cancelled the rehabilitation and kept him in. So like today this morning he's got chest pain. Yesterday morning he complained of not feeling well, nauseous, and um breathing, he says his breathing is much worse. This morning, same again, he looks very lethargic, apathetic, and he says his breathing is much worse than it was a few days ago. Generally he's not feeling well, he's out of it. He's not had any of his lunch, and he couldn't eat his pudding because he was sickly. Observation wise, there's no real change to get the doctors to come and review. Going by the colour and the way the patient is complaining he's not well, there's something about it, something's not right. So what I've done, we spoke to the dietitian to get umm to nutritionally to build him up. Because obviously he's nauseous and he's not eating his food or taking orally enough. And then I've umm, the team has not been round to review him yet. We did an ECG because he complained he had chest pain and because of the cardiac history we did an ECG and there's no change really. He's got just a paced rhythm there, so he's no different to what he's been before. So he's not compromised due to any infarct or anything. But still his colour is not right.

INTERVIEWER

What sort of age range in this gentleman in?

No 28
He's what?

INTERVIEWER

What sort of age range is he in?

No 28
He's over 60, 68 ish.

INTERVIEWER

So it's interesting because it was particularly you homing in on the fact that mobility-wise he wasn't ready for discharge? And then on the heels of that you noticed that his colour had changed?

No 28
Yes that's right. Because if we had followed the doctor's instructions - home. We could have sent him home, and a junior staff nurse would have sent him home.

INTERVIEWER

So would you say in that case then that the reduced mobility and the colour were early signs of something wrong?

No 28
Yes early signs. Something is telling me that this is not right. And the other thing is he has got pleural effusion building up already isn't he and he's waiting for a drain insertion. So maybe the pleural effusion is getting worse, so that's, hence we said to them, we need a chest x-ray really to review what his effusion's like. So we got the doctors to review him yesterday and they've decided to keep him in now and put a drain in as an in-patient. So yesterday they took him down to x-ray department and x-rayed him and marked his chest and then hopefully today or tomorrow they're going to sort it out to put a drain in.

INTERVIEWER

Do you think there could be something cardiac going on? Like an acute
cardiac thing?

No 28
This is it. This is my fear. So I said to them, because he is a cardiac patient he's very difficult to assess. It could be pulmonary or cardiac, you don't know what's what. But the colour tells me it's cardiac, although his breathing tells me it could be a pulmonary problem. So it's ...

INTERVIEWER
So it's complex isn't it?

No 28
Yes. And then I keep telling them I can see him having a cardiac arrest tonight and going off and not being here tomorrow because of the way he looks. So I wouldn't be surprised. So hopefully they'll get this drain in and get some of the symptoms off and see whether it's related to cardiac.

INTERVIEWER
And investigations would be done?

No 28
The ECG looks ok, yeah, but they haven't done any cardiac enzymes. Like this morning he complained of chest pain, so maybe it's worth for them to do Trop T 12 hours afterwards to...

INTERVIEWER
That's a very interesting case and you've gone through the early signs in detail there (Name). You've talked in detail about two cases, are there any others that come to mind?
Appendix 23
Extracts of interview data with codes attached

First interview from Appendix 22 (interview 6, cases 1 & 3) with codes:

Q.S.R. NUD*IST Power version, revision 4.0.
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+++ ON-LINE DOCUMENT: Int 6
+++ Document Header:
*Interview 06/MED/W/F
*Date 13/6/01
*2345678901234567890123456789012345678901234567890123456789

+++ Retrieval for this document: 304 units out of 787, = 39%
++ Text units 1-304:
012
(1 1 2) /Interviewees/Interviewee's gender/female
(1 2 2) /Interviewees/Interviewee's age/30s
(1 3 3) /Interviewees/years experience/>10 yrs
(1 4 1) /Interviewees/years in speciality/<5yrs
(1 5 1) /Interviewees/Current speciality/medical

*INTERVIEWER
Em [Name] thank you very much for agreeing to talk to me about my project it's a huge help and em it's greatly appreciated. I've given you a little bit of background into the study and em basically er I just just to recap I'm particularly interested in patients who are becoming more seriously ill and you're working on an acute medical ward here and I would think that it's possible you see quite a lot of that kind of condition. And I was wondering if you could perhaps er think about patients that you're currently nursing or have nursed in the past who they have come in perhaps in an acute illness state and you were then subsequently more concerned about

*No 6
Ya

*INTERVIEWER
Is that a useful place to just begin to talk?

*No 6
Ya ya that's fine

*INTERVIEWER
And then I can ask some more questions as we go along

*No 6

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

(2 1 1 6 24) //Free Nodes/Cases whole/Patients/Int 6 Cases/Int 6 C 1

Ya. Em right it's em we had a gentleman a couple of months ago now

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(5 4) /Clin signs & symptoms- cues/subj pt self report
(7 1) /Consequences (cases)/Cardiac arrest

and he was feeling quite nauseated em during the night and then on

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 1) /Cues considered important/Early cues
the early shift he had his breakfast and promptly collapsed. And that was quite an acute situation however a nurse was with him at the time a health care assistant actually got him onto the bed and shouted for help. The gentleman by the time I got there was actually pretty unresponsive but breathing and his pulse was good so at that point that's when we put out the MET call simply because his condition had suddenly deteriorated.
INTERVIEWER

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

Right em

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

No 6

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 1) /Cues considered important/Early cues
(5 3) /Clin signs & symptoms- cues/subj clinician data
(7 1) /Consequences (cases)/Cardiac arrest

Em we needed assistance by we didn't need a full crash team. He was

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 1) /Cues considered important/Early cues
(5 3) /Clin signs & symptoms- cues/subj clinician data
(7 1) /Consequences (cases)/Cardiac arrest

breathing OK in actual fact em a few minutes after we put the MET

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 1) /Cues considered important/Early cues
(5 3) /Clin signs & symptoms- cues/subj clinician data
(7 1) /Consequences (cases)/Cardiac arrest

call out he stopped breathing and he had a respiratory arrest. And

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 2) /Cues considered important/Late cues
(6 2 1) /Interventions required/Patient condition support needed

/Requires emergency medical intervention
(7 1) /Consequences (cases)/Cardiac arrest

at that point we put a crash call out and to this day I don't know

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 2) /Cues considered important/Late cues
(6 2 1) /Interventions required/Patient condition support needed

/Requires emergency medical intervention
(7 1) /Consequences (cases)/Cardiac arrest

whether the doctors responded to the MET or the crash call

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(4 2) /Cues considered important/Late cues
(6 2 1) /Interventions required/Patient condition support needed

/Requires emergency medical intervention
(7 1) /Consequences (cases)/Cardiac arrest

INTERVIEWER

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

Right

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

No 6

(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
But I know that we got assistance quickly. Em basically we needed help and we needed it there and then so that's why I put the MET call out for that gentleman.

Can you recall some of the circumstances about that man's em medical history? *INTERVIEWER No.

Em he ya I'm trying to think he was actually he had an MI but it wasn't a confirmed at that stage and I believe they were actually querying a PE with this gentleman. That's right because that was actually the concern at the time if I was thinking that you know he'd had another PE. Em so he was a fairly fairly new admission probably on the ward a couple of days and no real confirmed diagnosis lots of queries.

*No 6. *INTERVIEWER (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 1) /Case data/Case med condition/cardiac & C Vasc /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest (2 2 2) /Case data/Case med condition/respiratory (5 5) /Clin signs & symptoms- cues/Patient history /Consequences (cases)/Cardiac arrest
INTERVIEWER

Was he having any treatment at the time for any of those things, although he was being observed was there anything else being done?

*No 6

(2 2 1) /Case data/Case med condition/cardiac & CVaSc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

I would thinking back I would say that he was probably having Clexane em he wouldn't be having any other anti coagulants until they confirmed. He would have been planned to have a V/Q scan I'm sure of that but he hadn't had that at that stage.

(2 2 1) /Case data/Case med condition/cardiac & CVaSc
(2 2 2) /Case data/Case med condition/respiratory
(5 2) /Clin signs & symptoms- cues/paraclinical or lab
(7 1) /Consequences (cases)/Cardiac arrest

*INTERVIEWER

Was the resuscitation attempt successful?

*No 6

(2 2 1) /Case data/Case med condition/cardiac & CVaSc
(2 2 2) /Case data/Case med condition/respiratory
(7 1) /Consequences (cases)/Cardiac arrest

Yeah yeah it was. Em he actually his I mean to he honest his breathing returned before the doctors arrived I mean he stopped breathing and em we started resusc. but we didn't need to do CPR

(2 2 1) /Case data/Case med condition/cardiac & CVaSc
(2 2 2) /Case data/Case med condition/respiratory
(4) /Cues considered important
(5 1) /Clin signs & symptoms- cues/obj measures
(7 1) /Consequences (cases)/Cardiac arrest

*INTERVIEWER

Right uhhuh.

*No 6

(2 2 1) /Case data/Case med condition/cardiac & CVaSc
(2 2 2) /Case data/Case med condition/respiratory
Because he still had a good output and when we attempted to put in a normal airway that stimulated his breathing excellently and he had a gag reflex and em he was transferred to high dependency immediately afterwards.

Ahah

Immediately afterwards

*INTERVIEWER
Did he come back to you then?

*No 6

Not as far as I'm aware he didn't no.

*INTERVIEWER

So was there anything in the sort of the hours leading up to that event that made you more concerned?

