THE USE OF WOUND DRESSINGS TO PROTECT INJURIES FROM THE ENVIRONMENTAL HAZARDS ENCOUNTERED IN THE WORKPLACE

by

DIANA CATHERINE CAUDWELL
RGN, SCM, OHN Cert, Dip PSM.

Submitted for the Degree of Master of Philosophy
In the Department of Nursing and Midwifery
University of Surrey
September 1994

© D C Caudwell 1994
ABSTRACT

This study is an investigation into the management of work-induced injuries in hospital Accident and Emergency (A&E) Departments with particular emphasis on the protection afforded by the wound dressing for patients who return to their workplace immediately after receiving treatment.

Using an interview checklist to collect information from patients attending two A&E Departments, a survey was conducted to determine the type and severity of work-induced injuries and the wound dressings selected by hospital staff.

The most common work-induced injuries encountered in A&E Departments and the wound management products used for the treatment of work-induced injuries are identified.

The injuries encountered were mainly lacerations and contusions to the hands and fingers. The most frequently encountered wound dressings were dry gauze, Melolin™ and Airstrip™ waterproof adhesive island dressing.

Environmental hazards encountered by injured employees returning to work were identified as extremes of moisture, contact with organic solvents, detergent solutions, lubricant oils, abrasive materials and radiation.

A series of laboratory experiments was designed to test the penetration of three common environmental hazards, water, detergent solutions and cutting fluids at varying temperatures through the wound dressings identified.

The results of the laboratory tests are presented with reference to the penetration of the three liquids through the wound dressings so to enable A&E Department staff to
formulate a basis on which to select dressings, and for manufacturers to produce suitable wound dressings to protect patients with work-induced injuries.

It is concluded that there is a need for the development of wound dressings which provide greater protection for employees at work. Criteria on which evaluation of new dressings may be based are proposed.
ACKNOWLEDGEMENTS

I would like to thank my supervisors Mr C Turner, Professor R Crow and Mrs S McLaren, University of Surrey for their guidance, support and encouragement during this project. I am greatly indebted to a number of persons without whom this thesis would not have been possible. In particular, I would like to extend my sincere thanks to Mrs D M Radwanski, past Chief Employment Nursing Advisor, Health and Safety Executive who sowed the seed in 1977 which finally culminated into the fruition of this thesis. I would also like to thank Mrs T Amor, Chief Technician, Microbiology; Mr P Kentish, Technician for laboratory experiment advice; Mr R Chapman for help with design and development of interview checklists and Dr K Getliffe, University of Surrey for useful discussions throughout the project. I would like to thank the Accident and Emergency staff in the study hospitals who allowed me access into their departments and the patients who so willingly participated in providing me with information. I would also like to thank Smith and Nephew Ltd, Johnson and Johnson Ltd and Safety and First Aid Supply Ltd for their generosity in supplying the wound dressings for experimental testing in the laboratory. Finally, I would like to thank Mrs M Whatley for her patience in the typing of this thesis.
PREFACE

Wound dressings must both protect the wound and promote wound healing. Approximately 80% (Cullen, 1987) of workers do not have access to Occupational Health Services and are generally reliant for their professional treatment of work-induced injuries, mainly lacerations and contusions to the hands and fingers, by hospital A&E staff although they may have received prior treatment by first aiders. Many of these employees return to their workplace immediately after receiving treatment. Therefore, the penetration of fluids through the applied wound dressings poses a problem since any penetration found in the workplace may be detrimental to wound healing. How effectively wound dressings prevent penetration has not been tested, nor has the range of environmental hazards been identified. Therefore, A&E staff are unable to make an informed choice as to the suitability of particular wound dressings for use with work-induced injuries. Consequently, a survey was carried out in two A&E Departments to describe the type of injuries presenting for treatment and the wound dressings applied to these injuries. This thesis also reports the results of a series of laboratory experiments carried out to test the identified wound dressings in use for penetration by commonly reported hazardous fluids.
DECLARATION

I declare that this thesis is my own composition and that I have conducted the research reported. Due acknowledgements are given to the people who have assisted with this work, with details of their contribution.
## CONTENTS

Abstract ................................................. i
Acknowledgements ................................. iii
Preface ................................................. iv
Declaration ......................................... v

**Chapter 1 – INTRODUCTION**

1.1 The structure and function of normal skin ........... 2
1.2 The functions of the skin ............................. 4
1.3 Wounds ............................................. 4
1.4 Nature and types of wounds ....................... 5
1.5 Cuts and incisions ................................ 5
1.6 Lacerations ........................................ 5
1.7 Contusions ......................................... 6
1.8 Abrasions .......................................... 6
1.9 Burns .............................................. 6
1.10 The process of wound healing and the conditions it needs under which to take place ....... 7
   1.10.1 The traumatic inflammatory stage .......... 7
   1.10.2 The proliferative stage ................... 9
   1.10.3 The maturation stage ..................... 11
1.11 The nature and problems of wound healing .......... 12
   1.11.1 Local factors ............................... 12
   1.11.2 systemic and other factors that affect wound healing ........................................... 13
   1.11.3 Metabolic factors .......................... 13
   1.11.4 Experimental approaches to wound healing ........................................... 14
1.12 Optimum micro-environment-dressing characteristics

1.12.1 Maintain a high humidity between the wound and dressing

1.12.2 Remove excess exudate and toxic compounds

1.12.3 Allow gaseous change

1.12.4 Thermally insulate the wound surface

1.12.5 Be impermeable to bacteria

1.12.6 Be free from particles and toxic wound contaminants

1.12.7 Allow removal without causing trauma

1.12.8 Be available in a wide range of sizes to cover all wounds

1.12.9 Be easy to handle when both wet and dry

1.12.10 Conform to body contours without loss of adhesion

1.12.11 Maintain sterility and stability in storage

1.12.12 Be easy to dispose of following use

1.12.13 Be impermeable to water and other fluids and afford protection from any environmental hazard

1.13 Conclusion

Chapter 2 – A SURVEY OF WOUND DRESSINGS USED IN ACCIDENT AND EMERGENCY DEPARTMENTS FOR THE TREATMENT OF WORK-INDUCED INJURIES

2.1 Background

2.2 Objectives

2.3 Study design and data collection

2.4 Results

2.4.1 Patient characteristics

2.4.2 Patient occupation
3.7 Results

3.7.1 Penetration of water

3.7.2 Penetration of detergents

3.7.3 Penetration of industrial cutting fluids

3.8 Discussion

3.8.1 Limitations of experimental study

3.8.2 Results of experimental testing

3.9 Summary

---

Chapter 4 - IMPLICATIONS OF RESULTS

4.1 Summary of results

4.2 General Discussion

4.2.1 Implications for nurses

4.2.2 Summary

4.2.3 Implications for employers/employees

4.2.4 Summary

4.2.5 Implications for manufacturers

4.2.6 Summary

4.2.7 Implications for managers

4.2.8 Summary

4.2.9 Liaison between suppliers, pharmacists and hospital managers

4.2.10 Summary

4.2.11 Shared obligations - nurses and employers

4.2.12 Summary

4.2.13 Future research

4.2.14 Summary

4.3 Summary
Appendix E
List of subjects' occupations
Appendix F
Hazard Data sheets
Appendix G
Sources of reference

REFERENCES
Chapter 1

INTRODUCTION

This thesis investigates the penetration of hazardous materials found in industry through wound dressings applied in hospital Accident and Emergency (A & E) Departments to cover injuries received at work. Wound management both in hospital and community settings has received considerable attention, for example, Turner 1975, Turner and Puddifer 1976, Turner 1978, 1978b, 1979, 1984, 1985 and 1990; Williams 1980, Lawrence 1982; Kemble and Lamb, 1987. However, the management of wounds presenting to A & E Departments, caused while at work and where the injured person will return to work following treatment, remains largely unknown. For example, whether wound dressings will afford protection from penetration by hazardous materials found in the work environment (environmental hazards) poses a number of questions. Which dressings are used by A & E Nurses, and are they suitable for the treatment of work-inflicted injuries? Will the dressings applied protect the wound from environmental hazards encountered in the workplace, or will they allow penetration through the dressing on to the wound surface? To answer these questions wound dressings used in A & E Departments required to be identified, and then tested against penetration by environmental hazards encountered in the workplace.

For the purpose of this project, work can be considered to be every activity carried out under the Health and Safety at Work etc. Act 1974, excluding the private householder.

Under the Health and Safety at Work etc. Act 1974 the meaning of work and at work has been defined as:

"a) 'Work' means work as an employee, or as a self-employed person.

b) An employee is at work throughout the time when he is in the course of employment, but not otherwise; and"
c) a self-employed person is at work throughout such time as he devotes to work as a self-employed person (Fife and Machin, 1976).

Non work refers to in the home or during recreational activities, leisure time, and in one's own time.

However, this thesis relates specifically to the management of wounds presenting to A & E Departments, caused while at work and where the injured person will return to work following treatment.

1.1 The structure and function of the normal skin

The skin is the largest organ of the body (Davies 1957, Sears, 1958, Ross and Shannon 1990). The skin is the outer covering of the body and consists of two distinct layers:

1. The epidermis

The outer layer, the epidermis, varies in thickness. It may be up to 7 mm thick on the palms of the hands and the soles of the feet but is much thinner on the back of the hand, and thinner and softer on the inner thighs and abdomen (Ross and Shannon, 1990). The epidermis consists of stratified squamous epithelium which is divided into superficial and deep layers. The superficial or horny layer is formed by flattened cells which have lost their nuclei and whose cytoplasm has been replaced by a hard protein called keratin. These cells are actually dead and the most superficial layers are constantly shed and replaced by cells from the deeper layers. The cells of the deeper layers are rounded and contain nuclei. The flattening of the cells gradually becomes apparent as the surface is approached (Sears 1958).
The epithelial cells in the basal cell layer undergo mitotic division and allow regeneration of the epidermis. Cells produced by the basal layer gradually migrate upward, losing their nuclei and transforming through a process called keratinization into tough, flattened, dead cells of the horny layer, which is waterproof and when undamaged relatively impermeable (Ross and Shannon 1990). There are no blood vessels in the epidermis, so that if this alone is cut it does not bleed.

2. The dermis
Beneath the epidermis is the inner layer, the dermis, which consists of fibrous and connective tissue. It contains sweat glands, sebaceous glands, nerve fibres and their endings, blood vessels and capillaries (Sears 1958). The dermis varies in thickness in different parts of the body and is generally much thicker in the dorsal (back) surface of the trunk and the limbs than on the ventral or front surfaces and when cut into, it bleeds and is painful (Davies 1957). The dermis provides strength, distensibility, and elasticity to the skin. The dermis consists of a mesh of collagen and elastin fibres interspersed within mucopolysaccharide matrix. The vascular function of the dermis is the most comprehensive of any organ system; it assists in the regulation of body temperature and skin colour to a limited extent only, provides oxygen and nourishment to the epidermis, and helps remove waste (Ross and Shannon 1990).

The hair follicles, sweat glands and sebaceous glands are served by a network of dermal capillaries and nerves. A subcutaneous layer of fat underlies the dermis, providing cushioning, insulation and support for other tissues, Beneath the fat layer lie the fascial tissue and muscle layers which cover bone (Ross and Shannon 1990).
1.2 The functions of the skin, according to Davies (1957) are:

1. Temperature regulation:

   It is achieved by the outpouring and evaporation of sweat and also by conduction and radiation from the blood vessels of the dermis. The blood supply to the dermis is rich, and the blood vessels dilate when the body is warmed and contract when exposed to cold, thus regulating the heat lost in this manner.

2. Sensation

   It is the largest sensory organ in the body mediating to the sensations of touch, heat, pain, cold and pressure.

3. Protection

   The skin is the protective and waterproofing layer of the body. When unbroken it prevents the entry of micro-organisms into the tissues beneath.

4. Excretion

   The excretions of the skin escape by way of the sweat and sebaceous glands. The main substances lost in this way are water and salts.

5. Production of vitamin D

   The skin contains ergosterol, a substance converted into vitamin D by the action of sunlight. Melanocytes produce melanin which is a pigment responsible for colour and ultra violet light protection.

6. It gives origin to the hair and nails.

1.3 Wounds

A wound is a cut or break in the continuity of any tissue as defined by Cape (1957), caused by injury or operation. Wounds are the visible result of individual cell damage or death and can be subdivided by site on the body surface area, size, depth and causation - surgery, accident or circulatory failure (David 1986; Baxter and Rodeheaver, 1990). For the purposes of wound treatment, classification into wounds
with or without tissue loss (where pressure sores and surgical incisions represent [Ross and Shannon, 1990] wounds with and without tissue loss respectively), is often recorded.

Wounds in the context of this project are confined to skin wounds. Skin wounds defined by Eaglstein (1990) are structural or physiological disruptions of the integument that incite normal or abnormal repair responses.

1.4 Nature and types of wounds
A wound can be classified according to its nature, the four basic forms are lacerations, contusions, abrasions and burns (Churchill's Medical Dictionary, 1989). Wounds are divided into four fundamental types by depth and extent, superficial wounds, partial-thickness, full-thickness wounds and wounds involving muscle, tendon and/or bone.

1.5 Cuts and incisions
Cuts and incised wounds are usually the result of an operation or accident and are produced by a knife or similar instrument (Cape, 1957). The edges of the wound can remain in apposition. Surgical incisions are examples of wounds without tissue loss.