*No 6

Yeah, the vomiting, it was completely unexplained. Em and when he vomited he became vague. Now it had only been overnight em and so he had been seen by the on call doctor but no action had been taken. And he was in bed at the time so there was no major concern. But when we came on duty in the morning I was concerned about the fact that he was you know becoming vague with the vomiting and the query with the PE I was concerned that you know he might be throwing off clots or...
So that's really why

that's really why

Yeah

Have you any other patients now that you've em talked about that man?

That's very helpful. Em obviously your intervention at that stage

you know was important. Have you got any other patients that you can

recall at the moment em em that you noticed a change in their

condition over maybe a period of hours or days?

Yeah we had when I was on night duty there was. a patient in the team

next door. Staff Nurse who was in charge there was very new to the

job and she came up and told me that this gentlemen she was a bit

concerned about him because his urine output had dropped off and I

*INTERVIEWER

So that's a very good example

*INTERVIEWER

*No 6

Yeah

*INTERVIEWER

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recall at the moment em em that you noticed a change in their

condition over maybe a period of hours or days?
asked her about him and she really couldn't tell me a great deal. He was on CPAP I think. I think it was CPAP as opposed to BIPAP and em but she just wasn't happy and the MET call had only just been brought in at that time and I didn't know the gentleman in anyway whatsoever and by reading the notes and things I wasn't being informed. So we made a decision at that point to em to get the MET score down and put that on the desk and we scored him for MET and he was just outside of the range. So we actually observed him continuously over probably a couple of hours and his output dropped and his respirations increased and it was at that point that...
We decided to put the MET call out because we really didn't know. We felt, we knew this gentleman wasn't right but we didn't know what was happening. He was yeah he was conscious. Em and the gentlemen was transferred to the High Dependency Unit but it was I mean it was a classic call em you know MET because it was it was a call for help really in...
that the patient was deteriorating but quite slowly and we couldn't put our finger on it but we knew he wasn't right and we knew we couldn't cope with it. It was getting to the point where we were thinking this patient is unsafe on the ward and em we need assistance especially during the night you feel quite isolated *INTERVIEWER Uhuh.

*No 6

In the night

*INTERVIEWER

Certainly em if you're thinking about his condition how would you describe it?

*No 6

Emm he was definitely unstable definitely unstable. Em yeah again you see it wouldn't have been a situation where I would have chosen...
It was a slow deterioration so we scored him regularly.

INTERVIEWER: What about in that sense, I know it was nighttime, would the on-call Medical Registrar medical cover be an option?

No.

The yeah.
right at all. He's come in with a right pleural effusion. He's um, 221
he did have a pig-tail drain in about a week ago, they took it out, 222
they think everything's fine, then they did a chest x-ray and he's 223
started building up again, he's got more fluid, pleural effusion. 224
They wanted to tap it but meanwhile he dropped his haemoglobin down 225
to 8.8 or something, 8.7 I think it was. And he was passing out blood 226
in his stool. So they transfused him and sent him up to endoscopy and 227
he's got a bleeding DU, 228

INTERVIEWER

Oh...

No
They couldn't do um the chest drain now so they cancelled that. They said they will put him on iron tablets, stabilise his anaemic state, send him home, and bring him back as an out-patient and do the chest drain. That was the plan. But something about this guy, his previous history, you always check out the previous history. He's got AVR, aortic valve replacement, and he's got a permanent pacemaker in there which we weren't aware of until he went for his um echo cardiogram which showed it um now he's back and his colour's not right. I go a lot Dy colour. And his colour is ashen. He's got a really grey, ashen looking colour on his face and it's not like him. He's normally, previously he was admitted with the same pleural effusion problems on the other side. And he was independent he walked with a stick to the toilet up and down. His mobility is totally down now. He
just about manages to get to the chair. That tells us overall that something is not right. And then his umm, like I said, you can't put your finger on it, something's not right. The doctors came round last week, they said right he can be discharged home, send him home tomorrow, and bring him back as an outpatient for a chest drain, right. Then I said to them, he needs, his mobility is not good, he's not good in himself, generally he's not feeling well, so we need to really fast-track re-hab him before he goes home because he lives alone. So they said fair enough, let's fast-track. So we got through to [ward] and we found a bed for him. And they said they'd have him next day down in [ward] for fast-tracking. Then what happens, that evening before I went home, 3 o'clock I just went into that bay and I looked at him. I thought something's not right here, look at the colour of
him, he looks grey and he was breathless, his breathing was getting worse. So I came back and I said to the registrar who happens to be on the ward, I said to him "(Name), I think um Mr so and so is not well, he's got an awful colour, and I can't put my finger to it." And he turned round and he said "Don't send him for rehabilitation, keep him here. I'd rather have him here in a medical ward than send him to the care of the elderly ward." The doctor phoned [ward], and because of that we cancelled the rehabilitation and kept him in. So like today this morning he's got chest pain. Yesterday morning he complained of
not feeling well, nauseous, and umm breathing, he says his breathing 269

is much worse. This morning, same again, he looks very lethargic, 270

generally he's not feeling well, he's out of it. He's not 272

had any of his lunch, and he couldn't eat his pudding because he was 273

sickly. Observation wise, there's no real change to get the doctors 274

to come and review. Going by the colour and the way the patient is 275

complaining he's not well, there's something about it, something's 276

not right. So what I've done, we spoke to the dietitian to get umm to 277

nutritionally to build him up. Because obviously he's nauseous and 278

he's not eating his food or taking orally enough. And then I've umm, 279

Because obviously he's nauseous and
(5 4) /Clin signs & symptoms- cues/subj pt self report
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
the team has not been round to review him yet. We did an ECG because
(4 2) /Cues considered important/Late cues
(5 1) /Clin signs & symptoms- cues/obj measures
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
he complained he had chest pain and because of the cardiac history we
(2 1 1 1) /Case data/Case Biog data/gender/male patient
(2 1 2 5) /Case data/Case Biog data/Age/60s
(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4 2) /Cues considered important/Late cues
(5 1) /Clin signs & symptoms- cues/obj measures
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
did an ECG and there's no change really. He's got just a paced rhythm
(4 2) /Cues considered important/Late cues
(5 1) /Clin signs & symptoms- cues/obj measures
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
there, so he's no different to what he's been before. So he's not
(2 1 1 1) /Case data/Case Biog data/gender/male patient
(2 1 2 5) /Case data/Case Biog data/Age/60s
(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4 2) /Cues considered important/Late cues
(5 3) /Clin signs & symptoms- cues/subj clinician data
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
not right.
(2 1 1 1) /Case data/Case Biog data/gender/male patient
(2 1 2 5) /Case data/Case Biog data/Age/60s
(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(4 2) /Cues considered important/Late cues
(5 3) /Clin signs & symptoms- cues/obj measures
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
INTERVIEWER
What sort of age range in this gentleman in?
No 28
He's what?
INTERVIEWER
What sort of age range is he in?
No 28
(2 1 1 1) /Case data/Case Biog data/gender/male patient
(2 1 2 5) /Case data/Case Biog data/Age/60s
(2 2 1) /Case data/Case med condition/cardiac & C Vasc
(2 2 2) /Case data/Case med condition/respiratory
(5 1) /Clin signs & symptoms- cues/obj measures
(7 3) /Consequences (cases)/Acute illness +
(F 1 1 28 93) //Free Nodes/Cases whole/Patients/Int 28 cases/Int 28 C 2
He's over 60, 68 ish.
INTERVIEWER

No, it's interesting because it was particularly you homing in on the fact that mobility-wise he wasn't ready for discharge. And then on the heels of that you noticed that his colour had changed.

INTERVIEWER

So would you say in that case then that the reduced mobility and the colour were early signs of something wrong?

INTERVIEWER

the other thing is he has got pleural effusion building up already. So maybe the pleural isn't he and he's waiting for a drain insertion. So maybe the pleural...
INTERVIEWER: Do you think there could be something cardiac going on? Like an acute cardiac thing?

No 28

INTERVIEWER: This is it. This is my fear. So I said to them, because he is a cardiac patient he's very difficult to assess. It could be pulmonary or cardiac, you don't know what's what. But the colour tells me it's...
cardiac, although his breathing tells me it could be a pulmonary
problem. So it's...  

So it's complex isn't it?  

No 28  

Yes. And then I keep telling them I can see him having a cardiac
arrest tonight and going off and not being here tomorrow because of
the way he looks. So I wouldn't be surprised. So hopefully they'll
get this drain in and get some of the symptoms off and see whether
it's related to cardiac.  

The ECG looks ok, yeah, but they haven't done any cardiac enzymes.

The interviewer asks whether investigations would be done.

The interviewer asks whether the symptoms are cardiac.
That's a very interesting case and you've gone through the early signs in detail there (Name). You've talked in detail about two...
Matrix: Analysis of cases according to cue composition and the structure of judgements. Interview 6 (first in Appendix 22) - case 1

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of patient condition: Current condition and predicted condition.</th>
<th>Intervention</th>
<th>Late cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of current and predicted condition.</th>
<th>Intervention</th>
<th>Consequences Clinical Outcome State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective measures</td>
<td>Clinical indicator Vomiting unexplained, and vague when vomited. (Seen by doctor during night). Continued to have vague episodes when vomited next day, but recovered quickly. MET calling criteria used- team was called, but didn’t need Crash Team as patient was still breathing.</td>
<td>Referral to MET</td>
<td>Diagnostic cue A few minutes later patient stopped breathing- respiratory arrest.</td>
<td>Current condition Respiratory arrest.</td>
<td>Crash team called. Basic life support commenced. As airway introduced breathing re-started.</td>
<td>Respiratory arrest Successful resuscitation-breathing returned before team arrived-still had good output. As airway introduced breathing re-started. Patient transferred to High Dependency Unit.</td>
<td></td>
</tr>
<tr>
<td>Paraclinical, laboratory and investigations data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjective clinician and behavioural</td>
<td>Clinical indicator, evaluative judgement ... and then on the early shift he had his breakfast and then promptly collapsed in presence of health care assistant. Unresponsive, breathing and pulse good.</td>
<td>Current condition Developing critical illness, acute deterioration with sudden collapse, unresponsive, breathing good, pulse satisfactory in patient with possible myocardial infarction (later confirmed), possible pulmonary embolism.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient history</td>
<td>Diagnostic cues Male 2 days after admission with possible Myocardial Infarction and possible Pulmonary Embolus. Awaiting v/Q scan. On Cloxane (Enoxaparin low molecular weight heparin) medication.</td>
<td></td>
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<tr>
<td><strong>Int. 6 case 1</strong></td>
<td>Early cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of patient condition: Current condition and predicted condition.</td>
<td>Intervention</td>
<td>Late cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of current and predicted condition.</td>
<td>Intervention</td>
<td>Consequences Clinical Outcome State</td>
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<tr>
<td>Types of cues</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient self-report</td>
<td>Clinical indicator ...he was feeling quite nauseated em during the night (seen by doctor).</td>
<td>Prognosis Critical illness and increased risk of cardiac arrest based on current state and patient history.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Response to treatment</td>
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</tr>
</tbody>
</table>

Matrix: Analysis of cases according to cue composition and the structure of judgements. Interview 6 (first in Appendix 22) - case 3.

<table>
<thead>
<tr>
<th><strong>Int. 6 case 2</strong></th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of patient condition: Current condition and predicted condition.</th>
<th>Intervention</th>
<th>Late cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of current and predicted condition.</th>
<th>Intervention</th>
<th>Consequences Clinical Outcome State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of cues</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective measures</td>
<td>Clinical indicator-evaluative judgement and prognostic indicator. MET score-just outside calling range for MET. So we observed him continuously over a period of a couple of hours ...</td>
<td>Nurses monitored patient closely for a couple of hours, re-checked MET score.</td>
<td></td>
<td>Clinical indicator-evaluative judgement. Urine output dropped and his respiration rate increased - MET called out.</td>
<td>Current condition Critically ill with significant changes in physiological measures in patient receiving respiratory support and history of chronic respiratory condition.</td>
<td></td>
<td>Seen by MET and transferred to high dependency unit.</td>
</tr>
<tr>
<td>Paraclinical, laboratory and investigations data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Critical Illness</td>
</tr>
<tr>
<td>Types of cues</td>
<td>Early cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of patient condition: Current condition and predicted condition.</td>
<td>Intervention</td>
<td>Late cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of current and predicted condition.</td>
<td>Intervention</td>
<td>Consequences Clinical Outcome State</td>
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</tr>
<tr>
<td>Subjective clinician and behavioural</td>
<td>Clinical indicator...We felt, we knew this gentleman just wasn’t right but we didn’t know what was happening. Patient was conscious.</td>
<td>Current condition Acute deterioration with decreased urine output, subjective clinician opinion that patient was deteriorating (outside range for MET) in patient with chronic respiratory condition receiving respiratory support.</td>
<td></td>
<td>Clinical indicator-evaluative judgement...deteriorating but quite slowly and we couldn’t put our finger on it but we knew he wasn’t right and we knew we couldn’t cope with it. It was getting to the point where we were thinking this patient is unsafe on the ward ...he was definitely unstable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient history</td>
<td>Diagnostic cue Male admitted to medical ward. Called to see patient being treated with CPAP (continuous positive pressure ventilation) as urine output had dropped off.</td>
<td>Prognosis Vulnerable to physiological instability, deterioration to critical illness.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Patient self-report</td>
<td></td>
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<td>Response to treatment</td>
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</table>
Matrix: Analysis of cases according to cue composition and the structure of judgements. Interview 28 (second in Appendix 22) - case 2.

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<tr>
<th>Types of cues</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of patient condition: Current condition and predicted condition.</th>
<th>Intervention</th>
<th>Late cues considered important in judgements of patient condition</th>
<th>Verbal descriptor of current and predicted condition.</th>
<th>Intervention</th>
<th>Consequences Clinical Outcome State</th>
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<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>Clinical indicators Passing blood in stool</td>
<td>Clinical indicators, evaluative judgement Observation wise, there's no real change to get the doctors to come and review. Going by the colour and the way the patient is complaining he's not well, there's something about it, something's not right.</td>
<td>Glucose measured 1 in 2</td>
<td>(Plans for fast-track rehabilitation on hold). If we had followed the doctor's instructions - he would have been sent home. We could have sent him home, and a junior staff nurse would have sent him home.</td>
<td>Acute illness (on top of chronic illnesses) and vulnerable to instability. (see Interview 29 case 4 - this patient's case is discussed a few days on required emergency admission to ICU).</td>
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<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td>Diagnostic cues Chest X ray confirmed re-occurrence of pleural effusion. (They wanted to tap it but meanwhile...) he dropped his haemoglobin down to 8.8 or something, 8.7g/L.</td>
<td>Diagnostic cues ECG and there's no change really. He's got just a paced rhythm there, so he's no different to what he's been before. The ECG looks ok, yeah, but they haven't done any cardiac enzymes this morning he complained of chest pain, so maybe it's</td>
<td>Glucose measured 2 in 2</td>
<td>Diagnosis Acute illness on top of chronic illness</td>
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<td>Int. 28 case 2</td>
<td>Early cues considered important in judgements of patient condition</td>
<td>Late cues considered important in judgements of patient condition</td>
<td>Voral description of current and predicted condition</td>
<td>Intervention</td>
<td>Consequence</td>
<td>Clinical outcome</td>
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<td>Paraclinical, laboratory and investigative data (continued)</td>
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<tr>
<td>Subjective clinician and behavioural</td>
<td>Clinical indicators, evaluative judgement. Does he look right? He's got a really grey face and he's not like him. He's got an awful colour, and I can't put my finger to it. He looks very lethargic, and he's apathetic; and he says his breathing is much worse than it was a few days ago. Colour is out of it. Colour is not right... his breathing tells me it could be a pulmonary problem.</td>
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<td>Late cues considered important in judgements of patient condition</td>
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<td>for the patient to do</td>
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<tr>
<td>Int. 28 case 2</td>
<td>Early cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of patient condition: Current condition and predicted condition.</td>
<td>Intervention</td>
<td>Late cues considered important in judgements of patient condition</td>
<td>Verbal descriptor of current and predicted condition.</td>
<td>Intervention</td>
<td>Consequences Clinical Outcome State</td>
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<tr>
<td>Patient history</td>
<td>Diagnostic cues Male 60s with right pleural effusion. History of Aortic Valve Replacement and permanent pacemaker insitu (discovered in echocardiogram). Pig-Tail drain removed a week ago but fluid collected on the other lung. Had transfusion and endoscope recently - bleeding duodenal ulcer, re-insertion of chest drain cancelled and given oral iron supplements.</td>
<td>Prognosis Chronic illness with acute illness on top, vulnerable to deterioration to critical illness based on complications, current patient condition and patient history.</td>
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<tr>
<td>Patient self-report</td>
<td>Clinical indicator generally he’s not feeling well- not ready for discharge home (fast-track rehabilitation planned).</td>
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<td>“This morning he’s got chest pain yesterday he complained of not feeling well, nauseous, and um breathing, he says his breathing is much worse”. Refused food, feeling sick.</td>
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<td>Response to treatment</td>
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## Critical Illness Cross Case Analysis

### Cross-case matrices

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Patient condition</th>
<th>Critical illness cases n = 46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective measures</td>
<td>Blood pressure (21.1, 11.4, 13.1, 12.1, 11.2, 11.3)</td>
<td>EWS (4.2, 1.2, 13.1, 12.1)</td>
<td>EWS (4.2, 1.2, 13.1, 12.1)</td>
<td>Clinical signs of shock</td>
<td>Oxygen saturation levels (0.1, 0.1, 0.1, 0.1, 0.1)</td>
</tr>
<tr>
<td>ECG</td>
<td>Cardiac arrest (0.1, 0.1, 0.1, 0.1, 0.1)</td>
<td>Cardiac arrest (0.1, 0.1, 0.1, 0.1, 0.1)</td>
<td>Cardiac arrest (0.1, 0.1, 0.1, 0.1, 0.1)</td>
<td>Cardiac arrest</td>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Pulmonary and respiratory data</td>
<td>EWS (4.2, 1.2, 13.1, 12.1)</td>
<td>EWS (4.2, 1.2, 13.1, 12.1)</td>
<td>EWS (4.2, 1.2, 13.1, 12.1)</td>
<td>Respiratory failure</td>
<td>Respiratory failure</td>
</tr>
<tr>
<td>Subjective symptoms and other outcomes</td>
<td>Breathing difficulties/shortness of breath</td>
<td>Breathing difficulties/shortness of breath</td>
<td>Breathing difficulties/shortness of breath</td>
<td>Sleepiness</td>
<td>Sleepiness</td>
</tr>
</tbody>
</table>

### Critical Illness Cross Case Analysis

The frequency of cues reported across cases is shown in brackets after each cue.
### Critical Illness