1.6 Lacerations
Lacerations are irregular, torn wounds, as opposed to an incision or cut (The Penguin Medical Encyclopaedia, 1976). Lacerated wounds are those in which great tearing takes place such as injuries caused by machinery (Black's Medical Dictionary, 1990). In lacerations the skin, subcutaneous and deeper tissues are torn apart. Nerve tissue and blood vessels may maintain their continuity and be seen in the depth of the wound. Many lacerations have abraded edges and are usually associated with some degree of
bruising. However, as the wound is open, blood will escape through the laceration rather than spread into the soft tissue.

1.7 Contusions
Contusions or bruises are injuries to deeper tissues through intact skin usually caused by a blow. Contusions or bruises are more or less extensive injuries of the deeper part of the skin and underlying tissues, accompanied generally by the outpouring of blood from damaged vessels but unattended by corresponding open wounds. The spilt blood is gradually decomposed and absorbed; in the process the red pigment haemoglobin turns blue as it loses its oxygen and is later broken down into green and yellow bile pigments (Black's Medical Dictionary, 1990).

1.8 Abrasions
An abrasion is a superficial, partial-thickness wound that may be associated with embedded foreign material and debris that predispose to infection, permanent scarring and pigmentation changes (Baxter and Rodeheaver, 1990). These wounds are mechanical and are caused by knocks and scrapes.

1.9 Burns
The type of injury called a burn is denaturation of tissue proteins (The Penguin Medical Encyclopaedia, 1976). Burns are injuries caused by dry heat, scalds by moist heat, but the two are similar in symptoms and treatment. Severe burns are also caused by contact with live electric wires, and by the action of acids and other chemicals, and cold injury (Black's Medical Dictionary, 1990). Of all burns, scalds are the most common. They are often of limited extent and depth, and heal quickly with insignificant scarring, but they may be extensive and deep. Burns are classified as:-
First-degree burns

First-degree burns are superficial and exhibit erythema and pain; damaging only the epidermis and superficial layers of the dermis.

Second-degree burns

Second-degree burns are partial thickness which involve blistering and pain. They destroy the epidermis and part of the dermis. In partial-thickness burns enough skin often remains for epithelial regeneration, provided that no further damage is done, e.g. by infection (Baxter and Rodeheaver, 1990).

Third-degree burns

Third-degree burns are full thickness which show extensive eschar formation and involves damage to the entire epidermis and dermis. They are painless because of the damage to nerve endings. In a third-degree burn new skin can only grow from the edges, unless the defect is covered by skin-grafting.

1.10 The process of wound healing and the conditions it needs under which to take place.

Wound healing in well-nourished, healthy patients follows a predictable course. There are three main overlapping stages of healing common to all wounds, the inflammatory stage, proliferative stage and the maturation stage (Ross and Shannon, 1990).

1.10.1 The traumatic inflammatory stage (0-3 days)

Inflammation is the initial response to injury and a reaction of the soft tissues and lasts for about 3 days (Ross and Shannon, 1990). The inflammatory reaction is characterised clinically by heat, oedema, erythema and pain. Within a few seconds after the injury occurs, there is a short period of vasoconstriction that lasts for 5 to 10 minutes (Alvarez, et al. 1987). Vasoconstriction may be caused in part by platelets which secrete vasoconstrictive substances according to Clark (1985). Immediately after
injury platelets aggregate along the endothelium of the injured blood vessels and promote formation of a fibrin clot to prevent excessive hemorrhage and dissemination of bacteria (Clark, 1985).

This short period of vasoconstriction is followed by dilation of the capillaries. Vasodilation is caused by stimulation of local sensory nerve endings, local reflex action, and vasodilatory substances. The prostaglandins are important mediators of many aspects of the inflammatory response including vasoactive substances (Alvarez et al. 1987). Vasoactive substances induce the formation of gaps between the endothelial cells in the basement membrane of the capillaries; these gases allow leakage of plasma into the wound area for several days.

A variety of chemotactic substances attract leukocytes to the injured site within 20 minutes after wounding which rid the wound of contaminants and initiate tissue repair (Alvarez et al. 1987). Leukocytes migrate through the permeable vascular wall to enter damaged tissue and phagocytose foreign material.

One type of leukocyte, the neutrophil, is predominant for the first 3 days and is important for removing bacteria from the wound site. The continued presence of large quantities of neutrophils can signal infection or other tissue injury. However, experiments conducted in neutropenic animals indicate that neutrophils may not be essential in the wound healing process. Simpson and Ross (1972) studied pigs depleted of neutrophils and found that "neither wound debridement nor formation of granulation tissue is dependent on the presence of neutrophils". However, these findings were as a result of experiments conducted on non-infected animals. Wounds in which infection exists cannot heal in the absence of adequate numbers of neutrophils. Pollock (1987) stated "healing cannot take place until all bacteria have been eliminated
by the humoral and cellular host defences", and it is in this connection that neutrophils play such an important part.

By day 3, the presence of neutrophils is superseded by that of macrophages — cells which are vital for tissue repair (Alvarez et al. 1987). Macrophages are transferred from monocytes that enter damaged tissue in day 2 through the process of wound closure, scavenging dead or foreign material and elaborating many of the growth factors that regulate repair. Like neutrophils, macrophages engulf bacteria and debris to clean the wound. They also secrete regulatory peptides (growth factors) and ingest worn-out neutrophils. Also macrophages mediate many processes in skin repair including the formation of blood vessels via angiogenesis (Knighton et al. 1981). During the inflammatory stage, wound sites are also affected by special constituents of serous fluid. These constituents include proteolytic enzymes which degrade necrotic tissue (David, 1988).

1.10.2 The proliferative stage (3-24 days)
The proliferative stage overlaps the inflammatory phase and continues until the wound is healed. The main features of the proliferative stage are the formation of granulation tissue and epithelialization characterised by considerable cellular and chemical activity (Ross and Shannon, 1990). Granulation tissue is bright red, raised and thickened. Its appearance is due to capillary dilation and active collagen formation. Macrophages secrete chemotactic and growth-promoting factors that trigger the formation of various types of tissue. In broad terms the cellular activity of the proliferative stage consists of macrophage-stimulated collagen synthesis; angiogenesis, wound contraction and re-epithelialization. The second stage of healing is concluded and a wound is considered healed if epithelialization has resurfaced the wound, a collagen layer has formed and the initial remodelling is complete (David, 1988). Epithelialization, although part of the
proliferative stage, begins within hours after injury. The keratinocytes - keratin-secreting epithelial cells - migrate in a leapfrog fashion (Jackson and Rovee, 1988) from the margin of the wound and form epidermal appendages. When cells meet, contact inhibition stops horizontal movement (Bryant, 1977). Additional vertical layers of epithelial cells form. Foreign material and desiccation impede epidermal regeneration. If the basement membrane - the area between the epidermis and dermis - has been destroyed, the epithelial cells move over a temporary matrix of fibronectin and fibrin, which may adjust the healing response. After migration is completed, a new basement membrane is regenerated (Alvarez et al. 1987; Clark, 1985).

As the proliferative stage begins, a matrix of fibrin strands has been formed around the wound. Epidermal migration occurs over this matrix, as does migration of undifferentiated mesenchymal cells, which travel to the matrix from the wound margin (Hotter, 1982). The mesenchymal cells mature into fibroblasts which are important cells in the proliferative stage of wound healing. They synthesize and secrete strands of collagen, a protein that forms the network of connective tissue that binds the wound together and increases its tensile strength. (Tensile strength is defined as the ability of a healed wound to withstand the stresses of normal activity). To synthesize collagen, fibroblasts depend upon oxygen and nutrients delivered from regenerated capillaries within the wound. Collagen synthesis also requires an adequate nutritional intake, including the amino acids of which it is composed, and ascorbic acid (vitamin C) (Reed and Clark, 1985).

During the proliferative stage, endothelial cells form buds at the end of the capillaries and grow throughout the wound. This process of angiogenesis produces a network of regenerating vasculature that eventually link together to restore the capillary system of the dermis (Hunt and Goodson, 1988).
The maturation stage of healing begins approximately 3 weeks after wounding and may continue for several years (Ross and Shannon, 1990). Wound maturation results in the reorganisation and a strengthening of the disorderly arranged collagen-formed scar tissue, which can be seen as shrinking and thinning of the scar and loss of redness. Capillary regression is responsible for the fading colour of the scar (David, 1988). Cellular activities in the maturation stage of healing are extensive matrix formation and scar tissue remodelling. The matrix is reorganised as the fibroblasts leave the wound site. In addition, the accumulation of large fibrous bundles of collagen increases the tensile strength of the scar (Alvarez et al. 1987). Scar tissue is made up of collagen, glycoproteins, proteoglycons and other proteins (Jackson and Rovee, 1988).

Scar tissue is delicate during the first weeks of healing, possessing around 10% of the skin's normal strength. Tensile strength increases rapidly during the fourth and fifth weeks but only 80% of the original strength of the skin is ever regained (Shumann, 1982).

Collagen synthesis (via fibroblasts) and reorganisation (via collagenase, an enzyme that breaks down collagen) occurs in both the proliferative and maturation phases but once the collagen bed has been formed, the total amount of collagen in the wound does not change. The gelatinous type of collagen that is produced during the proliferative stage is replaced in the maturation stage with stronger, more highly organised collagen, which remains in a continued state of dynamic modelling (Bryant, 1987; Rudolph and Noe, 1983).
Optimum healing requires a balance of collagen production and breakdown (Ross and Shannon, 1990). Excessive collagen destruction results in a reduction of tensile strength, whereas over-production results in hypertrophic scar tissue. The period of collagen turnover is very important for in patients who are unable to synthesize adequate collagen to overcome the action of collagenase, wounds will lose strength and may tear open (Rudolph and Noe, 1983).

1.11 The nature and problems of wound healing

Wound healing is a complex process. The rate of progression through and between each of the three stages of healing is dependent on a constellation of intrinsic and extrinsic influences, such as age, anaemia, anti-inflammatory drugs, diabetes mellitus, systemic infection, jaundice, malignant disease, malnutrition, obesity, temperature, trauma, uraemia, vitamin deficiency, zinc deficiency, blood supply, denervation, haematoma, lack of protection, local infection, mechanical stress, radiation, surgical technique, suture material and technique, type of tissue, and the selection of topical wound treatment, including the use of a covering wound dressing (Harding, 1990).

The above factors, which may impede normal wound healing, can be elaborated on by using the broad headings such as local, internal, external and systemic (Baxter and Mertz, 1990).

1.11.1 Local factors include: Microorganisms. Infection may develop where the bacteria are in a concentration greater than $10^5$ organisms per gram of tissue; contributing factors include hypoxia, necrosis, foreign matter and the health of the patient. Foreign bodies, necrotic tissue and eschar may impair healing and dispose toward infection.
Dessication impedes epithelialization and angiogenesis — the process whereby new blood vessels are formed. Pressure, friction and shear can cause ulceration and significantly slow down wound healing. The lack of oxygen can cause ischaemia and hypoperfusion. On the other hand low oxygen tension at a wound site fosters angiogenesis and faster epithelialization (Knighton et al. 1983). Inefficient fibrin breakdown can retard healing. Fibrin is a major constituent of the tissue that develops in the healing wound. It is formed in the clotting process when prothrombin is converted to thrombin, which in turn converts fibrinogen to fibrin. After haemostasis has been achieved, the clot must dissolve in order to allow healing. This involves the breakdown of fibrin (Baxter and Mertz, 1990).

1.1.1.2 Systemic and other factors that affect wound healing
Nutritional status. Good nutrition is essential for wound healing. Malnutrition delays or prevents healing (Silane and Oot-Giromini, 1990). Nutritional assessment is an important factor in wound healing and water needs increase in patients with large area wounds. Protein helps improve tissue integrity and vitamin C is required for collagen synthesis. Vitamin A is required and involved in epithelialization, collagen production, and resistance to infection. Zinc is essential to protein synthesis and tissue repair, and iron is vital to red blood cell function because it enables transport of oxygen.

1.1.1.3 Metabolic factors
Diabetes mellitus is a major systemic cause of poor wound healing due to impaired circulation, reduced sensation in feet, increased risk of infection and reduced inflammatory response. Renal failure increases risk of infection, delays granulation, increases the risk of wound dehiscence, and promotes faulty collagen deposition. Age delays epithelialization, decreases collagen synthesis/degredation, decreases inflammatory response, delays angiogenesis, decreases cohesion between the dermal
and epidermal layers, decreases sebaceous gland function and alters melanocyte function (Silane and Oot-Giromini, 1990).

Clotting disorders, excessive bleeding (haematoma) delays healing. Platelet aggregation initiates haemostasis and releases growth factors. Patients at risk include those with clotting factor deficiencies (e.g. haemophilia, malnutrition, hepatic disease) or thrombocytopenia, and those undergoing anticoagulant therapy are prone to prolonged bleeding into the wound site and delays in wound healing (Silane and Oot-Giromini, 1990).

Further factors in wound healing attributed to Silane and Oot-Giromini, 1990 are:-

- Immunosuppression predisposes wounds to infection, and diminishes the inflammatory phase of healing (and macrophage function). Glucocorticoid therapy (e.g. hydrocortisone and prednisone) may impair healing by interrupting all aspects of the healing process.

Psychological factors, such as sleep patterns may affect tissue restoration.

The vast majority of skin wounds heal, but because of the number of impeding factors such as local, internal, external and systemic which can interfere with normal wound healing, a holistic approach is essential.

1.11.4 Experimental approaches to wound healing

Prior to the early 1960s it was generally believed that wounds should be allowed to dry to avoid the risk of infection. Three laboratory studies questioned this assumption and developed the concept of moist healing as an improvement over dry dressings. It was a concept that promoted direct interaction with, as opposed to passive protection of the wound environment. In 1958, Odland observed that blisters healed faster when left
unbroken than when left open to the air. Winter (1962) created a series of skin wounds in pigs. Within each animal, Winter covered half the artificial wounds with polythene film, leaving the others exposed to air. The rate of epithelialization under the polythene film, which maintained a moist wound surface, was twice that observed under the dry scab of the control wound. Winter attributed this result to the enhanced migration of epidermal cells through the serous exudate on the surface of the moist wound. Hinman and Maibach (1963) reproduced these findings in human healthy volunteers, thereby establishing the beneficial effect of moist wound healing. Rovee (1972) showed that a moist, crust-free environment enhanced the migration of epithelial cells across the wound defect and facilitated resurfacing. There is a difference between moist wound healing as above which is (isotonic) relating to serum and wetting by water which is (hypotonic) and damaging to the wound.

The term occlusive in the context of this study is used to describe all of the types of moisture-retentive dressings. Occlusive dressings prevent the formation of a crust in partial thickness wounds. Occlusion influences both epidermal resurfacing and dermal repair by the creation of a moist environment (Alvarez et al. 1984). Studies by Rovee and Miller (1968), showed that an incision in the plantar surface of the guinea pig foot demonstrated that substantial epidermal strength is developed long before collagen repair has begun. Their findings revealed that occlusive dressing enhanced the tensile strength of the wound.

More recent research into the benefits of moist wound healing and the use of occlusive dressings has been developed further by Alvarez and his coworkers (1989). Occlusive dressings have barrier properties that enable them to prolong the presence of moisture and wound fluid in the wound bed, creating a moist environment. This moist
environment facilitates the migration and proliferation of epithelial cells in the wound resurfacing process (Mertz, 1990).

1.12 Optimum micro-environment-dressing characteristics.

To create the optimum micro-environment for the healing of skin and subcutaneous wounds, according to Turner (1979) a dressing should exhibit certain characteristics:

1. Maintain a high humidity between the wound and dressing.
2. Remove excess exudate and toxic compounds, while also being suitable for dry non-exuding wounds.
3. Allow gaseous change.
4. Provide thermal insulation to the wound surface.
5. Be impermeable to bacteria.
6. Be free from particles and toxic contaminants.
7. Allow removal without causing trauma during dressing change.
8. Be available in a wide range of sizes to cover all wounds.
9. Be easy to handle when both wet and dry.
10. Conform to body contours without loss of adhesion.
12. Be easy to dispose of following use.

Caudwell (1981) added to these characteristics wound dressing should:

13. Be impermeable to water and other fluids and afford protection from any environmental hazard.

The first seven and no.13 of these are concerned with the micro-environment, the other five relate to physical characteristics which the user will require to assist in the overall dressing procedure.
1.12.1 Maintain a high humidity between the wound and dressing

Optimal epithelialization occurs in a moist wound environment. The importance of wound humidity was first observed by Odland (1958) when he discovered that a blister healed faster if left unbroken. Winter (1962) demonstrated in a study of porcine skin, that the rate of epithelialization was increased in wounds in which a moist environment was maintained with polythene film dressings. Hinman and Maibach (1963) established the beneficial effect of occlusion on the resurfacing of wounds in normal human volunteers. Other investigators have confirmed the significance of a moist wound environment (Alvarez et al. 1983; Alvarez, et al. 1984; Alvarez et al. 1989; Alvarez et al. 1990; Jackson and Rovee, 1988, Mertz 1990; Evans 1991).

1.12.2 Remove excess exudate and toxic compounds

Wound exudate is an extracellular fluid rich in nutrients, phagocytes and antibodies produced as part of the inflammatory response (David 1986). If a wound dressing provides insufficient absorption of exudate, the excess may cause sloughing of the tissue and could act as a medium for the growth of bacteria (David 1986). Absorption of exudate removes metabolic waste products, toxins and dead cells from the wound surface and may relieve oedematous tissues, reducing both swelling and pain (Turner 1985). However, whilst removing exudate the dressing should not allow 'strike-through', i.e. the penetration of exudate to the upper surface of the dressing. If 'strike-through' occurs, a moist path allowing migration of 'toxic compounds' causing contamination and the potential for wound infection to the surface of the wound, is created (Winter 1962). The passage of organisms following 'strike-through' may take as little as six hours (Turner 1985).
1.12.3 Allow gaseous change

There remains considerable confusion regarding the benefit of gaseous transfer across wound dressings (Turner, 1985). Inadequate wound healing is most commonly caused by oxygen deficiency of the local tissues (Hunt, 1980) and results in the formation of unstable collagen with low tensile strength. On the other hand, Knighton et al. (1983) discovered that macrophages, which instigate the healing process, require hypoxia in order to stimulate angiogenesis. Within wounds with tissue loss, angiogenesis has been found to be enhanced under occlusive dressings (Cherry and Ryan, 1985). Whereas the rate of epithelialization is greatest when oxygen can freely diffuse across the dressing (Winter 1962; Hinman and Maibach, 1963). Alvarez and coworkers (1984) using a porcine wound model found that superficial wounds covered with an oxygen-impermeable hydrocolloid dressing healed more rapidly than wounds covered with an oxygen-permeable film. They proposed that the supply of oxygen via the systemic circulation was sufficient to meet the requirements of the regenerating epithelium in their wound model. Whatever the qualities of an occlusive dressing, its oxygen permeability, according to Silver (1985), is likely to have little influence on conditions at the wound surface unless the surface is kept relatively free of exudate, particularly if the latter contains large numbers of inflammatory and bacterial cells. An occlusive dressing maintains moisture, and if a moist wound is well oxygenated epithelial migration is enhanced. Most oxygen permeable dressings in the presence of exudate are however poor providers of oxygen. The effect on macrophages in this respect is particularly important since hypoxia may reduce their production of some inflammatory and pain producing mediators such as prostaglandins, and at the same time enhance others that encourage angiogenesis. Hypoxia reduces fibroblast mitosis and collagen synthesis (Silver, 1985).
1.12.4 Thermally insulate the wound surface

It has been suggested that reductions in the temperature of the surface wound may delay healing (Turner 1985). Peacock (1984) reported that wound healing is inhibited by reflex vasoconstriction brought about by decreases in local air temperature or by alternating cold and warm environments. Wounds have been reported to demonstrate faster healing at 30°C, local air temperature, as opposed to 18 to 20°C. Tensile strength is decreased about 20% when local air temperature is dropped from 20° to 12°C. A drop in temperature at the wound site, even by 2°C is enough to slow down cell mitosis, while also resulting in vasoconstriction (Turner, 1985). Dressings should therefore maintain a wound temperature close to the body core temperature by thermally insulating the surface of the wound, this will result in high mitotic activity with rapid epithelialization and improved granulation (Turner, 1985).

1.12.5 Be impermeable to bacteria

All wounds are subject to bacterial contamination (Jackson and Rovee, 1988). Wound healing will take place in the presence of bacteria in the clinical situation, but it is the concentration of bacteria that creates alterations in the reparative process and not the presence of bacteria (Robson et al. 1990). It is the delicate balance between bacteria and host resistance. Favourable microflora in the wound bed may actually stimulate epidermal cell migration and healing (Pollack, 1984). Those bacteria most frequently associated with post-operative wound contamination include: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Streptococcus faecalis*, *Proteus spp.*, *Klebsiella spp.* *Bacteriodes fragilis*, *anaerobic cocci* and *Clostridium spp* (Baxter and Mertz, 1990). The body's normal defence mechanisms overcome limited numbers of bacteria via granulocytes and the immune response, but protection is needed from secondary infection (Jackson and Rovee, 1988). A dressing should be both impermeable to air-borne micro-organisms and form a barrier to organisms tracking
upwards from the skin surface, otherwise cross-infection may result. The transmission of organisms occurs most often in dressings which exhibit 'strike through' of exudate to the wound surface (Turner, 1985).

1.12.6 Be free from particles and toxic wound contaminants

The presence of foreign matter on the surface of a wound impairs the healing of a wound and may prolong the inflammatory stage or contribute to wound infection (Harris, 1979). Any foreign or necrotic material - even sutures - can predispose to bacterial colonization and infection. Elek (1956) in his experiment, demonstrated that a single silk suture reduced the critical number of *staphylococci* required to produce a clinical infection from $10^6$ to $10^2$.

Wound eschar (scab) also causes problems. Eschar is thick, fibrin-containing necrotic tissue. Fluid may collect and infection may occur under the eschar. Eschar can also impair healing by preventing wound contraction (Rudolph and Noe, 1983). Foreign bodies can also result in abnormal scar tissue by the incorporation of fibrous particles into a wound which may induce keloid scarring (Turner, 1985).

1.12.7 Allow removal without causing trauma

If a dressing adheres to the surface of the wound it may cause secondary trauma when removed (Turner, 1985; Thomas, 1990), particularly if new capillary loops penetrate the dressing material, for removal of the dressing will cause renewed bleeding, leading to a second inflammatory phase and so delay epithelialization.

1.12.8 Be available in a wide range of sizes to cover all wounds

Dressings should be available in a wide range of sizes to cover all wounds.
1.12.9 *Be easy to handle when both wet and dry*

Dressings when in use should have a good resistance to physical damage when either wet or dry and be easy to handle by the user.

1.12.10 *Conform to body contours without loss of adhesion*

Dressings should have the ability to conform to body contours without any loss of adhesion to the skin.

1.12.11 *Maintain sterility and stability in storage*

All dressings must be delivered sterile to the user. Each dressing should be individually packaged and should be batch numbered with expiry date related to storage and environmental conditions.

1.12.12 *Be easy to dispose of following use*

The dressing should be easy to dispose of following use, minimising the risk of contamination and infection by the user.

1.12.13 *Be impermeable to water and other fluids and afford protection from any environmental hazard*

Wound dressings should afford protection from contamination of a wound by any environmental hazard. Dressings should be impermeable to water, detergent solutions and organic solvents, and be impervious to oils, where these materials present a hazard to wound healing (Caudwell, 1981).

In her study, Caudwell (1981) observed the dressing materials used by nurses in a number of Occupational Health Departments in the United Kingdom, United States of America, Holland, Germany and Eire, and reported on procedures and products used. The most frequently encountered dressings were surgical adhesive tapes, adhesive strip
and adhesive island dressing (see glossary for definition of these terms). The types of injuries sustained at work on which the dressings were used were not reported, however hazards in the workplace such as oils, industrial fluids, detergents, organic solvents from which the dressings would have to protect the wound were identified. Occupational Health Nurses were asked to rate several factors in order of importance when selecting wound dressings (Table 1), and protection of the wound surface was considered a 'very important' function of wound dressings.

Table 1: Nurses ratings of factors influencing choice of wound dressings

<table>
<thead>
<tr>
<th>Factor</th>
<th>Very important</th>
<th>Important</th>
<th>Not very important</th>
<th>Not at all important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>11%</td>
<td>68%</td>
<td>17%</td>
<td>3%</td>
</tr>
<tr>
<td>Availability</td>
<td>57%</td>
<td>41%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Sterile</td>
<td>50%</td>
<td>41%</td>
<td>19%</td>
<td>3%</td>
</tr>
<tr>
<td>Comfortable</td>
<td>75%</td>
<td>24%</td>
<td>3%</td>
<td>–</td>
</tr>
<tr>
<td>Simple to secure</td>
<td>34%</td>
<td>48%</td>
<td>20%</td>
<td>–</td>
</tr>
<tr>
<td>Safe for work</td>
<td>89%</td>
<td>11%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Protect the wound</td>
<td>89%</td>
<td>7%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Non-allergenic</td>
<td>58%</td>
<td>34%</td>
<td>7%</td>
<td>–</td>
</tr>
<tr>
<td>Non-adherent</td>
<td>34%</td>
<td>75%</td>
<td>17%</td>
<td>–</td>
</tr>
<tr>
<td>Man-made fibres</td>
<td>3%</td>
<td>7%</td>
<td>50%</td>
<td>41%</td>
</tr>
<tr>
<td>Durability</td>
<td>31%</td>
<td>51%</td>
<td>19%</td>
<td>–</td>
</tr>
</tbody>
</table>

Source: from Caudwell (1981)

The percentages do not add up to 100% because some respondents did not answer the questions and some ticked more than one box.
A further study conducted by Turner, Caudwell and Cockbill (1986) identified the injuries sustained at work, the encountered environmental hazards and the wound dressings used by Occupational Health Nurses for the treatment of work-induced injuries in the manufacturing industries. They reported the type of injury most frequently encountered was laceration, which accounted for 46% of the total reported. Of these lacerations, 93% were to the upper limbs, the remaining 7% being distributed between head and lower limbs. These injuries compared to the present survey were similar. Their findings showed that employees returning to work after sustaining an injury to the upper limbs, came into contact with five major groups of environmental hazards such as:

- Temperature and moisture
- Detergent solutions
- Lubricating oils
- Organic solvents
- Abrasive materials

In the work of Turner et al. (1986) the data was limited to collection by a single researcher which restricted the number of places visited. Constraints such as time and resource availability, resulted in fifty three Occupational Health Departments being visited, distributed in Scotland, Wales, West Midlands, South-West England, and northern and southern areas of the industrial South-East (London) area. A single researcher, using a questionnaire and personal interview, identified the hazards encountered by employees in the workplace and the wound dressings used by Occupational Health Nurses for the treatment of work-induced injuries. The dressings most commonly encountered were surgical adhesive tapes, adhesive strip dressings and adhesive island dressings.
Thirty different surgical adhesive tapes and forty different adhesive strip and adhesive island dressings identified in the survey were then compared in two ways:

a) whether environmental hazards such as temperature and moisture, detergent solutions, lubricating oils, organic solvents and abrasive materials presented at differing temperatures penetrated the wound dressing, and

b) whether in the presence of potentially hazardous materials the wound dressings would remain adherent to the wound site.