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective clinician and behavioural (continued)</td>
<td>colour, ashen, grey, cyanosed, mottled, flushed, pale looking (22.2, 22.3, 7.1, 9.1, 11.1, 29.4) distended abdomen (17.2) cold to touch (11.2) sweaty or clammy (7.1, 11.2, 19.1) looked or seemed unwell, not right (8.1, 9.2, 30.2)</td>
<td>13.1, 14.1, 19.1, 18.3, 5.1, 8.1) spots or bruises on abdomen (14.1, 11.1) distended abdomen (23.1) sweaty or clammy (2.1, 4.2, 6.4, 7.1, 7.2, 11.1, 21.3) peripheral refill or peripheral shut-down / cold to touch (4.2, 5.1, 6.4, 19.1) thready pulse (19.1) looked or seemed unwell, not right (1.4, 4.2, 6.3, 7.1, 8.1, 11.1, 22.3, 29.4, 30.1) pedal pulses (2.1) legs not swollen (2.1) dark stools (23.3) incorrect medical diagnosis (2.1)</td>
<td>perforation (30.1) emergency gelofusine requested for patient in x ray department (17.2)</td>
</tr>
<tr>
<td>Patient history</td>
<td>(see summary in Graph 17(a), p22)</td>
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<tr>
<td>Patient self-report</td>
<td>Pain (chest pain, chest tightness, knife like pain between shoulder blades) (1.2, 19.1, 32.2) felt unwell or knew something was wrong, not getting air into lungs (11.1, 32.2, 1.4)</td>
<td>Chest pain/ chest tightness/ back or abdominal pain/ exacerbating pain in leg (2.1, 7.1, 7.2, 21.1, 22.2, 17.2, 21.3, 30.1) not complaining of pain (4.2, 13.1, 15.3) bruise on abdomen (11.1) short of breath or felt breathing was a problem (4.2, 7.2, 13.1, 18.3, 21.1, 22.2, 23.1) felt unwell (9.1, 11.1, 13.1) refusing food (18.1)</td>
<td>Feeling grim (11.1) Pain present or absent (2.1, 12.1) breathing problems or shortness of breath (9.1, 13.1)</td>
</tr>
</tbody>
</table>

Matrix: Cardiac Arrest Cross Case Analysis according to cue composition. Cardiac Arrest Cases n= 23.

### Cardiac Arrest

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective measures</td>
<td>Blood pressure (3.1, 13.2, 16.1, 17.4) urine output (3.1, 8.3) respiratory rate (4.1, 17.4) heart rate or pulse (16.1, 17.4) oxygen saturation levels (4.1, 8.2) vomiting (6.1)</td>
<td>Blood pressure (1.1, 3.3, 4.1, 5.2, 8.3, 10.1) urine output (3.1, 5.2, 13.2) respiratory rate (3.1, 8.3, 10.1, 31.1) heart rate or pulse (4.1, 6.1) MET score (3.3, 4.1, 6.1) physical measures/ vital signs no changes (3.5, 21.2, 24.1) oxygen saturation levels (10.1) vomiting (2.2, 6.1) temperature (8.3, 10.1, 18.2)</td>
<td>Blood pressure (2.2, 3.3, 4.1, 5.2, 8.2, 8.3, 13.2, 16.1) oxygen saturation levels (2.2, 17.4, 18.2) heart rate or pulse (4.1, 5.2, 8.3) vomiting (2.2) diarrhoea (2.2) MET score (3.1) CVP (5.2) respiratory rate (4.1, 8.3) receiving oxygen continuously (24.1) urine output (2.2, 5.2) hypovolaemic shock (4.3) haematemesis (4.3) Respiratory or cardiac arrest (1.1, 1.3, 1.5, 3.1, 3.3, 3.5, 4.3, 6.1, 7.3, 8.2, 8.3, 11.3, 13.2, 16.1, 17.4, 18.2, 21.2, 24.1, 31.1)</td>
</tr>
<tr>
<td>Paraclinical, laboratory and investigations data</td>
<td>ECGs (1.3, 3.3, 4.1, 5.2, 8.2, 8.3, 10.1) Scans- echocardiogram, computerised tomography scan (1.5, 31.1) ABGS (8.2) haemoglobin (13.2) Blood sugar (21.2)</td>
<td></td>
<td>ECG (16.1) Scans- CT scan, ultrasound scan (2.2, 3.5) abdominal x ray (4.1)</td>
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App.25


Matrix: Cross Case Analysis Acute Illness and Vulnerable to Physiological Instability/ Deterioration to Critical Illness or Cardiac Arrest Analysis According to Cue Composition. Acute Illness and Vulnerable to Physiological Instability Cases n= 25

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>Oxygen saturation levels (27.4) blood pressure (25.2, 27.2) heart rate or pulse (22.1) respiratory rate (27.4) bleeding (27.3)</td>
<td>Oxygen saturation levels (1.8, 2.3, 3.2, 6.5, 27.2, 29.3) blood pressure (2.4, 3.4, 6.5, 20.1) heart rate or pulse (1.7, 26.1, 27.2) MET score (2.3, 7.4) respiratory rate (27.2), temperature (3.4) urine output (20.1, 27.2) bleeding (27.3, 28.2) fractured neck of femur (32.4) observations satisfactory (26.1)</td>
<td>No major changes, no events (1.6, 1.7, 1.8, 1.9, 3.4, 25.2, 27.4) oxygen saturation levels (3.2) MET score (17.3) no intravenous access (27.3) no change in observations/observations satisfactory (27.3, 28.2) received sedation and analgesia (29.3) post-operative physiological signs satisfactory (32.4) vomited (25.2)</td>
</tr>
<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td>ECG (1.6, 1.7, 2.4, 3.2, 22.1, 27.2) haematology results (1.7, 3.4, 28.2) chest x ray (1.7, 1.8, 28.2) biochemistry results (1.7, 8.4) blood sugar (16.3)</td>
<td></td>
<td>Biochemistry results (8.4, 20.1, 22.1) haematology results (8.4, 27.3) ABGs (2.3, 17.3, 20.1) ventilation perfusion lung scan (v/Q scan) (26.1) ECG (3.2, 26.1, 27.2, 28.2) Troponia T (28.2)</td>
</tr>
<tr>
<td><strong>Subjective clinician and behaviour</strong></td>
<td>looked unwell/ not right (8.6, 22.1, 7.4, 28.2) abnormal colour, very pale, ashen, grey or very red (7.4) breathing difficulties (2.3, 17.3, 29.3) psychological signs-agitated, anxious looking or distressed (6.5, 26.1) pain (27.4, 29.3) LOC (20.1, 27.2, 27.3) behavioural (27.3)</td>
<td>Behavioural signs including withdrawn (1.8, 2.4, 3.2, 6.5, 8.6, 17.3, 20.1, 25.2, 27.2, 28.2, 32.4) looked unwell/ not right (1.8, 2.4) abnormal colour, very pale, ashen, grey or very red (1.8, 2.4, 22.1, 28.2, 3.4, 25.2) breathing (2.4, 27.2) psychological signs-agitated, anxious looking or distressed (2.4, 3.2, 22.1, 29.3, 22.3) pain (3.4, 22.1, 32.3) LOC (22.1, 25.2) irregular pulse (22.1, 27.2) no colour changing (1.9) increased confusion (8.4) sleepy (20.1) posture poor for chest function (27.4) nausea and not passing flatus (32.3) well perfused looking (27.2) sweaty or clammy (2.3)</td>
<td>Colour grey (3.2, 28.2) breathing difficulties (including allergy to Salbutamol) (7.4, 17.3, 28.2) Psychological signs calmer/ more settled/ anxious/ panicky/ mood (2.3, 2.4, 17.3, 29.3, 32.4) behavioural sign-wanted to take GTN, lethargic, apathetic, decreased appetite, chest pain on exertion (2.4, 3.2, 28.2, 32.4) raised blood sugars were left untreated (16.3)</td>
</tr>
<tr>
<td><strong>Patient history</strong></td>
<td>(see summary in Graph 17(c), p227)</td>
<td></td>
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<tr>
<td><strong>Patient self-report</strong></td>
<td>Severe or almost constant chest pain (2.3, 2.4) shortness of breath (2.3, 2.4, 3.2) felt unwell or uncomfortable (3.2) abdominal pain (32.3) Psychological sign-frightened (6.5)</td>
<td>Severe or almost constant chest pain (1.6, 26.1) shortness of breath (29.3) nausea (22.1, 25.2, 32.3) felt unwell or uncomfortable (28.2) abdominal pain (8.6, 22.1, 32.3), abdominal distension, not passing flatus (32.3) no chest pain (3.2) felt well or a lot better than previously (1.7, 27.3) tingling in arms over period of six months (3.4)</td>
<td>Headache (2.4) unwell (28.2, 32.4) chest pain (2.4, 28.2) breathing worse (28.2) refused food and felt sick (28.2)</td>
</tr>
<tr>
<td><strong>Response to treatment</strong></td>
<td>Chest pain unresponsive to maximal anti-anginal therapy (1.6) fast atrial fibrillation unresponsive to treatment (1.7) delayed recovery (1.8, 8.6) responded well to oxygen therapy and analgesia (2.3) shortness of breath unresponsive to diuretic therapy (3.2) constipation treated</td>
<td></td>
<td>GTN administered, developed headache and was treated with Paracetamol (2.4) oxygen percentage increased, bed-rest and condition improved (3.2) responded to increased oxygen delivery (6.5) breathing responded to intravenous Almophylline</td>
</tr>
</tbody>
</table>
### Acute Illness and Vulnerable to Physiological Instability/ Deterioration