Turner et al. (1986) in their laboratory experiments used glass plates on which to apply the dressings to measure the penetration of the fluids such as moisture, detergent solutions, lubricating oils and organic solvents, at differing temperatures through the adhesive tapes and adhesive dressings. The types of adhesive tapes were divided into fabric—backed, plastic-backed and non-woven backed tapes and adhesive strip and adhesive island dressings were divided into fabric-backed and plastic-backed. "Samples of these adhesive dressings, 25 mm wide were positioned on the glass plate and a free standing roller described as applying a force of 2 kg.cm⁻¹ width of tape was traversed along the tape length at a rate of approximately 60 cm per min." (Turner, et al. 1986). A 5 mm moisture indicator paper was placed beneath each sample. The glass plates were immersed in water, detergent solutions, lubricating oils and organic solvents at differing temperatures for four hours and tested for the effects of penetration and adhesion. When challenged all the adhesive tapes showed some penetration by all of the environmental hazards. Most of the plastic-backed, non-perforated tapes showed no penetration to water and oil but the non-woven tapes and fabric tapes were penetrated by both water and oil. Detergent solutions penetrated through some of the
plastic adhesive tapes. All the adhesive tapes and adhesive strip and adhesive island dressings were penetrated by the organic solvent which was trichloroethylene. The results from the testing of the adhesive island dressings showed penetration of the fluids and detachment of the pad from the adhesive area which would therefore not provide protection to a wound.

To measure adherence to the wound site, Turner et al. (1986) developed an instrument to abrade the wound dressing which determined the resistance to abrasion of the adhesive island dressings when moved under sustained pressure horizontally over a defined abrasive surface using a specially designed piece of equipment. The resistance was recorded in time and distance travelled. The abrasive surface they used was a fixed abrasive sheet, Diamond Grit™ M2 grade, 7.074C. Glass cylinders with flat bases were used for the application of the adhesive island dressings which were applied with pressure to ensure good contact and maximum adherence. Triplicate samples were placed in a rack unit and abrasion carried out for a period of five minutes. This time period represents an estimated duration of the maximum abrasion that adhesive island dressings would meet during an eight-hour shift (Turner et al. 1986). The results of the testing of the adhesion were recorded for each sample. The degree of surface abrasion on the back of the adhesive island dressing was recorded and also the loss of adhesion and liftage at the edge attachment and total detachment of the sample. Turner et al. (1986) showed that adhesive island dressings which had any overlap showed some liftage at the edge of the tape area and a reduced resistance to abrasion. The results showed that of the thirty eight adhesive island dressings tested, seventeen lost at least a half of the adhesive backing through abrasion and only nine products showed no detachment at the end of the tests. The remaining adhesive island dressings showed some loss of the adhesive backing through abrasion, which would have resulted in contamination from the external environment. Turner et al. (1986) concluded that the
smooth polymers (outer plastic-backing of adhesive island dressings) were the hardest wearers, providing there were no perforations in the adhesive dressings which would allow penetration of the abrasive.

These two investigations, Caudwell (1981) and Turner et al. (1986) both looked at the use of wound dressings in use in Occupational Health Departments. Caudwell highlighted the main problem Occupational Health Nurses faced; protecting the wound by using dressings which will stay intact and not come off when working with machinery, whereas Turner, et al., described how commonly used dressings such as surgical adhesive tapes, adhesive strip and adhesive island dressings, allowed penetration of fluids to the wound site and also failed to adhere to the wound site. Both Caudwell (1981) and Turner, et al. (1986) were restricted to industries which employed Occupational Health Nurses, representing about 20% of the working population (Health and Safety Commission, 1977). The remaining 80% of workers do not have access to Occupational Health Services and rely on First Aiders in the workplace and A & E Departments for the management of any injuries caused while at work.

As a consequence of these two previous investigations, Caudwell (1981) and Turner, et al. (1986) there was a need to set up a third investigation, Turner, Caudwell and Cockbill (1989A and B) to identify the users of First Aid products and to investigate the function, performance and design of First Aid wound management products.

First Aiders are restricted to the contents of their First-Aid Box for the treatment of any injury sustained in the workplace. In the United Kingdom, the contents of a First-Aid Box are governed by the Health and Safety (First-Aid) Regulations (1981), Statutory Instrument (S.I.917). The Guidance Notes to this regulation lists the minimum contents of First-Aid Boxes in relation to the numbers of employees and specifically
states 'and nothing else'. (see Appendix B, for the contents of First-Aid Boxes). The regulations do not allow the inclusion of dressings which may protect work-induced injuries in specific working environments (Turner, et al. 1989A and B). In 1989, Turner, et al. interviewed First Aiders from a sample of 47 industrial locations throughout the U.K. to identify the users of First-Aid products, the types of injuries treated, and to investigate the function, performance and design of First-Aid wound management products. Samples of first-aid dressings in current use were collected at the time of the interview for laboratory testing of the rate of fluid uptake.

This study (Turner, et al. 1989A and B) reported that the majority of injuries treated by First-Aiders in the workplace were lacerations and contusions to the hands and fingers, and the most commonly used dressing encountered was the 'Sterile Adhesive Dressing', (see Appendix A: Glossary for definition of terms). The types of injury and dressings used were similar to those reported by Turner, et al. (1986), with the exception of the 'standard' first-aid dressing (non-adhesive) contained in a First-Aid Box (see Appendix B for details of contents of First-Aid Boxes). The 'standard' first-aid dressing consists of an absorbent pad attached by stitching to a length of bandage, standards being laid down in the British Pharmaceutical Codex (BPC, 1973) (See Appendix A: Glossary for definition of these terms).

In all their laboratory tests, Turner, et al. (1989A and B) used a polyurethane foam dressing (Lyofoam™, Ultra Laboratories Ltd) as the control when comparing the time taken to saturate 'standard' first-aid dressings. The time taken for the test fluid to reach the upper face of the control dressing (Lyofoam™) was four minutes, whereas the results of the samples of 'standard' first-aid dressings ranged from 1-30 seconds. Turner, et al. (1989A and B) concluded that the pads available to First-Aiders had not been designed to resist fluid penetration and would not protect the surface of the
wound. Turner, et al. (1989A and B) surmised that outmoded dressings were being specified for use in first-aid situations to the exclusion of currently available wound dressings which could provide better protection to the wounds sustained by injured employees in the workplace.

1.13 Conclusion

These three previous studies of Caudwell (1981) and Turner et al. (1986 and 1989A and B), only looked at the work of Occupational Health Nurses and First-Aiders in the workplace. The dressings they tested were limited to adhesive tapes, adhesive strip and adhesive island dressings and first-aid dressing. Therefore, there remains a need to look at the dressings used in A & E Departments and to test those identified dressings which have not been tested.

To conclude, this thesis builds on knowledge gained from the earlier studies of Caudwell (1981), Turner, et al. (1986 and 1989A and B), through seeking to identify:

a) The types of injuries sustained in the workplace which may present for treatment in hospital A & E Departments.

b) What dressings they actually used to cover these injuries.

c) The protection afforded by these dressings against penetration by fluids and any loss of adhesion to the wound site.
Chapter 2

A SURVEY OF WOUND DRESSINGS USED IN ACCIDENT AND EMERGENCY DEPARTMENTS FOR THE TREATMENT OF WORK-INDUCED INJURIES.

2.1 Background

Work-induced injuries may be treated by nurses within Occupational Health Departments, and First Aiders in the workplace; the wound dressings applied in these circumstances were described by Caudwell (1981) and Turner et al., (1986 and 1989A and B). These surveys identified three classes of product to be most widely used. These were single dressing pads such as Melolin™, (Smith & Nephew Ltd), Telfa™ (Kendall Ltd), dry gauze (Vernaid Ltd) and Opsite™Smith & Nephew Ltd) with multiple tape strips or net or woven bandages as retention layers, adhesive strip dressings and adhesive island dressings. (Appendix A: Glossary for definition of these terms). However, approximately 80% of the workers do not have access to such Occupational Health Services (Cullen, 1987), and are generally reliant for the professional treatment of work induced injuries within Accident and Emergency Departments, although they may have received prior treatment by first aiders.

2.2 Objectives

The objectives of this survey were:

a) To determine the nature and site of work-induced injury most commonly presented to Accident and Emergency (A&E) Departments.

b) To identify the wound management products used in A&E Departments for the treatment of work-induced injuries.
c) To identify the environmental hazards encountered by injured employees returning to work.

2.3 Study design and data collection

Two A&E Departments were selected for their convenience of location in relation to the surrounding industry, accessibility, distance and travelling time, and time and resource availability of the researcher: one in Surrey and one in Middlesex. Application to the Ethics Committees for approval of the project was sought and given by each Committee to proceed. A visit was arranged to meet the Consultant and Senior Nurse Manager of each A&E Department to explain the project. The staff in these two A&E Departments were cooperative and willing to participate in the study. The catchment area around both A&E Departments provided a broad range of industry from construction, vehicle industry, electrical and engineering, other manufacturing, public services industry, local authority, agriculture, postal services and other industries. Most of these workplaces in both Surrey and Middlesex were predominantly small and employed less than 50 people but provided a wide range of industry, hence they were unlikely to have their own Occupational Health Nurse.

An interview checklist was designed to assist the researcher in accurate recording of information collected by interview from patients attending A&E Departments on the type and severity of work-induced injuries and the wound dressings applied to these injuries (see Appendix C for interview checklist). The checklist was designed and adapted from earlier research by Turner, et al. (1986). This checklist had been previously piloted for any ambiguity for question construction on the checklist among 13 nurses who were participating in the Distance Learning Programme for Occupational Health Nurses, run by the Health and Safety Executive in conjunction with the Royal College of Nursing (HSE/RCN, 1984). Content validity was established by review of the literature in the previous chapter. Ethical Committee
approval to conduct the surveys was obtained prior to data collection. Medical details were obtained from medical and nursing notes.

Within each A&E Department, data was collected by the researcher over a five-day period (Monday to Friday, 10 am - 6 pm) from 31st July - 4th August 1989 (Site A) and from 15th - 19th January, 1990 (Site B). Prior to collection, the project, and the survey interview checklist were explained to the A&E Department nursing, medical and clerical staff. During data collection, the researcher remained with the A&E admissions clerk in order to identify all patients on entry to A&E with work-induced injuries. The survey was explained to the injured employees who were then asked if they would be willing to participate. All patients gave their consent. For each patient giving consent, the confidentiality and anonymity of any information given was assured by assigning a code number to the interview checklist and a consent form signed. Each subject was then interviewed on arrival in the A&E Department and a checklist completed by the researcher.

In order to ensure that no patients were missed by the researcher when the researcher was away from the department for meal breaks, the admissions clerk would make a note of any patients with work-induced injuries and identify them to the researcher on return to the department. Approximately only 15 minutes was taken by the researcher for each meal break in order to avoid any such problems. Throughout the survey, patients with work induced injuries arrived in the A&E Departments separately, which allowed the researcher to complete each interview checklist.

There were differences in the opportunities for observation of wound treatments carried out within the two A&E Departments. In Site A, the researcher was provided with access to patients before and following treatment, although no direct observations of treatment could be made. Therefore, wound treatment was only identified through questioning the patient on discharge or by reading the admissions card completed by the
nursing and medical staff. However, within Site B, the researcher was given full access to patients which included direct observations of wound treatment carried out by nurses. All the dressings were applied by nurses.

2.4 Results

2.4.1. Patient characteristics

Data were collected from a total of 50 people with work-induced injuries, 25 subjects presenting themselves in each A&E Department on the 5 days of observation. In Site A 24 male and 1 female, and in Site B 22 male and 3 female subjects' ages (Figure 1) ranged from 16 to 64 years with the mode falling between 25-34 years (n = 15).

2.4.2. Patient occupation

The subjects' occupations were divided into the broad industrial classifications using the Standard Industrial Classification (SIC, 1980) produced by the Central Statistical Office (Figure 2). The largest single group worked in construction industries; n = 13, (26%). Other groupings represented were the vehicle industry n = 6, (12%), electrical and engineering n = 6, (12%), other manufacturing industries n = 6, (12%), public service industries n = 5, (10%), local authority establishments n = 3, (6%) and others detailed in Figure 2). It should be noted however, that this classification relates to the employer: the individual subject's occupations as employees are listed in Appendix E.
Figure 1. Age distribution of subjects (male and female) recruited in A and E Departments with work induced injuries.
Figure 2.
Number of subjects with work-induced injuries by type of employer

Number of subjects

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Vehicle industry</td>
<td>14</td>
</tr>
<tr>
<td>Electrical</td>
<td>6</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>Public service</td>
<td>8</td>
</tr>
<tr>
<td>Local Authority</td>
<td>10</td>
</tr>
<tr>
<td>Agriculture</td>
<td>12</td>
</tr>
<tr>
<td>Postal service</td>
<td>14</td>
</tr>
<tr>
<td>Other industries</td>
<td>34</td>
</tr>
</tbody>
</table>
2.4.3 *First aid and referral in the workplace*

Persons referring employees with work-induced injuries to A&E Departments and rendering first-aid in the workplace (see Appendix A Glossary for definitions of these terms) were classified under headings in Table 2. Most subjects referred themselves to A&E Departments \( n=31 \), (62%) with \( n=29 \), (58%) giving first-aid to themselves prior to attending A&E Departments. Only \( n=7 \), (14%) of injured employees were treated by first aiders and a further \( n=4 \), (8%) by nurses in the workplace.

**TABLE 2: Persons referring employees with work-induced injuries to A&E Departments and giving first-aid in the workplace**

<table>
<thead>
<tr>
<th>Person</th>
<th>Referral</th>
<th>First-aid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>First-aider</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Nurse</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Doctor</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ambulance Service</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>50</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>
2.4.4. Injuries sustained at work

Of 58 injuries observed, lacerations and contusions to the limbs were the most frequently encountered injury $n=36$, (62%) with most $n=25$, (43%) occurring on the hands and fingers while at work (Table 3).

Multiple injuries were relatively uncommon with only two patients sustaining multiple injuries, including lacerations to the back of the head, contusions to the shoulder, leg and finger and lacerations and contusions to two fingers.

Nine of the 50 patients experienced severe injuries under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR, 1985), (see definitions in Appendix A: Glossary for definitions of these terms) which included fractures to the foot, ankle and hand ($n=3$), severe sprains of the foot ($n=2$), dislocated and torn shoulder ligaments ($n=2$), lacerated tip of finger which required a skin graft ($n=1$) and a head injury ($n=1$).
TABLE 3: Injuries caused during paid employment and treated within two Accident and Emergency Departments during a one-week period

<table>
<thead>
<tr>
<th>Location</th>
<th>Lacerations and open wounds</th>
<th>Contusions</th>
<th>Sprains and strains</th>
<th>Other injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEAD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye</td>
<td>3</td>
<td></td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Other parts of face</td>
<td>2+(2)=4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head (excluding face)</td>
<td>1+(1)=2</td>
<td></td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td><strong>All head locations</strong></td>
<td>6+(3)=9</td>
<td></td>
<td></td>
<td>(2)</td>
</tr>
<tr>
<td><strong>UPPER LIMB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One digit (finger or thumb)</td>
<td>7+(2)=9</td>
<td>4+(2)=6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or more digits (fingers/thumbs)</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand</td>
<td>2(1)=3</td>
<td>1</td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Wrist</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest of upper limb</td>
<td>1</td>
<td>2</td>
<td>1+(2)=3</td>
<td></td>
</tr>
<tr>
<td><strong>All upper limb locations</strong></td>
<td>12+(3)=15</td>
<td>8+(2)=10</td>
<td>1+(3)=4</td>
<td></td>
</tr>
<tr>
<td><strong>LOWER LIMB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot</td>
<td>2</td>
<td>5+(3)=8</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Ankle</td>
<td></td>
<td>1</td>
<td>2</td>
<td>(1)</td>
</tr>
<tr>
<td>Rest of lower limb</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>All lower limb locations</strong></td>
<td>2</td>
<td>6+(3)=9</td>
<td>2+(2)=4</td>
<td>1+(2)=3</td>
</tr>
<tr>
<td><strong>TOTAL (n=58)</strong></td>
<td>20+(6)=26</td>
<td>14+(5)=19</td>
<td>2+(2)=4</td>
<td>2+(7)=9</td>
</tr>
</tbody>
</table>

2 subjects had multiple injuries
( ) = Injuries in subjects who did not return to work immediately following treatment
2.4.5 **Treatment outcomes**

30 subjects were (17 from site A and 13 from site B) able to return immediately to employment following treatment of their injuries within the A&E Department. These 30 subjects had injuries comprising mainly of lacerations and contusions to the hands and fingers (number of patients, n=15) or the feet and ankles (n=8). The remainder experienced a range of injuries, lacerations to the head and face (n=3), corneal abrasions to the eye (n=3), a damaged radial nerve (n=1) and fluid on the knee (n=1). However, 20 subjects were unable to return to work following treatment. Of these subjects 9/20 experienced severe injuries (see 2.4.3).

2.4.6 **Topical applications used to clean industrial injuries treated, and the wound dressings applied within the A&E Departments**

The predressing treatment differed between the two survey sites according to hospital policy. For cleaning wounds Site A used a 0.05% solution of chlorhexidine gluconate, while Site B used sterile normal saline. Table 4 details the wound dressings (primary dressings), bandages (dressing attachments) and adhesive tapes (fasteners) applied to the injuries of the 30 subjects who were able to return to work following treatment. Only considering treatments applied to the hands or upper limbs, three primary dressings were used within the two A&E Departments, with dry gauze the most prevalent (used with 11 subjects). Most subjects with upper limb injuries were provided with a bandage to keep the primary dressing in place, most commonly this dressing was Tube gauze tubinette™ (Seton Healthcare Group Ltd). Finally the bandage and primary dressing were attached to the subject using adhesive tape (n=14).
<table>
<thead>
<tr>
<th>Wound management product</th>
<th>Number of subjects provided with product</th>
<th>Subjects with hand and upper limb injuries only</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRESSING (Primary dressing)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing : Gauze</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Melolin™</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Airstrip™ waterproof adhesive island dressing</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Eye pad</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>No dressing</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bandage (Dressing attachments)</th>
<th>Number</th>
<th>Hand and upper limb only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conforming bandage peha crepp™</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Crepe bandage</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Tube gauze tubinette™</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Tubigrip™</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Triangular bandage</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>No bandage</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tape (Fastener)</th>
<th>Number</th>
<th>Hand and upper limb only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastoplast™ fabric adhesive plaster</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>Micropore™</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No Tape</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

n=30
2.4.7. Environmental hazards faced by injured workers returning to employment.

Within sites A & B subjects who were able to return to work immediately following treatment were requested by the researcher at interview to identify environmental hazards encountered in their place of work (Table 5). However, in site B where the researcher observed the treatment of the patient, in no case did the nurse or medical staff ask about the patient's occupation or the environmental hazards they encountered in their workplace. Therefore it was inevitable that inappropriate dressings might be applied.

**TABLE 5:** Environmental hazards encountered by injured employees in site A and B returning to work

<table>
<thead>
<tr>
<th>Number of injured employees returning to work and coming into contact with:</th>
<th>Hazard</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme cold</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Extreme heat</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Radiation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Detergent solutions</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Organic solvents</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Lubricant oils</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Abrasive materials</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>None of the above</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Employees often encountered multiple hazards</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Only three of the 30 subjects (10%) returning to work believed they would not encounter one or more of the potential hazards to the integrity of the dressings
or the process of wound healing. Three hazards appeared most frequent to the subjects returning to work; extremes of moisture and contact with either organic solvents or abrasive materials.

2.5 Discussion

The objectives of this survey were:

a) To determine the nature and site of work induced injury most commonly treated in two Accident and Emergency (A & E) Departments.

b) To identify the wound management products used in two A & E Departments for the treatment of work induced injuries.

c) To identify the environmental hazards encountered by injured employees returning to work.

2.5.1. Type of work-induced injury

Work-induced injuries most commonly presented to A&E Departments include lacerations and contusions (Bagley and Richardson, 1975; Bamford, 1987). The type of injury most frequently encountered in the present survey was lacerations and contusions to the upper limb (43%), compared with (44%) reported by Bagley and Richardson (1975) and (51%) by Bamford (1987). Bagley and Richardson also reported similar proportions of patients with such injuries who were able to return to work 67% (n = 72) compared with 60% (n = 30) in the present survey.

Although the types of injuries reported on by the patients in the present survey and the two earlier surveys were similar, they were drawn from different geographical locations. The Bamford, and Bagley & Richardson surveys were
conducted in the West Midlands and the Greater Brighton areas respectively and both covered single A&E Departments. The present survey was conducted in the South of England, one in Surrey and one in Middlesex, covering two A&E Departments within two Health Regions.

Two separate classifications of industry were used. The industrial classification used in the present survey and by Bamford (1987) was the standard Industrial Classification (1980) produced by the Central Statistical Office. Bagley and Richardson (1975) however, used a different classification, grouping industries into retail, outdoors or those factory based. In the present survey, the largest single group worked in construction industries, while engineering and metal goods were the principal industrial bases in the Bamford (1987) survey. In the present survey, in addition to the industrial classification of the employers business, the occupations of patients were also recorded in Appendix E.

In addition to these three surveys, Turner, et al. (1986) conducted a national survey in the manufacturing industries to identify the work-induced injuries and wound dressings used for the treatment of injuries by Occupational Health Nurses employed in 53 Occupational Health Departments across 16 manufacturing industrial divisions. The industrial classification used was the Standard Industrial Classification (1980). The highest number of injuries were reported in bricks, pottery, glass and cement industries. The range of industries in the present survey is different to Turner, et al. (1986). Although the present survey is smaller in size and area encompassed, it covered a wider range of industries which included all workplaces such as the public service industries, local authorities, postal and telecommunication services, agriculture and the National Health Service.
2.5.2. Predressing treatment

An interesting finding to emerge from this study was that most subjects referred themselves to A&E Departments \( n = 31, \) (62\%) with \( n = 29, \) (58\%), (see page 35), giving first aid to themselves prior to attending A&E Departments. Only 14\% (\( n = 7 \)) of injured employees were treated by first aiders prior to attending A&E Departments which indicates that if available first aiders were not used, or they were not available. The effect would be to thwart the Health and Safety (First-Aid) Regulations 1981. A previous survey by Caudwell (1990) reported similarly that 59\% of employees treated and referred themselves to A&E Departments and only 2\% were treated by first-aiders.

The Health and Safety (First Aid) Regulations came into operation on 1st July, 1982 and applies to all places of employment and to the self-employed. These regulations place a general duty on employers to make, or to ensure there is made, adequate First Aid provision for their employees should they be injured or become ill at work. There is also a duty on the employee to report accidents to the employer. Employers must also inform their employees of the First Aid provision made for them and self-employed persons are also required to provide adequate first-aid equipment so they can render First Aid to themselves if they are injured at work. The employer is required to provide suitably trained persons to carry out first-aid in the workplace. A 'suitable person' is a first-aider who holds a current first-aid certificate issued by an organisation whose training and qualifications are approved by the Health and Safety Executive for the purposes of the regulations. The length of the first-aid training course is 4 days, the certificate is valid for 3 years followed up by a 2-day refresher course every 3 years. Where there are no trained First Aiders available an injured person relies upon 'self help'. Even when a First Aider is available many employees prefer to 'self aid' from a First Aid box, but both First Aiders and employee are restricted solely to the contents of a First Aid box as laid down by
the Health and Safety (First Aid) Regulations (1981) (see Appendix B, page 113 for the contents of a First Aid box).

Whilst First Aid dressings may be used in the workplace to act as a protective dressing to aid the healing of minor injuries, they will also function to act as a 'transit' dressing to protect the injury in transition from workplace to A&E Department or Occupational Health Nurse, where they will receive professional treatment. However, if the employee returns to work from the A&E Department after receiving treatment and requires the wound to be re-dressed at his workplace where there are solely First Aiders, this will be restricted to the contents of a First Aid box. The full range of dressings applied in the A&E Departments are not available in the workplace where there are solely First Aiders employed. First aid dressings may be unsuitable to work in because they afford less protection than those provided by A&E or Occupational Health Nurses, other than to aid the healing of minor injuries.

The cleansing of wounds differed between the two survey sites according to hospital policy. Site A used sterile normal saline which has no antiseptic properties, while Site B used a 0.05% solution of chlorhexidine gluconate (antiseptic) (Rutala, 1990). It may be questioned whether, in view of the diversity and causation of injuries suffered in the workplace, such blanket policies are satisfactory.