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response to treatment (continued)</td>
<td>but remained agitated (6.5) raised blood sugars untreated on medical ward (16.3) unresponsive to nebuliser therapy (17.3) LOC and blood pressure responded to increased rate of intravenous infusion, position change and suctioning (25.2) respiratory distress related to analgesia being discontinued overnight (no explanation available) (29.3) initially improving post-operatively then deteriorated (32.3) dysphasia improved with speech therapy (32.4)</td>
<td>(17.3) cardiac arrhythmias unresolved- transferred to cardiac ward for monitoring (27.2) cardiac arrhythmias due to withdrawal from Amiodarone (27.2) acute haemorrhage responded to nurses first aid treatment (27.3) respiratory distress and pain responded to analgesia and sedative infusions (29.3) abdominal pain-paralytic ileus responded to restig the gastrointestinal tract, nil orally and intravenous fluids (32.3) Responded to GTN and bed rest, colour improved (3.2) Responded to increased oxygen delivery, and seen by doctor (6.5)</td>
<td></td>
</tr>
</tbody>
</table>

No initial cues as patients had not had any acute events- 1.6, 1.7, 1.8, 1.9, 3.4, 8.4, 8.6

Matrix: Acute Illness Cross Case Analysis According to Cue Composition. Acute illness cases n= 3

### Acute Illness

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective measures</td>
<td>MET score satisfactory (30.3)</td>
<td>Chest infection treated (improved) (8.5)</td>
</tr>
<tr>
<td>Paraclinical, laboratory and investigations data</td>
<td>Pain control good (30.3) weak, tiny and emaciated (8.5) reduced mobility (8.5) no post-operative problems (30.3) tired (30.5) eating post operatively without problem (32.5)</td>
<td>Reduced mobility, required Zimmer frame (8.5) bowel function normal (32.5)</td>
</tr>
<tr>
<td>Subjective clinician and behavioural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient history</td>
<td>(see summary in Graph 17(d), p228)</td>
<td></td>
</tr>
<tr>
<td>Patient self-report</td>
<td>No pain complaints (30.3) No complaints of feeling unwell (30.3)</td>
<td></td>
</tr>
<tr>
<td>Response to treatment</td>
<td>Rapid post operative recovery (30.3)</td>
<td>Responded to antibiotic therapy (8.5) uneventful post operative recovery (30.3)</td>
</tr>
</tbody>
</table>
Matrix: Chronic Illness Cross Case Analysis According to Cue Composition. Chronic Illness Cases n= 7

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective measures</td>
<td>Blood pressure (28.3)</td>
<td>Blood pressure (7.5, 28.3) oxygen saturation levels (19.4, 29.2) heart rate (28.3) respiratory rate (29.2) not vomiting (31.4) pyrexia (19.3)</td>
<td>No change in objective measures (7.5) oxygen saturation levels (19.4) urine output (29.2) requires oxygen therapy (29.2)</td>
</tr>
<tr>
<td>Paraclinical, laboratory and investigations data</td>
<td>Computerised tomography scan (29.2)</td>
<td>Requires cardiac monitoring due to tachycardia induced by medication (Aminophylline) (29.2) Sliding scale insulin regime (29.2)</td>
<td></td>
</tr>
<tr>
<td>Subjective clinician and behavioural</td>
<td>Behavioural signs (7.5, 19.3, 28.3) Psychological signs mood/ withdrawn (7.5)</td>
<td>Behavioural signs (7.5, 19.3, 28.3, 31.3, 31.4) Psychological signs mood/ withdrawn/ seemed depressed (7.5, 31.4) looked unwell/ sickly (7.5, 19.3, 31.3) Colour pale/ very yellow (7.5, 31.3) breathing difficulties/ gasping for breath (19.4, 29.2) Level of consciousness/ collapse (29.2) Confusion (7.5) ascites/ distended abdomen (31.3) nauseous (31.3)</td>
<td>Difficult to judge when invasive ventilation required in Cystic Fibrosis patient (19.4) medication reviewed (28.3) Level of consciousness (29.2) sensitive to touch (29.2) nausea (31.3) behavioural signs (31.3).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient history</th>
<th>(see summary in Graph 17(e), p228)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient self-report</td>
<td></td>
<td></td>
<td>Difficult to get patient’s view due to bravado of patient (29.2)</td>
</tr>
<tr>
<td>Response to treatment</td>
<td>Perindopril given in divided doses to decrease hypotensive effect (7.5) requires 60% oxygen to maintain adequate oxygen saturation levels (19.4) responded to Parvolex treatment and antiemetics, nausea subsided (31.3) responded to psychotherapy for eating disorder (31.4) Breathing unresponsive to Bricanyl and given Aminophylline (29.2)</td>
<td>Oxygen saturation responded to physiotherapy and nebuliser medication (19.4) medication altered due to hypotension / chronically low blood pressure (28.3) Frusemide administered for low urine output with poor response (29.2) Aminophylline administered to treat breathing difficulty with some response (29.2)</td>
<td></td>
</tr>
</tbody>
</table>
### Palliative and Terminal Illness Cases n=5

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>Blood pressure (15.1)</td>
<td>Oxygen saturation levels (19.2) observations not recorded as patient at end of life (29.1)</td>
<td>Respiratory arrest (19.2, 29.1) percutaneous enterogastrostomy (PEG) tube was not inserted (9.4) oxygen saturation levels (15.1) blood pressure (15.1) urine output (15.1) no major changes in physical signs (10.3)</td>
</tr>
<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td>Behavioural signs including mental status, tiredness, pain control (10.3) Level of consciousness/ became unresponsive (15.1) chest sounds, secretions (10.3) breathing difficulties (10.3, 15.1, 19.2) Colour of skin/ translucency (10.3)</td>
<td>Behavioural signs including mental status, tiredness, pain control (10.3) Level of consciousness/ became unresponsive (15.1) chest sounds, secretions (10.3) breathing difficulties (10.3, 15.1, 19.2) Colour of skin/ translucency (10.3)</td>
<td>Behavioural signs including mental status, tiredness, pain control (10.3) Level of consciousness/ became unresponsive (15.1) chest sounds, secretions (10.3) breathing difficulties (10.3, 15.1, 19.2) Colour of skin/ translucency (10.3)</td>
</tr>
<tr>
<td><strong>Subjective clinician and behavioural</strong></td>
<td>Behavioural signs removing nasogastric tube/ sleeper (9.4, 10.3) Colour pale (19.2, 29.1)</td>
<td>Behavioural signs including tingling motion in lips (9.4, 10.3, 19.2) Level of consciousness (10.3, 15.1) Psychological signs (10.3) Grey or pale colour (15.1) Inotrope support had been discontinued (15.1) breathing deterioration (19.2) possible intestinal obstruction (29.1)</td>
<td>Behavioural signs including mental status, tiredness, pain control (10.3) Level of consciousness/ became unresponsive (15.1) chest sounds, secretions (10.3) breathing difficulties (10.3, 15.1, 19.2) Colour of skin/ translucency (10.3)</td>
</tr>
<tr>
<td><strong>Patient history</strong></td>
<td>(see summary in Graph 17(0), p228)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patient self-report</strong></td>
<td>Did not talk about malignancy on readmission to ward (10.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Response to treatment</strong></td>
<td>Not recovering from surgery (15.1) Breathing deteriorated whilst on oxygen therapy (19.2) urine output did not respond to fluid challenge overnight (29.1)</td>
<td></td>
<td>Diamorphine infusion planned but not commenced as patient did not exhibit signs of pain (10.3) Low blood pressure treated with some response then dropped again (15.1)</td>
</tr>
</tbody>
</table>
Matrix: Critical Illness Cross Case Analysis according to cue composition. Medical Cases (excludes coronary care cases) n=28

The frequency of cues reported across cases is shown in brackets after each cue.

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>blood pressure (1) pulse or heart rate (2) oxygen saturation levels (1) respiratory rate (1) urine output (3)</td>
<td>blood pressure (19) pulse or heart rate (3) oxygen saturation levels (11) respiratory rate (7) objective measures/ vital signs normal (6) MET (medical emergency team)/ EWS early warning score (6) urine output/ fluid balance (4) central venous pressure (CVP) (1) temperature (1)</td>
<td>oxygen saturation levels or unable to maintain adequate oxygenation (6) MET score (6) blood pressure (5) heart rate or pulse (5) respiratory rate (4) urine output/ fluid balance/ renal failure (4) physical signs/ measures unchanged, always poor (1) temperature (1)</td>
</tr>
<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td>Cardiac enzymes/ markers (1) Blood sugars (1)</td>
<td>Electrocardiograph (ECG) (5) cardiac enzymes/ markers (2) chest x-ray (1) blood sugars (1) bladder scan (1)</td>
<td>ECG (3) cardiac enzymes/ markers (2) arterial blood gases (4) blood sugar (3) chest x-ray (2) ultrasound scan (3) haemoglobin (2) ventilation perfusion (v/Q) scan (1) Methicillin resistant staphylococcus aureus (MRSA) (1)</td>
</tr>
<tr>
<td><strong>Subjective clinician and behavioural</strong></td>
<td>breathing difficulties/ breathlessness /chest sounds/ use of accessory muscles or respiration (8) confusion (1) psychological distress/ agitation/ anxiety (2) behavioural/ functional changes including tiredness / weakness/ demeanour/ position abnormal (6) level of consciousness LOC (drowsy, unrousable or decreased LOC) (4) skin colour, ash, grey, cyanosed, mottled, flushed, pale looking (4) distended abdomen (1) cold to touch (1) sweaty or clammy (3) looked or seemed unwell, not right (1)</td>
<td>breathing difficulties/ breathlessness (5) confusion (3) psychological distress/ agitation/ anxiety/ mood (4) looked in pain, pain description (3) behavioural/ functional changes/ tired/ withdrawn/ lethargic/ restless or uncomfortable/ position abnormal/ demeanour (8) level of consciousness LOC (drowsy, unrousable or decreased LOC) (3) fitting (1) swallow reflex or swallow deficit (2) Skin colour, ash, grey, cyanosed, mottled, flushed or pale looking (5) spots or bruises on abdomen (1) sweaty or clammy (5) peripheral refill or peripheral shut-down / cold to touch (2) tready pulse (1) looked or seemed unwell, not right (6) pedal pulses (1) legs not swollen (1) incorrect medical diagnosis (1)</td>
<td>LOC or Glasgow Coma Scale changes (6) breathing difficulties/ breathlessness/ changes in breathing (7), behavioural/ functional changes (4) psychological distress/agitation (1) colour poor or grey (1) leg cold (1) pedal pulses absent (1) fluid in abdomen (1) looked very unwell, condition not right or deteriorating (1)</td>
</tr>
<tr>
<td>Types of cues</td>
<td>Initial cues considered important in judgements of patient condition</td>
<td>Early cues considered important in judgements of patient condition</td>
<td>Late cues considered important in judgements of patient condition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Patient history</td>
<td></td>
<td>(See section 7.4.1 critical illness cases for patient history)</td>
<td></td>
</tr>
<tr>
<td>Patient self-report</td>
<td>pain (chest pain, chest tightness, knife like pain between shoulder blades) (3) felt unwell or knew something was wrong, not getting air into lungs (3)</td>
<td>Chest pain/ chest tightness/ back or abdominal pain/ excruciating pain in leg (6) not complaining of pain (1) bruise on abdomen (1) short of breath or felt breathing was a problem (4) felt unwell (3) refusing food (1)</td>
<td>Feeling grim (1) Pain present (1) or pain absent (1) breathing problems or shortness of breath (2)</td>
</tr>
<tr>
<td>Response to treatment</td>
<td>Not responding to treatment (4) Responding to treatment (1)</td>
<td></td>
<td>Not responding to treatment (7) Responding to treatment (3)</td>
</tr>
</tbody>
</table>
Matrix: Cardiac Arrest Cross Case Analysis according to cue composition. Medical Cardiac Arrest Cases (excludes coronary care cases), n = 19.