There are differing approaches and controversial views about the use of cleansing agents, antiseptics and disinfectants. Some commonly used topical antiseptics (see Appendix A, page 112, for definitions of these terms) and cleansing agents such as chlorhexidine, povidone, iodine and hydrogen peroxide might in certain strengths retard wound healing in spite of their antibacterial and cleansing actions because they are too caustic for the wound.
itself and are toxic to tissue defences if they are disinfectants (Alvarez, Rozint and Wiseman, 1989). For example, although povidone iodine is a topical antiseptic which has bactericidal, sporicidal and fungicidal properties which may be considered useful, it is also toxic to tissue defences (Aronoff, Friedman, Doedens et al, 1980) and will inhibit wound healing. Brennan and Leaper (1986) in their studies using rabbit ear chamber used chlorhexidine 0.05% and povidone iodine 1% and found they only caused a very mild inflammatory reaction, and therefore considered them to be relatively safe. However, these topical antiseptic solutions are only suitable for use on healthy, unbroken skin surrounding the wound (Baxter and Rodeheaver, 1990). Branemark and Ekholm (1967) concluded in their research that disinfectants, regardless of type, damage tissue and interfere with tissue function, thereby worsening the existing injury and delaying wound healing. However, if bacterial contamination is sufficient to predispose to infection, specific antibiotics, and not cleansing solutions should also be considered (Jackson and Rovee, 1988). Sterile water and sterile normal saline used to irrigate wounds are advocated as the best cleansing agents by Baxter and Rodeheaver (1990) and have been shown to be safe and non-caustic in an open wound.

2.5.3. Wound management products used.

Among patients who were able to return immediately to their work place after treatment, the most frequently used wound dressings (Table 4, page 39)were primary dressings, dry gauze, Melolin™, and Airstrip™ waterproof adhesive island dressings, and dressings attachments were conforming bandages, crepe bandages, Tube gauze tubinet™ secured by a tapefastener, Elastoplast™ fabric adhesive plaster and Airstrip™ waterproof adhesive island dressings. (Appendix A: Glossary for definition of these terms).
There was considerable similarity between the results of the present survey and those previously conducted in Occupational Health Departments (Caudwell, 1981 and Turner, et al., 1986). Primary dressings such as dry gauze and Melolin™ were the most frequently used products to cover the wounds in all three surveys. However, Turner, et al., (1986) also identified, as being in frequent use in Occupational Health Departments, low-adherent pads such as proprietary dressings, Telfa™ (Kendall Ltd), Release™ (Johnson and Johnson Ltd) and Alutex™ (Ortmann Ltd).

In the present survey the encountered wound dressings were classified by the researcher as either primary dressings or dressing attachments. Primary dressings according to David (1986) are those placed directly onto the wound and are classified into adherent and low-adherent dressings. Although dry gauze is an adherent dressing, it is often commonly encountered being applied directly to the wound to protect the wound surface and absorb exudate (Harding, 1990). Gauze dressings may stick to the wound if exudate dries. Capillary loops may also have grown through the dressings and the wound may be reopened and bleed when the dressing is removed.

Dressing attachments such as tube gauze tubinette conforming bandages and crepe bandages were the most commonly used products, to keep the primary dressing in place and provide additional protection in the present survey and in the other three surveys (Caudwell, 1981 and Turner, et al. 1986 and 1989A and B). Similarly in the present and in the other three surveys the tape (fastener) most frequently used to secure a dressing in place was Elastoplast™ fabric adhesive plaster. Airstrip™ waterproof adhesive island dressings were also used in the present survey and in the other three surveys.
In the present survey a single researcher collected the data in a standardised format by direct observation, interview and completion of an interview checklist in both A&E Departments to identify the types and severity of work induced injuries presenting for treatment and the wound dressings used. The data collection was carried out on two sites over five-day periods from Monday to Friday, 10am–6pm which represents a typical eight-hour working shift.

2.5.4. Return to work; environmental hazards

Both A&E Departments recorded similar patterns of hazards on the interview checklist. Each patient in Site A and B was interviewed by the researcher and gave a list of different hazards according to his occupation and his/her interpretation of the hazards within the job in which he worked. For example, the construction industry showed the widest range of hazards but not all workers in construction came into contact with the same hazards. The hazards encountered were related to specific patient occupations (see Appendix E page 123 for list of subjects' occupations). For example, carpenters operate machinery and come into contact with extreme heat, extreme cold, moisture, detergent solutions, lubricant oils and abrasives; whereas painters came into contact with extreme heat and extreme cold, organic solvents and abrasives. Welders operate machinery and come into contact with fluxes, extreme heat and ultraviolet light. Patients often encountered multiple hazards. These included extreme cold, extreme heat, radiation, moisture, detergent solutions, organic solvents, lubricant oils and abrasive materials. The most common hazards encountered in this study were moisture, organic solvents, abrasive materials, detergent solutions and lubricant oils and the least common were radiation and extreme cold. These findings are similar to those reported by Turner, et al. (1986).
If any one of these hazards or a combination, were to penetrate through the wound coverings applied to injured patients returning to work, the overall effect to the wound would be to cause possible further damage and delay the normal wound healing process.

For example Turner, *et al.* (1986) found that temperature and moisture were the most common causes of dressing loss and subsequent wound damage. Extremes of temperature could be met either in moist or dry conditions, from freezing temperatures to temperatures near 70°C. Heat coagulates cell protein while extreme cold forms crystals in the cytoplasm both of which cause loss of cell function (David, 1986). The most common heat injuries are burns (David, 1986). Freezing temperatures may cause frostbite, gangrene, impairment of cell function and skin necrosis as described by Baxter and Rodeheaver (1990).

Optimal epithelialisation occurs in a moist wound environment (Winter, 1962; Mertz, 1990), but too much moisture will cause maceration of a wound.

Although these substances may be hazardous to health and come under the Control of Substances Hazardous to Health Regulations (C.O.S.H.H. Regulations, 1988), it is the employer's duty to assess the risks and ensure compliance with the regulations by the employees. However, there are the long-term and short-term effects of these substances which need to be assessed. For example, the short-term effects of oil getting into a laceration would delay wound healing, but the long-term effects caused by excessive contact with lubricant oils, and detergent solutions may cause dermatitis and oil acne (Cook, 1989). Dermatitis may be caused by solvents used to clean the skin (Cook, 1989) which may imply non-compliance with the (C.O.S.H.H. Regulations, 1988) by the employees. Solvents are defatting agents causing dry and cracking skin and would delay wound healing by destroying the moist wound
environment. Continued wetting of the skin with solvents in the long term, can lead to defatting and dry cracking dermatitis (Cook, 1989). Radiation destroys cell replication capacity and may result in burns and dermatitis (David, 1986). According to Baxter and Rodeheaver (1990) the short-term effects of radiation are inflammatory reaction, with skin redress, dryness, scaling and serous weeping. Abrasive particulate materials such as sugar, sand and cement which come into contact with the skin may result in the short-term effects, burns of the skin and in the long-term effects, dermatitis (Cook, 1989). Protection of a wound from these environmental hazards is of prime importance. The selection of a wound dressing and its suitability for the treatment of work-induced injuries must be based on the evidence from the results of the testing of dressings against the hazards which injured employees come into contact with in their workplace.

Turner, et al. (1986) tested the effects of differing environmental hazards on the adhesiveness and penetrability of certain surgical adhesive tapes, strip dressings and adhesive island dressings used by Occupational Health nurses. The hazards investigated were similar to those identified in the present survey. They were simulated in a laboratory situation to test penetration and adherence performance of the dressings applied to flat glass surfaces.

The 1986 study showed that the ability to resist ranges of temperature, moisture, detergent solutions, abrasive materials, oil penetration and organic solvent dissolution varies between products. Most of the plastic-backed, non-perforated tapes showed no penetration to water and oil but the non-woven tapes and fabric tapes were penetrated by both water and oil. Detergent solutions penetrated through some of the plastic adhesive tapes. All the adhesive tapes and adhesive strip and adhesive island dressings were penetrated by the organic solvent, trichloroethylene. The results from the adhesive strip
dressing showed there was no adhesion in the pad area. Adhesive strip dressings have an open-sided dressing pad which will not protect a wound from the differing environmental hazards encountered in the workplace. Some of the adhesive island dressings did not have a large enough adhesive surround, in order to provide a complete seal round the dressing pad to protect the wound from penetration of environmental hazards. Overall, for both occlusion and wear resistance the polymeric backings (plastic-backed adhesive dressings) showed the greatest protection from penetration of hazards.

The present survey also tested adhesive tape and additionally tested other dressings, primary dressings and bandages used in A&E Departments rather than in Occupational Health Departments. Therefore the findings in this study extend the findings in the 1986 study. There were differences in the methodology, in the present survey glass test tubes were used as opposed to flat glass plates used in the previous study.

2.5.5. Limitations of this survey

Limitations were imposed by restricting the survey to two A&E Departments in Surrey and Middlesex, and the use of a single researcher for a set time due to the constraints of the researcher's time and resource availability. Therefore this survey did not include those worker-induced injuries or the wound dressings used during the hours of 6 pm to 10 am. However, although the survey was small and limited to 50 subjects in total, the results can be regarded as having acceptable validity and reliability due to the presence of a single researcher, and the use of a standardised recording procedure.

In Site A the researcher had restricted access to the patient and was relying on patient interview before and after treatment and the data recorded by observing the nursing and medical staff on the patient's record card. Whereas in Site B
the researcher had full access to the patient and was free to interview the patient on arrival, before and during treatment and to establish the outcome by observing the nursing and medical staff. Direct observations of treatments were made and recorded throughout all the procedures carried out by the nursing and medical staff from admission to outcome. These observations are reported in 2.4.7. page 40.

An alternative approach to the method used in the present survey could have been by leaving questionnaires in the department over a 24-hour period. Although this may be a more cost-effective way of collecting information, previous research (Bamford, 1987) has showed that more information was collected when the researcher was present in the department. Bamford (1987) highlighted the value of personal collection of data by demonstrating the lack of information available from the National Health Service (NHS) records in an A&E Department which would be valuable to industry.

Another method could have been to rely on the information recorded on the patient record cards alone. In the present survey this method would not have been possible because the information recorded in both A&E Departments differed and lacked detail on injuries caused at work. Site A only asked for the patient's occupation whereas Site B asked for the patient's occupation plus the accident details, e.g. whether the accident was at work, at home or a road traffic accident (RTA). Similarly, in Bamford's survey the record system used in an A&E Department in the West Midlands did not readily supply information which would be useful to industry, such as the identification of work-induced injuries and patient's occupation. However, Bagley and Richardson (1975) in their survey of industrial injuries in an A&E Department in Greater Brighton, relied solely on patient record cards and were able to identify injuries sustained in the workplace by this method. But records do not identify specific hazards.
Bagley and Richardson (1975) also used postal questionnaires in their survey in the less serious cases to assess what time had been lost by the injured person in travelling to the A&E Department, and what working time they had subsequently lost. They recorded a 64% response rate by this method. Similarly Caudwell (1981) in a survey of dressing materials used by Occupational Health Nurses, used postal questionnaires and personal interviews in industrial locations in the United Kingdom, Holland, West Germany, the United States and Eire. 86% of all questionnaires sent were completed and returned. Difficulties with postage services in the United States were mainly responsible for the shortfall. Some of the questionnaires returned were incorrectly completed and two were indecipherable. However, the record of visits allowed most of the gaps to be filled. To rely solely on postal questionnaires may result in varied response rates as indicated, and may not provide the information required by the researcher.

A further limitation was that the results of the present survey are confined to two A&E Departments surveyed in the South of England in Surrey and Middlesex. Other A&E Departments throughout the whole of the United Kingdom may use different wound dressings and the work-induced injuries presenting for treatment may differ from the results in this survey. However, there was considerable similarity between the results of the present survey and those conducted in A&E Departments (Bamford, 1987 and Bagley and Richardson, 1975) with respect to the work-induced injuries but the earlier surveys did not record the wound dressings used. The information on the patient record cards differs in different A&E Departments. A nation-wide survey using more researchers and the availability of more financial resources may counteract these problems. A standardised medical record form such as that developed as a result of this study (see Appendix D) would also allow valid comparisons between different centres.
Turner, et al. (1986) demonstrated one form of testing restricted to surgical adhesive tapes, strip dressings and adhesive island dressings. According to these authors, the non-adhesive dressings and bandages (dressing attachments) are under constant user evaluation in both hospital and community nursing. However, this does not usually include feedback information from the 28 million working population (Central Office of Information, 1991) who, if sustaining injuries at their workplace, will need suitable dressings to protect their wounds from environmental hazards. Approximately 80% of workers do not have access to an Occupational Health Service, (Cullen, 1987) and are therefore, primarily reliant for the professional treatment of work induced injuries in A&E Departments, their G.P. or home. Turner, et al. (1986) did not test non-adhesive (primary dressings) or bandages (dressing attachments).

2.5.6. Experimental testing of suitability of dressings

The dressings investigated in the experimental section are restricted to those applied to the 15 subjects who returned to work with hand and finger injuries and who were arguably at most risk from exposure to hazards.

Chapter 3 of this report will describe a further series of laboratory investigations designed to extend the experimental observations of Turner et al. (1986), to include the dressings identified in the present survey as being used in A&E Departments.

2.6 Summary

1. The objectives of the survey were to determine the type of work-induced injury most commonly presented to A&E Departments and to identify the wound dressings used in A&E Departments for the treatment of work-induced injuries.
2. Two A&E Departments were surveyed in the South of England, one in Surrey and one in Middlesex by a single researcher over 2 five-day periods from Monday to Friday, 10 am - 6 pm.

3. An interview checklist was designed to collect information on the type and severity of work-induced injuries and the covering wound dressings used in A&E Departments.

4. Data was collected from 50 subjects, 46 male and 4 female with work-induced injuries being interviewed in both A&E Departments with the mode falling between 25-34 years.

5. The employers were divided into the broad industrial classifications using the Standard Industrial Classification (1980) produced by the Central Statistical Office with construction industries accounting for the largest number of people employed. Data was also recorded on the specific occupations of the subjects, which give a more precise guide to their exposure to workplace hazards (see Appendix E for list of subjects' occupations).

6. Half of the work-induced injuries were lacerations to the hands and fingers. Fifty percent of patients with such injuries, after receiving treatment in the A&E Departments returned immediately to their place of work.

7. Most subjects (62%) referred themselves to A&E Departments with (58%) giving first aid to themselves prior to attending.

8. The cleansing of wounds differed from the two A&E Departments. Site A used a 0.05% solution of chlorhexidine gluconate, while Site B used sterile normal saline.
9. Dressings most commonly used in both A&E Departments were dry gauze, Tube gauze tubinette™ and Elastoplast™ fabric adhesive plaster and were similar to the findings in previous surveys.

10. Environmental hazards identified as the most common were moisture, organic solvents and abrasive materials, and the least common, radiation and extreme cold. Patients often encountered multiple hazards on return to work. The dressings applied in A&E Departments may not have been suitable.

11. Laboratory experiments were designed and set up to test the wound dressings found to be in use, for penetration of substances through wound coverings and their effects on adhesion of tape fasteners (ie suitability). These investigations form the basis of Chapters 3 and 4 of this thesis.
Chapter 3

THE PENETRATION OF WOUND DRESSINGS BY WATER, DETERGENT SOLUTIONS AND CUTTING FLUIDS.

3.1 Background

The previous chapter reported that injured employees who returned to work following local treatment in A&E Departments were likely to be exposed to a variety of environmental hazards which could delay the healing of existing injuries or produce further tissue damage. The most commonly reported hazards were; extremes of moisture and contact with organic solvents, abrasive materials, detergent solutions and lubricant oils. To protect the wound site from these hazards, any wound covering or dressing must act as a barrier (Turner, et al., 1986). For the purposes of this investigation the researcher chose to test three hazards to examine the suitability of wound dressings. A series of laboratory experiments was designed to compare the penetration of three liquids, water, detergent solutions and cutting fluids (which are mineral oils emulsified in water) through the dressing. Additionally, variations in penetration as a consequence of different liquid temperatures were investigated.

The survey (chapter 2) identified the most frequently encountered wound dressing was dry gauze (see Table 4) used as an inner (or primary) dressing covered by a bandage and secured by a standard tape. The laboratory test investigated the penetration of three liquids through four primary dressings, two dressing attachments and one tape fastener:

Primary dressing: dry gauze (Vernon Carus Ltd).

Melolin™ (Smith & Nephew Ltd).
Dressing attachment: Conforming bandage-peha crepp™ (Hartmann Ltd)
Tube gauze tubinette™ (Seton Healthcare Group Ltd).

Tape fastener: Elastoplast™ fabric adhesive plaster (Smith & Nephew Ltd).

Dry gauze is an adherent dressing, Melolin™ is a low-adherent pad and Opsite™ is a transparent semi-permeable film permeable to water vapour, oxygen and other gases but impermeable to water and bacteria. Opsite™ was not identified as being in use during the survey of A&E Departments but was included in the laboratory tests as a potential alternative to dry gauze and Melolin™. Opsite™ was previously reported to be used within Occupational Health Departments (Turner, et al., 1986) and by First Aiders working in industry (Turner, et al., 1989A and B).

3.2 Experimental objectives
The objectives of the experimental studies were:

a) To design a series of laboratory experiments to test the three environmental hazards water, detergent solutions and cutting fluids.

b) To compare the penetration of the three liquids through wound dressings at different temperatures and their effects on adhesion of dressing attachments.

c) To ascertain whether the dressings applied in A&E Departments (Chapter 2) were suitable for exposure to environmental hazards encountered on return to work.

3.3 Experimental methods
Wound dressings are normally applied to human skin. However, to establish a standard method for comparing penetration through dressings, glass test-tubes were selected to simulate the shape and dimensions of a finger, the most frequently injured
part of the body. Although glass differs in many respects to human skin, it was chosen for the purposes of the experiments because it has low chemical reactivity, and adequate heat and solvent resistance properties. In the previous study (1986) flat glass plates were used for the testing of adhesive dressings for penetration and adhesion by fluids. In the present study, where it was considered desirable also to test non-adhesive primary dressings, flat glass plates would have been disadvantageous, cylindrical glass test tubes provide a more convenient model on which to apply primary dressings and bandages.

The dressing coverings compared are set out in Table 6.

**TABLE 6: Code and dressing combination**

<table>
<thead>
<tr>
<th>Code</th>
<th>Primary dressing inner</th>
<th>Dressing attachment bandage outer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gauze</td>
<td>Conforming bandage-peha crepp™</td>
</tr>
<tr>
<td>2</td>
<td>Gauze</td>
<td>Tube gauze tubinette™</td>
</tr>
<tr>
<td>3</td>
<td>Melolin™</td>
<td>Conforming bandage-peha crepp™</td>
</tr>
<tr>
<td>4</td>
<td>Melolin™</td>
<td>Tube gauze tubinette™</td>
</tr>
<tr>
<td>5</td>
<td>Opsite™</td>
<td>Conforming bandage-peha crepp™</td>
</tr>
<tr>
<td>6</td>
<td>Opsite™</td>
<td>Tube gauze tubinette™</td>
</tr>
<tr>
<td>7</td>
<td>Airstrip™ waterproof adhesive island dressing</td>
<td></td>
</tr>
</tbody>
</table>

All dressing attachments were secured by (Tape fastener) Elastoplast™ fabric adhesive plaster.
3.4 Preparation and application of samples

All wound dressings were obtained direct from the manufacturers and maintained for a minimum of 72 hours at a temperature of 22°C to simulate normal or as near-normal user conditions (Turner, *et al.*, 1986). Glass test tubes 125mm long x 16mm diameter were cleaned with toluene in a fume cupboard to remove any grease and allowed to regain laboratory temperature to simulate normal user conditions. To identify whether the liquid had penetrated through the wound dressing, a pH indicator strip (Pehonon Macherey-Nagel\(^{\text{MN}}\) Camlab) was attached to the side of the test tube with double-sided adhesive tape beneath each sample to observe the colour change (Figure 3). The colour of the pH indicator strip changed from yellow to mauve on contact with a fluid of approximately neutral or alkaline pH which penetrated the dressing (Figure 7). The pH range of the indicator paper used was 5.2 - 6.8. The indicator strip was tested with the tap water used in the laboratory before experimental testing commenced to confirm that a significant colour change occurred. Samples of 25.4mm square dressing and 50.8mm bandage or tape length and width were cut and used to cover the circumference of the test tube without overlap.

**FIGURE 3:** Attachment of indicator pH strip (Pehonon Macherey-Nagel\(^{\text{MN}}\) Camlab) to the side of the test tube with double-sided adhesive tape.
Seven different combinations of dressings (Table 6), were attached to the glass test tubes in triplicate. Each dressing combination comprised three components, an inner (or primary) dressing, an outer bandage (dressing attachment), secured by a tape (fastener). Dressing samples, inner dressings of dry gauze, Melolin™, Opsite™ and Airstrip™ waterproof adhesive island dressings size 25.4mm by 50.8mm were positioned onto the test tubes 25.4mm from the base of the test tubes. The inner dressings of dry gauze and Melolin™ covered the circumference of the test tubes without overlap and were secured in place by a piece of Elastoplast™ fabric adhesive plaster at the join (see diagram 1). The inner dressing was then covered by a 76.2mm length x 3 layers of a conforming bandage Peha crepp™ (Hartmann Ltd) or Tube Gauze Tubinette™ (Seton Healthcare Group Ltd). The tube gauze was applied by the use of a tube gauze finger size applicator as shown in Figure 4. Lengths of tube gauze size 3 x 76.2mm were cut and placed on the applicator. The applicator was pushed over the inner dressing onto the test tube, holding the end of the tube gauze in position with one hand, pulling back the applicator with the other hand, leaving the length of tube gauze in position on the test tube. Holding the end of the tube gauze on the test tube, the applicator was pulled back and twisted twice and then pushed back onto the test tube again. The applicator was withdrawn leaving three layers of tube gauze on the test tube. The end of the tube gauze and bandages were secured to the test tubes with Elastoplast™ fabric adhesive plaster. All dressing combinations were retained at laboratory temperature for four hours before proceeding to the laboratory testing and were coded and numbered for ease of identification for recording the results from the testing of the wound dressings (Table 6). The procedure was repeated three times for each dressing combination.
Diagram 1. The relationship of primary dressings and the tape fastener secured to a glass test tube.

FIGURE 4: Application of tube gauze tubinette™ on to a glass test tube to simulate a finger dressing
3.5 Experimental procedure: General methods

A Grant water bath (Figure 5) was used for the laboratory testing. A one-litre glass beaker was used to contain the liquids for testing and placed in the water bath preheated to selected temperatures (Table 7). The water bath thermostat was calibrated by use of a thermometer in the beaker and the temperature was monitored throughout the period of the experiment.

FIGURE 5: A Grant water bath used for experimental testing
The seven dressing combinations shown in Table 6 were applied to glass test tubes, as previously described, and were immersed in a one-litre beaker of liquid as shown in Table 7. The glass test tubes with attached dressings were suspended from a test tube rack secured round the rim of each glass test tube with plasticine to hold them in place because there was no lip. The test tube rack was placed over a one-litre beaker containing the liquid maintained at the test temperature in a water bath as shown in Table 7. A mechanical stirrer was fixed into the centre of the glass beaker through the test tube rack holder, attached to a retort stand and switched on to agitate the liquid to ensure even distribution of temperature and to simulate movement of liquid during physical activity 'in vivo'.

Each series of tests using water, detergent solutions and cutting fluids at different temperatures set out in Table 7 were repeated three times. Testing was carried out for four hours between 10.00am and 2.00pm. Four hours was chosen to cover the maximum period sustained for the average person returning to work. One set of tests was carried out at a time because of the time required to set up each experiment and availability of only one Grant water bath.

After the testing period was completed the water bath and mechanical stirrer were switched off. The glass beaker and test tubes were removed from the water bath and placed on the laboratory bench and inspected for loss of adhesion. The dressings were removed from the test tubes layer by layer individually with forceps, and each component dressing was observed for the penetration of water, detergent solution and cutting fluids by the change in the colour of the indicator strip (Pehenon Macherey-NagelMN Camlab) attached to the outside of the glass test tube. (Figure 6).
FIGURE 6: Change in the colour of the pH indicator strip (Pehenon Macherey -Nagel\textsuperscript{MN} Camlab) from yellow to mauve as the reagent penetrated.

3.6 Specific wound dressing penetration test methods

Three commonly encountered liquids in the workplace, water, detergent and cutting fluid, at varying temperatures, were selected by the researcher to test for penetration through wound dressings in a series of laboratory experiments.
TABLE 7: Range of temperatures and liquids used for testing wound dressings

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Water</th>
<th>Detergent Solution (MP9) 1%</th>
<th>Ultracut (Rocol)370 cutting fluid (thin)</th>
<th>Ultracut (Rocol)390H cutting fluid (thick)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°C</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>40°C</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>50°C</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.6.1 Penetration of water

Water was selected for testing the penetration of wound dressings at temperatures of 30°C, 50°C, 60°C and 70°C to simulate the maximum temperatures likely to be encountered in industrial working conditions. The tests were repeated three times.

3.6.2 Penetration of detergent solution

The liquid selected for testing the penetration of wound dressings was a 1% solution of detergent MP9, (Premiere Products). MP9 is a commonly used concentrated multi-purpose cleaner and degreaser, containing a powerful organic solvent (propylene glycol ether solvent - Premiere Products). (See Appendix F for technical details of this product).

A 1% v/v solution of MP9 multi-purpose cleaner in water at temperatures of 30°C, 40°C and 50°C was used to simulate the temperatures likely to be encountered in normal working conditions. The tests were repeated three times.
3.6.3 Penetration of cutting fluids

Two cutting fluids commonly used as metal cutting lubricants were selected for testing the penetration of wound dressings, Ultracut 370 (Rocol), thin, an emulsion of synthetic mineral oil in water containing 25% refined mineral oil and Ultracut 390H (Rocol), thick, an emulsion of synthetic mineral oil in water containing 40% refined mineral oil before dilution. (See Appendix F for technical data sheet details). The dilution ratio of Rocol Ultracut 370 was 40 parts water to 1 oil and Rocol Ultracut 390H was 30 parts water to 1 oil according to the manufacturers recommendations with a final concentration of 0.625% and 1.33% of mineral oil respectively.

Penetration of wound dressings by cutting fluids were tested at temperatures of 30°C and 40°C to simulate the temperatures likely to be encountered in normal working conditions. The tests were repeated three times.

3.7 Results

The results of the laboratory tests, each repeated three times, are presented with reference to

a) penetration by fluid, deduced from the colour change of the indicator paper (see page 64 Fig 6).

b) adhesion of tape fastener to the underlying dressing, by visual observation (Fig. 7).

Figure 7 shows the partial loss of adhesion of the Elastoplast\textsuperscript{TM} fabric adhesive plaster after removal from the fluid in the glass beaker on completion of a four-hour period of testing.
3.7.1 Penetration of water

The results from the testing for the penetration of water through the different dressings are shown in Table 8 and the degree of adhesion of the Elastoplast™ fabric adhesive plaster is shown in Table 9. These tables summarise the results of three replicate trials which in every case gave the same results.
TABLE 8: Penetration of water through inner (primary) dressing at temperatures of 30°C, 50°C, 60°C, 70°C over a 4 hour period.