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>Blood pressure (3) urine output (2) respiratory rate (1) heart rate or pulse (1) oxygen saturation levels (1) vomiting (1)</td>
<td>Blood pressure (4) urine output (2) respiratory rate (4) heart rate or pulse (1) MET score (2) observations/ vital signs no changes (3) oxygen saturation levels (1) vomiting (2) temperature (3)</td>
<td>Blood pressure (5) oxygen saturation levels (3) heart rate or pulse (1) vomiting (1) diarrhoea (1) MET score (1) respiratory rate (1) receiving oxygen continuously (1) urine output (1) Respiratory or cardiac arrest (17)</td>
</tr>
<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td>ECGs (5) Scans echocardiogram, computerised tomography scan (2) ABGS (1) haemoglobin (1) Blood sugar (1)</td>
<td></td>
<td>Scans CT scan, ultrasound scan (2)</td>
</tr>
<tr>
<td><strong>Subjective clinician and behavioural</strong></td>
<td>Behavioural changes including being more withdrawn, lacking motivation, delayed mobility quieter, demeanour, tired (7) Psychological state, mood changes (2) colour change/ poor/ pale or grey colour (1) breathing (2) level of consciousness (3) looked unwell/ seemed unwell/ awful (3) sweaty/ clammy (1)</td>
<td>Behavioural changes including being more withdrawn, tired, lacking motivation, delayed mobility, quieter, posture, listless (6) Psychological state including agitated, mood changes (4) colour change/ poor or grey colour (5) breathing (3) level of consciousness including collapse (3) abdominal distension (1) looked unwell (2) bruises present or absent (2) oedematous (2) sweaty/ clammy (2)</td>
<td>Psychological state looked terrified, agitated (1) looked awful, didn’t look right (4) breathing worse (2) colour (3) behavioural changes including lethargy, looked exhausted (5) level of consciousness, collapse (4) confused (1) not for resuscitation order (2) doctor’s diagnosis incorrect (1) abdominal distension (1) fitting (1) asked for commode (1)</td>
</tr>
</tbody>
</table>

Patient history

(See section 7.4.2 cardiac arrest cases for patient history)
<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient self-report</td>
<td>chest, back, abdominal pain or discomfort (3) shortness of breath (2) nausea (1)</td>
<td>Feeling unwell (3) feeling alright (2) chest, back, abdominal pain or discomfort (5) shortness of breath (3) tired (1) nausea (1) speech clear, coherent but not wanting to talk (1) dizziness (1) refused food (1)</td>
<td>Feeling alright, not complaining of pain (3) chest or abdominal pain (3) did not want to be resuscitated (1) refused invasive treatment (1) felt unwell (2) body language fearful, unable to breath (1) reported fear of death/ frightened (2)</td>
</tr>
<tr>
<td>Response to treatment</td>
<td>Fluid challenge rationale not explained, patient went on to cardiac arrest (1) nausea treated, and not considered a significant sign at the time (1) first episode of breathing difficulty responded to Aminophylline (1)</td>
<td>Not responding to treatment (1) Warfarin discontinued due to low haemoglobin, treated with vitamin K, cross matched for blood but cardiac arrest before this was given (1)</td>
<td></td>
</tr>
</tbody>
</table>
Matrix: Cross Case Analysis Acute Illness and Vulnerable to Deterioration to Critical Illness or Cardiac Arrest. Medical cases (excludes coronary care cases) n = 16

<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective measures</strong></td>
<td>bleeding (1)</td>
<td>Oxygen saturation levels (5) blood pressure (3) heart rate or pulse (1) MET score (2) temperature (1) bleeding (2)</td>
<td>No major changes, no events (1) oxygen saturation levels (1) MET score (1) no intravenous access (1) no change in observations / observations satisfactory (1) received sedation and analgesia (1)</td>
</tr>
<tr>
<td><strong>Paraclinical, laboratory and investigations data</strong></td>
<td></td>
<td>ECG (4) haematology results (3) chest x ray (3) biochemistry results (2)</td>
<td>Biochemistry results (1) haematology results (2) ABGs (2) ECG (2) Troponin T (1)</td>
</tr>
<tr>
<td><strong>Subjective clinician and behavioural</strong></td>
<td>looked unwell/ not right (3) abnormal colour, very pale, ashen, grey or very red (1) breathing difficulties (3) psychological signs-agitated, anxious-looking, distressed (1) pain (1) LOC (1) behavioural (1)</td>
<td>Behavioural signs including withdrawn (8) looked unwell/ not right (2) abnormal colour, very pale, ashen, grey or very red (3) breathing (2) psychological signs-agitated, anxious looking, distressed (5) pain (1) no colour change (1) increased confusion (1) sweaty or clammy (1)</td>
<td>Colour grey (2) breathing difficulties (including allergy to Salbutamol) (3) Psychological signs calmer/ more settled/ anxious/ panicky/ mood (4) behavioural sign-wanted to take GTN, lethargic, apathetic, decreased appetite, chest pain on exertion (3)</td>
</tr>
<tr>
<td><strong>Patient history</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patient self-report</strong></td>
<td>Severe or almost constant chest pain (1) shortness of breath (3) felt unwell or uncomfortable (1) Psychological sign-frightened (1)</td>
<td>Severe or almost constant chest pain (1) shortness of breath (1) felt unwell or uncomfortable (1) abdominal pain (1), no chest pain (1) felt well or a lot better than previously (1) tingling in arms over period of six months (1)</td>
<td>Headache (1) unwell (1) chest pain (2) breathing worse (1) refused food and felt sick (1)</td>
</tr>
</tbody>
</table>

(See section 7.4.3 Acute Illness and Vulnerable to Deterioration cases for patient history)
<table>
<thead>
<tr>
<th>Types of cues</th>
<th>Initial cues considered important in judgements of patient condition</th>
<th>Early cues considered important in judgements of patient condition</th>
<th>Late cues considered important in judgements of patient condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response to treatment</td>
<td></td>
<td>Chest pain unresponsive to maximal anti-anginal therapy (1) fast atrial fibrillation unresponsive to treatment (1) delayed recovery (2) responded well to oxygen therapy and analgesia (1) shortness of breath unresponsive to diuretic therapy (1) constipation treated but remained agitated (1) unresponsive to nebuliser therapy (1) respiratory distress related to analgesia being discontinued overnight (no explanation available) (1)</td>
<td>GTN administered, developed headache and was treated with Paracetamol (1) oxygen percentage increased, bed-rest and condition improved (1) responded to increased oxygen delivery (1) breathing responded to intravenous Aminophylline (1) acute haemorrhage responded to nurses first aid treatment (1) respiratory distress and pain responded to analgesia and sedative infusions (1) Responded to GTN and bed rest, colour improved (1) Responded to increased oxygen delivery, and seen by doctor (1)</td>
</tr>
<tr>
<td>No initial cues as patients had not had any acute events</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.6, 1.7, 1.8, 1.9, 3.4, 8.4, 8.6
Appendix 29

A typology of cues for the prediction of critical illness or cardiac arrest in general medical patients.

This typology is based on findings for critical illness and cardiac arrest outcome states arising from the qualitative interview study and the systematic review.

<table>
<thead>
<tr>
<th>Source of cues</th>
<th>Clinical cues</th>
</tr>
</thead>
</table>
| **Objective measures of physical state** | blood pressure
respiratory rate
heart rate
oxygen saturation levels or SpO₂,
temperature
urine output
MET/EWS scores
bleeding
vomiting
Observations of physical status measures may be unchanged. |
| **Paraclinical/ laboratory/ investigative data** | blood sugar
electrocardiograph (ECG)
cardiac enzyme results;
haematology (haemoglobin);
biochemistry results (potassium);
x-rays,
scan results e.g. bladder scans. |
| **Clinician subjective and behavioural data** | breathing difficulties (includes laboured breathing/ unable to speak in sentences or able to speak in sentences/ additional chest sounds present / use of accessory muscles of respiration/ shallow breathing/ noisy breathing/ respiratory function worse and gasping for breath/ coughing/ sputum/ clapping oxygen mask/ still talking in sentences, or not able to talk in sentences/ tolerating lying flat/ not tolerating lying flat)
pulse volume (full/strong or weak) and regularity (regular or irregular) assessed manually
Level of consciousness (LOC) assessed using Glasgow Coma Score (GCS), or alert, verbal, responds to pain, unresponsive to painful stimuli scale (AVPU)
Confusion present/ absent
restlessness present/ absent
tiredness, looks exhausted, present/ absent
weakness present/ absent
lethargy present/ absent
abdominal distension present/ absent
position/ posture slumped/ sitting upright, normal/ abnormal
colour (cyanosed, ashen, grey, pale looking, mottled, and flushed).
skin clamminess, and assessments of perfusion made by touching/ feeling the skin including on the legs |
<table>
<thead>
<tr>
<th>Source of cues</th>
<th>Clinical cues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinician subjective and</td>
<td>appearance looks well or ill</td>
</tr>
<tr>
<td>behavioural data (continued)</td>
<td>demeanour normal/abnormal</td>
</tr>
<tr>
<td></td>
<td>pain- appears to be in pain assessed via patient’s facial expression, reluctance to move, tense posture as well as abnormal physical signs (such as raised pulse) or patient self-report. Looks uncomfortable/comfortable present/absent</td>
</tr>
</tbody>
</table>
|                               | **Functional cues** refer to performance and level of dependence in activities of living. This includes: -  
<p>|                               | Mobility- normal or abnormal/delayed mobilisation. Mobility improving/deteriorating.                                                                                                                        |
|                               | Urinary continence/incontinence                                                                                                                                                                              |
|                               | Eating and drinking                                                                                                                                                                                          |
|                               | Participation in personal hygiene tasks-able to cooperate/unable to cooperate or reduced cooperation (interactive cues)                                                                                      |
|                               | Communicating/responding to others/not responding to others (interactive cues).                                                                                                                                 |
|                               | Talkative/untalkative or quiet (interactive cues).                                                                                                                                                            |
|                               | Withdrawn/not withdrawn (interactive cues).                                                                                                                                                                  |
| Psychological/personal factors| refer to cues such as anxiety, fear (especially related to breathing difficulty or fear of impending death), psychological distress, and patients with reduced motivation. |
|                               | Systematic review findings—the main categories of cues reported were level of consciousness, intuition, dyspnoea, airway obstruction, patient distress. |
|                               | <strong>Patient history</strong> Medical history refers to diagnostic categories, acute or chronic illnesses, and comorbidities.                                                                                      |
|                               | The severity of patients’ symptoms prior to the current admission (categorised as asymptomatic, mild, moderate or severe) was considered important in the patients with chronic illnesses. Functional ability prior to admission may be used in the assessment of prior health status. |
|                               | Severity of current illness—(as mild, moderate or severe)                                                                                                                                                     |
|                               | Risk characteristics present/absent                                                                                                                                                                          |
|                               | Personal characteristics of age and gender.                                                                                                                                                                  |
|                               | Estimated physiological reserve (based on the above factors)                                                                                                                                                   |
|                               | In addition to the above the systematic review frequently reported the cue category, type of admission (emergency/planned; medical/surgical).                                                               |
|                               | <strong>Patient self-report</strong> Breathlessness, shortness of breath or dyspnoea                                                                                                                                        |
|                               | Different types of pain were reported; chest pain, chest tightness, back pain, abdominal pain, abdominal discomfort and calf pain.                                                                       |
|                               | Generalised complaints of feeling unwell, or feeling uncomfortable.                                                                                                                                             |
|                               | Systematic review findings—the main cue category was chest pain.                                                                                                                                                |
|                               | <strong>Temporal cues/type of change</strong> In the qualitative interviews these included: • Acute/sudden deterioration in clinical condition • Chronic/gradual deterioration in clinical condition • No change in clinical condition, or the same symptoms persisting without discernible change • Clinical condition improved |
|                               | In the systematic review temporal factors referred to all references to the patient’s clinical course, change in condition within a specified time, and change in practice such as comparison before and after introduction of Medical Emergency Team. |</p>
<table>
<thead>
<tr>
<th>Source of cues</th>
<th>Clinical cues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative/ organisational factors/ location</td>
<td>Qualitative study- all references to organisation of care, context of care, skill-mix and nurse/ doctor relations Systematic review- patient location ward or HDU/ critical care area, length of stay in ward/ ICU/ hospital.</td>
</tr>
<tr>
<td>Delayed response</td>
<td>Qualitative study- quality of intervention as delayed and/ or reactive intervention or early pro-active intervention Systematic review- delays in recognition of deterioration and delays in initiation of treatment</td>
</tr>
<tr>
<td>Treatment response</td>
<td>Qualitative study- the various responses in the qualitative interview study could be categorised as: • not responding to treatment, • delayed response to treatment, and • responding to treatment.</td>
</tr>
</tbody>
</table>

**Definition of selected terms included in the above table:**

- An acute illness presents with signs and symptoms of fast onset and short duration, but the effect can be severe and the person’s ability to function can be altered (Mosby’s Medical Nursing & Allied Health Dictionary, 2002).
- Chronic illness is defined as: *an illness that persists over a long period that may impact on physical, emotional, intellectual, social or spiritual function* (Mosby’s Medical Nursing & Allied Health Dictionary, 2002).
- Co-morbidities are defined as *two or more co-existing medical conditions or unrelated disease processes* (Mosby’s Medical Nursing & Allied Health Dictionary, 2002).
- Dyspnoea is defined as: *the distressful sensation of uncomfortable breathing* (Mosby’s Medical Nursing & Allied Health Dictionary, 2002).
- Risk characteristics encompass *risk factors* prior to the onset of the current disease or illness such as smoking or reduced physical activity which can be modified, and *risk markers* such as age or gender which cannot be altered (Jenicek, 1999).
- Demeanour – *the way a person behaves* (Collins Pocket English Dictionary, 1996)
- Functional ability - there is scope for use of a transition scale for functional status; a patient’s functional ability in various activities of living could be described as *substantially improved, slightly improved, no change, slightly worse, and substantially worse* (Feinstein, 1987 p 67).
Severity of illness – an important concept for critical care nursing?

Why focus on severity of illness? The severity of illness concept is applicable across the entire range of acute, chronic, acute-on-chronic, critical, and terminal illnesses. Within critical illness, severity describes an important dimension of the patient’s general state around which care is organized and delivered, thus making it an important concept for nursing. In everyday practice, critical care nurses make judgements about the severity and stability of patients’ conditions and use this information to make decisions about nursing care. Severity is often used to identify patients on a continuum ranging from no illness to mild, moderate, severe and moribund (Sax & Charlson 1987); experienced clinicians seem to have a shared understanding of these terms. In the ‘new’ specialty of ‘Comprehensive Critical Care’, directed towards the critically ill and those at risk of critical illness, severity of illness is a core concept (DoH 2000). This editorial explores definitions of severity of illness, considers the purposes of measuring severity of illness, briefly addresses why ‘concepts’ and ‘constructs’ are important for nursing, and presents a critical care nursing perspective on severity of illness.

The definition of severity of illness remains problematic due to the abstract nature of the concept and the breadth of its scope. However, a useful starting point is to differentiate between ‘illness’ and ‘disease’. The subtle differences are captured in the following definitions with illness identified as ‘...the actual manifestations of a disease in an individual patient’; and disease viewed as ‘...a well-defined model of a process of disruption in the normal homeostasis of psychological-physiological systems’ (Gonnella et al. 1984, p. 638). Illness severity has been defined as the ‘...degree and impact of change on health status of an individual as a result of illness or injury’ (Kreitzer et al. 1982, p. 21), thus reflecting the consequences of illness for an individual and a major concern of nursing as it focuses on helping individuals cope with their illnesses.

Severity of illness has been defined in a number of ways according to the perspective and purpose of the person using it. According to Iezzoni (1999), physicians focus on the effect of a disease on an individual’s physiological status and prognosis; psychiatrists are mainly interested in cognitive dysfunctions; physiotherapists and occupational therapists are mainly concerned with functional abilities and ability to undertake activities of living, whereas nurses draw on physiological, psychological and functional abilities. Healthcare managers would be interested in any relationship between resource needs and severity of illness. However, we should also consider the purpose of defining severity of illness from the nursing perspective, which is omitted from the above definition.

Nurses use physiological, psychological and functional indices of illness or disability to describe patients’ responses to help them cope with their illnesses or situations. The nursing discipline is concerned with dimensions which are complementary to medicine, but focuses on the meaning of the illness experience to the individual and how nursing interventions, particularly interpersonal interactions and other technical interventions, might assist coping. The medical frame of reference takes in medical diagnosis, pathological findings, and treatments...
Intensive and Critical Care Nursing

for pathologies to maximize an individual’s health, whereas the nursing perspective aims to provide scientifically appropriate and effective nursing care to promote the individual’s health (Kim 1983). Within critical care, we might argue that the interpersonal interactions’ dimension and the technical interventions have an equitable weighting; clearly expertise in both dimensions is vital.

Why measure severity of illness? Quantitative measures of illness severity are needed for a range of healthcare management, clinical and research purposes. These include quality assurance/evaluation of care including workload and staffing, prediction of mortality and morbidity, prediction of functional disability, as indicators for intervention, and to record patient condition in clinical research, such as when a particular intervention is being evaluated. The majority of severity of illness indexes focus either on quality assurance, or on the prediction of mortality and morbidity. Within critical care, mortality prediction scores are used to quantify patients’ risk of mortality based on criteria recorded at particular points in the patients’ stay. Such information can be used to evaluate the performance of different ICUs, a complex issue much documented in the literature. However, application of mortality prediction scores to individual patients treatment is inadvisable; morbidity; prediction of functional disability, as indicators for intervention, and to record patient condition in clinical research, such as when a particular intervention is being evaluated. Therefore use of TISS in higher TISS score, but for the acutely ill patient having more therapeutic interventions and a ‘at risk’ of critical illness therapeutic interventions may not yet be in place. Therefore use of TISS in the diagnosis of patients ‘at risk’ of critical illness could be inappropriate.

An alternative approach to the development of severity of illness indexes could make greater use of the ‘soft data’ or human phenomena which clinicians recognize as indicators of a change in state. Transition indexes could be used to record changes in severity in individual patients over time in both acute and critical care settings (Feinstein 1987). Currents ‘at risk’ scores focus mainly on objectively measured signs. However, experienced nurses frequently pick up early signs of a patient’s deterioration even before changes in objectively measured signs occur (Cioffi 2000; Grossman & Wheeler 1997; Smith 1988). Nurses seem to be responding to an array of cues such as changes in behaviour, colour, mental status, dyspnoea, pain, responses to therapy, and are using this to make a judgement that the patient’s condition has changed from that noted at an earlier point. This is similar to the ‘knowing the patient’ dimension reported in the nursing literature.

Alongside this discussion, it is useful to reflect on some of the terms used in theory development and research as they form the bridge between illness indexes (and vice versa). Concepts are abstract thoughts or ideas used to describe nursing practice, but the same concepts may be used by other disciplines (as in the case of severity of illness). To develop nursing’s scientific body of knowledge, the framework of reference must be nursing with the phenomena of interest and their related concepts focusing on what happens to individuals who either require or are receiving nursing care (Kim 1983). Nursing phenomena are the facts/events which can be observed in the real world; individuals make sense of real world events and physical structures using concepts or constructs to organize their thinking (Kim 1983). To ‘operationalize’ a concept, or make it available for measurement, the defining characteristics of the concept which can be observed need to be identified. This can be a difficult task in nursing as variables can be complex. Often used interchangeably with the term ‘concept’, a ‘construct’ is considered to be a type of concept which has been ‘deliberately and consciously’ invented or adopted for a special scientific purpose (Keilinger 1986, p. 27). Conceptual frameworks set out what is important in a study, guiding what should be examined or measured


524 App.30
and how various factors, constructs or variables may be related.

Severity of illness viewed from the critical care nursing perspective should reflect nursing's different focus and a broad definition of severity of illness might be more appropriate than a narrow physiological interpretation. A 'comprehensive' framework for the definition of severity of illness based on the constructs of biological, physiological, functional severity, burden of illness and other factors such as personal characteristics and environment provides considerable insight into how studies of severity of illness could be structured (Stein et al. 1987). A study from the nursing perspective could combine the most relevant constructs of severity depending on the research question. Physiological severity, functional severity and burden of illness describe aspects of the disease or condition, how the person is affected, and effects on the family unit respectively. Even though a patient's physiological severity of illness is reduced, the need for nursing may increase due to the effects of illness on other aspects of the patient's life. Functional severity refers to the effect of a disorder on a person's ability to manage activities of daily living, rather than effects on a specific organ or body system.

Severity may also be measured from the 'burden of illness' perspective, thus assessing the impact of disease or condition on the family unit or society (Stein et al. 1987). Biological severity is presented as an abstraction not yet directly accessible to measurement within the Stein et al. framework. Earlier studies on the prediction of mortality and morbidity focused mainly on physiological severity but the importance of functional severity and personal characteristics is now more widely acknowledged.

The severity of illness concept should contribute to further research and practice in the early identification of the acutely ill patient at risk of critical illness. Severity of illness is already evident in classifications to distinguish high dependency from critical care patients, but the picture is less clear for the identification of acutely ill patients 'at risk' of critical illness. The clinical state of the 'at risk' patient may not yet be well defined, the clinical state itself may be changing (becoming more unstable), and the individual's capacity to cope with the stress of acute illness may be unknown. Patients' severity of illness and the process of clinical judgement to elicit the patients' condition precede the more tangible elements or consequences identified as the patients' therapeutic requirements and involve judgements of patients' dependency and therapeutic requirements to identify patients 'at risk of their condition deteriorating' (DoH 2000).

However, identification of patients as requiring a particular 'level' of care represents the end stage in a complex clinical judgement that relies on careful analysis of a range of variables and indicators under conditions of uncertainty. A combination of objective measures, subjective assessments, context specific and personal characteristics is used in the accurate identification of patients 'at risk' of serious deterioration and critical illness. By concentrating on the development of transition scales, or indexes of change which draw on a range of clinical phenomena, subtle changes in severity could be recognized as early as possible, thus enabling interventions to minimize the risk of further deterioration.

Margaret A. Coulter
Assistant Editor

References
Feinstein AR 1987 Clinimetrics. Yale University Press, New Haven, CT
Kins HE 1983 The Nature of Theoretical Thinking in Nursing. Appleton-Century-Crofts, Norwalk, CT


the effectiveness of their treatment to be established. Indwelling catheterisation accounts for a significant number of hospital acquired infections; therefore clear, comprehensive guidelines encourage consistency with best practice. Following on from this, further algorithm for the use by the critical care outreach team was developed to provide continuity of care for patients who are oliguric.

**Intended learning outcomes**
- Identify people with potential to deteriorate due to oliguria.
- Be aware of the necessary actions required to treat patients with oliguria
- Be aware of the indications for catheterisation.
- Avoid catheterisation on an ad-hoc basis.

**Key reading references**
- Gray M (2000a) Urinary Retention, Management in the Acute Setting, part one, AJN. 100 (7), p 40-47
- Gray M (2000b) Urinary Retention, Management in the Acute Setting, part two. AJN. 100 (8), p 36-43
- Arya M - Hospital Medicine. 62 (3), p 145-149
- Peppereif E (2002) Producing Catheterisation Guidelines for Patients who have Oliguria Professional Nurse. 18 (1) p 27-29

**Session 6B – 8B**
**11.30 - 13.00**

**6B**
**Non invasive therapy in a district general hospital**

Joyce Wells, Educational Facilitator Critical Care Services /Emma Garnish, NIV Project Nurse Critical Care Services, Colchester District General Hospital

**Abstract**
- The presentation of a project which commenced in October 2002 until March 2003.
- Patients in wards were given non-invasive ventilation therapy in order to prevent critical care admissions.
- To date (22.02.02 – 06.12.02) out of 61 patients who were selected for this treatment within critical care area – 59% avoided intubation.

Project was then applied to general ward situations:
- Conditions treated include:
  - sleep apnoea
  - pneumonia
  - COPD
  - Septis
  - LVF

Out of 30 patients to date (07.10.02 – 06.12.02) 8 were admitted to critical care – the rest were managed on non-invasive ventilation on the wards.

**Sample of arterial blood gases**
- Prior to treatment: pH 7.1, PCO₂ 16.70 kPa
- Seven hours later: pH 7.43, PCO₂ 10.57 kPa
- One hour later: pH 7.4, PCO₂ 9.92 kPa

**Intended learning outcomes**
- Patients can be safely treated with non-invasive ventilation in a ward environment.
- Patients can be adequately ventilated without the need for sedation and endotracheal intubation.
- Shorter ventilation times can be achieved using non-invasive ventilation.

**7B**
**Identification of cues for the prediction of critical illness and cardiac arrest in general ward patients. A systematic review and synthesis of evidence**

Margaret Coulter, Lecturer Nursing Studies, University of Surrey, Guildford

**Abstract**
Previous systematic reviews on the prediction of critical illness and cardiac arrest have focused on indicators for admission to ICU (Bone, McElwee et al. 1983) and readmission to ICU (Rosenberg and Watts, 2000). The systematic review to be reported identifies, analyses and synthesises evidence for cues
predictive of critical illness and cardiac arrest in general ward patients.

Evidence is drawn from both the quantitative and qualitative research paradigms. The quantitative paradigm has informed studies on the prediction of critical illness and cardiac arrest, and studies within the qualitative paradigm have focused on cues valued by clinicians and used in judgements. If clinicians draw on different cues to known predictors of critical illness and cardiac arrest in the early stages of developing critical illness it is important to identify these cues, examine their use, and assess their predictive power.

Factors that helped identification and retrieval of relevant papers included setting clear objectives, a conceptual framework, pre-specified inclusion/exclusion criteria and the scoping approach for early searches (Mays et al, 2001). The critical appraisal of research evidence, data extraction and use of a database package shall be described. Narrative and tabular synthesis methods and theory-led methods (Mays et al, 2001) for the analysis and synthesis of research evidence shall be described and illustrated with extracts from the review findings.

Intended learning outcomes
- The challenges involved in the identification and retrieval of relevant papers for inclusion in systematic reviews of the delivery or organisation of health care.
- The potential for drawing on the quantitative and qualitative perspectives in the synthesis of evidence for systematic reviews and the methods that need to be developed to use this evidence.
- The evidence underpinning clinical judgements of developing critical illness in general ward patients.

Key reading references
- Bone RC, McEwene NE et al 1993 Analysis of indications for intensive care unit admission Chest 104 pp 1806-11