<table>
<thead>
<tr>
<th>Combination of dressings</th>
<th>1. 2. Gauze</th>
<th>3. 4. Melolin™</th>
<th>5. 6. Opsite™</th>
<th>7. Airstrip™ Waterproof Adhesive Island Dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30°C</td>
<td>P</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>50°C</td>
<td>P</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>60°C</td>
<td>P</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>70°C</td>
<td>P</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

KEY:  
P: Penetration  
—: No penetration
TABLE 9 Degree of adhesion of outer (fastener) tape at water temperatures of 30°C, 50°C, 60°C, 70°C

<table>
<thead>
<tr>
<th>Water Temperature</th>
<th>Combination of tape (fastener)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. 2. 3. 4. 5. 6. Elastoplast™ Fabric Adhesive Plaster</td>
</tr>
<tr>
<td>30°C</td>
<td>A</td>
</tr>
<tr>
<td>50°C</td>
<td>a</td>
</tr>
<tr>
<td>60°C</td>
<td>a</td>
</tr>
<tr>
<td>70°C</td>
<td>a</td>
</tr>
</tbody>
</table>

KEY: A Complete adhesion  
a: Partial loss of adhesion

(See Appendix A: Glossary for definition of these terms)

The results from the water tests, of three replicate trials, are summarised as follows:

1. At temperatures of 30°C, 50°C, 60°C, 70°C, the inner (or primary) dressing of gauze was penetrated by water irrespective of the nature of the outer dressing attachment.

2. At temperatures of 30°C, 50°C, 60°C, and 70°C, the inner (or primary) dressings of Melolin™, Opsite™ and the Airstrip™ waterproof adhesive island dressing did not allow penetration of water.

3. At temperatures of 30°C the Elastoplast™ fabric adhesive plaster tape fastener showed complete adhesion.
4. At temperatures at 50°C, 60°C and 70°C, the Elastoplast™ fabric adhesive plaster tape fastener showed partial loss of adhesion.

3.7.2 Penetration of detergents

The results from the testing for the penetration of detergent solutions through the different wound dressings are shown in Table 10 and the degree of adhesion of the Elastoplast™ fabric adhesive plaster is shown in Table 11. These tables summarise the results of three replicate trials each of which gave the same results.

TABLE 10: Penetration of 1% detergent solution (MP9) through inner (primary) dressings at temperatures of 30°C, 40°C, 50°C over a 4-hour period

<table>
<thead>
<tr>
<th>Combination of dressings</th>
<th>1. 2. Gauze</th>
<th>3. 4. Melolin™</th>
<th>5. 6. Opsite™</th>
<th>7. Airstrip™ Waterproof Adhesive Island Dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(MP9) 1% Detergent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30°C P</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>40°C P</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>50°C P</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

KEY: P: Penetration
—: No penetration
TABLE 11: Degree of adhesion of outer (fastener) tape at 1% detergent solution (MP9) temperature of 30°C, 40°C, 50°C over a 4-hour period.

<table>
<thead>
<tr>
<th>Combination of tape (fastener)</th>
<th>1. 2. 3. 4. 5. 6. Elastoplast™ Fabric Adhesive Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>(MP9) 1% Detergent Solution Temperature</td>
<td>A: Complete adhesion</td>
</tr>
<tr>
<td>30°C</td>
<td>a</td>
</tr>
<tr>
<td>40°C</td>
<td>a</td>
</tr>
<tr>
<td>50°C</td>
<td>a</td>
</tr>
</tbody>
</table>

KEY: A: Complete adhesion  
a: Partial loss of adhesion

The results from the 1% detergent solution (MP9) tests of these replicate trials, are summarised as follows:

1. At temperatures of 30°C, 40°C, 50°C, the inner (or primary) dressings of gauze and the Airstrip™ waterproof adhesive island dressing were penetrated by detergent solution irrespective of the nature of the outer dressing. Airstrip™. waterproof adhesive island dressing is obviously sensitive to detergent and not water.

2. At temperatures of 30°C, 40°C, 50°C, the inner (or primary) dressings of Melolin™ and Opsite™ did not allow penetration of detergent solution.
3. At temperatures of 30°C, 40°C, 50°C, the outer tape fastenings of Elastoplast™ fabric adhesive plaster showed partial loss of adhesion but in water alone at 30°C showed complete adhesion. Therefore Elastoplast™ fabric adhesive plaster is obviously sensitive to detergent.

3.7.3 Penetration of industrial cutting fluids

The results from the testing for the penetration of cutting fluid (thin) through the different wound dressings are shown in Table 12 and the degree of adhesion of the Elastoplast™ fabric adhesive plaster are shown in Table 13. These tables summarise the results of three replicate trials each of which gave the same results.

**TABLE 12:** Penetration of cutting fluid (thin) Ultracut 370 (Rocol) through inner (primary) dressings at temperatures of 30°C, 40°C over a 4-hour period

<table>
<thead>
<tr>
<th>Combination of dressings</th>
<th>Ultracut 370 (Rocol) Cutting fluid (Thin) Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30°C</td>
</tr>
<tr>
<td>1. 2. Gauze</td>
<td>P</td>
</tr>
<tr>
<td>3. 4. Melolin™</td>
<td>P</td>
</tr>
<tr>
<td>5. 6. Opsite™</td>
<td>—</td>
</tr>
<tr>
<td>7. Airstrip™ Waterproof Adhesive Island Dressing</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>40°C</td>
</tr>
<tr>
<td>1. 2. Gauze</td>
<td>P</td>
</tr>
<tr>
<td>3. 4. Melolin™</td>
<td>P</td>
</tr>
<tr>
<td>5. 6. Opsite™</td>
<td>—</td>
</tr>
<tr>
<td>7. Airstrip™ Waterproof Adhesive Island Dressing</td>
<td>P</td>
</tr>
</tbody>
</table>

**KEY:**
- **P:** Penetration
- **—:** No penetration
TABLE 13: Degree of adhesion of outer (fastener) tape at cutting fluid (thin) Ultracut 370 (Rocol) at temperatures of 30°C, 40°C over a 4-hour period

<table>
<thead>
<tr>
<th>Combination of tape (fastener)</th>
<th>1. 2. 3. 4. 5. 6. Elastoplast™ Fabric Adhesive Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultracut 370 (Rocol) Cutting fluid (Thin) Temperature</td>
<td>30°C</td>
</tr>
<tr>
<td>30°C</td>
<td>a</td>
</tr>
<tr>
<td>40°C</td>
<td>a</td>
</tr>
</tbody>
</table>

**KEY:**
- **A:** Complete adhesion
- **a:** Partial loss of adhesion

The results from the cutting fluid (thin) tests, of three replicate trials are summarised as follows:

1. At temperatures of 30°C, 40°C, the inner (or primary) dressings of gauze, Melolin™ and the Airstrip™ waterproof adhesive island dressings were penetrated by the aqueous component of the cutting fluid (thin) irrespective of the nature of the outer dressing.

2. At temperatures of 30°C, 40°C, the inner (or primary) dressings of Opsite™ did not allow penetration by the aqueous component of the cutting fluid (thin).

3. At temperatures of 30°C, 40°C, the outer tape fastener of Elastoplast™ fabric adhesive plaster showed partial loss of adhesion.
The results from the testing for penetration of cutting fluid (thick) through the different wound dressings are shown in Table 14 and the degree of adhesion of the Elastoplast™ fabric adhesive plaster are shown in Table 15. These tables summarise the results of three replicate trials each which gave the same results.

**TABLE 14: Penetration of cutting oil (thick) Ultracut 390H (Rocol) through inner (primary) dressings at temperatures of 30°C, 40°C**

<table>
<thead>
<tr>
<th>Combination of dressings</th>
<th>1. 2. Gauze</th>
<th>3. 4. Melolin™</th>
<th>5. 6. Opsite™</th>
<th>7. Airstrip™ Waterproof Adhesive Island Dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultracut 390H (Rocol) Cutting fluid (Thick) Temperature</td>
<td>30°C P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>40°C P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

**KEY:**
- P: Penetration
- —: No penetration
TABLE 15: Degree of adhesion of outer (fastener) tape at cutting fluid (thick) Ultracut 390H (Rocol) at temperatures of 30°C, 40°C over a 4-hour period

<table>
<thead>
<tr>
<th>Combination of tape (fastener)</th>
<th>1. 2. 3. 4. 5. 6. Elastoplast™ Fabric Adhesive Plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultracut 390H (Rocol) Cutting Oil (Thick) Temperature</td>
<td></td>
</tr>
<tr>
<td>30°C</td>
<td>a</td>
</tr>
<tr>
<td>40°C</td>
<td>a</td>
</tr>
</tbody>
</table>

KEY: A: Complete adhesion
     a: Partial loss of adhesion

The results from the cutting fluid (thick) tests, of three replicate trials, are summarised as follows:

1. At temperatures of 30°C, 40°C, all the inner (or primary) dressings of Gauze Melolin™, Opsite™ and the Airstrip™ waterproof adhesive island dressings were penetrated by the aqueous component of the cutting fluid (thick) irrespective of the nature of the outer dressing.

2. At temperatures of 30°C, 40°C, the outer tape fastenings of Elastoplast™ fabric adhesive plaster showed partial loss of adhesion.
Table 16 summarises the experimental results from tables 8-15 based on the results from dressings tested for penetration and adhesion by water, detergent solution and cutting fluids.

**Gauze**: showed penetration by all three liquids and would therefore be unsuitable to protect a wound from further damage from fluids in a typical workplace environment.

**Melolin™**: showed no penetration by water and detergent solution but was penetrated by the aqueous component of the cutting fluid which would limit its suitability to protect a wound from further damage in certain situations.

**Airstrip™ waterproof adhesive island dressing**: showed no penetration by water but was penetrated by detergent solution and the aqueous component of the cutting fluids which would limit its suitability to protect a wound from further damage.

**Elastoplast™ fabric adhesive plaster (tape fastener)**: showed partial loss of adhesion to the dressing in all the tests except with water at 30°C and would therefore be unsuitable to secure a bandage (outer dressing attachment) in place in many situations.

**Opsite™**: although not identified as in use during the survey, was included in the laboratory tests as a potential alternative to gauze and Melolin™. This dressing was found to be the most suitable wound dressing for use to protect against penetration by water, detergent solution and thin cutting fluid but not against penetration by thick cutting fluid.
<table>
<thead>
<tr>
<th>Temperature</th>
<th>ELASTOPLAST™</th>
<th>FABRIC ADHESIVE PLASTER</th>
<th>AIR STRIP™</th>
<th>WATERPROOF ADHESIVE</th>
<th>ISLAND DRESSING</th>
<th>OPSITE™</th>
<th>MELolin™</th>
<th>GAUZE</th>
<th>DRESSINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40°C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HAZARDS**

**TABLE 15** Summary of the experimental results from tables 8 to 15
3.8 Discussion

The objectives of the experimental studies were:

a) To design a series of laboratory experiments to test three environmental hazards; water, detergent solution and cutting fluids.

b) To compare the penetration of these three liquids through wound dressings at different temperatures and their effects on adhesion of a dressing attachment.

c) To ascertain whether the dressings applied in the 2 A&E Departments (chapter 2) were suitable for patients returning to environmental hazards encountered on return to work.

3.8.1. Limitations of experimental study

An 'in vitro' laboratory model was established to compare penetration of liquids through various combinations of dressings (Table 6). This model comprised a series of glass test tubes providing a suitable surface on which to apply dressings. Glass test tubes were selected to provide the right shape as a standardised cylindrical surface to simulate the shape of a finger, the most frequently injured part of the body. Glass was considered to be suitable for the experiments as it has low chemical reactivity, adequate heat and solvent resistant properties with a standard polished surface. Glass test tubes 125 mm long x 16 mm diameter were used to simulate the size and shape of an average finger. The effect of adhesion of the outer tape to the dressing could also be observed.

The model was an artificial one in that skin unlike glass secretes sweat and oil, these being likely adversely to affect the adhesion of the tape to the finger.

Furthermore, a glass test tube has no mobility and does not bend as do human fingers. In the working environment manual activity and the exposure to abrasion can also be expected to reduce adhesiveness. Therefore in these two respects, the model provides
a less rigorous test of adhesiveness than the ‘in vivo’ situation and may underestimate it.

In the experiments fluids were agitated to maintain the temperature; it is possible that this circulation may have positively affected the penetration. However, similar forces may operate in the working environment, where hand or fluid is in motion.

No other ‘in vitro’ models were previously identified in the research literature except that described by Turner, et al. (1986) who used glass agar plates to evaluate dressing permeability. The use of cylindrical test tubes in the present investigation, rather than flat glass plates, enabled a wider range of dressings to be tested, and more accurately modelled the shape of a human finger.

The temperature range selected for the experimental testing of the liquids was from 30°C to 70°C as set out in Table 7, to simulate the conditions likely to be prevalent in a wide variety of working conditions. These temperatures were previously used by Turner, et al. (1986). The effect of temperature was not tested independently of the presence of water and it is possible that the loss of adhesion of the tape fastener was as much attributable to the softening of the rubber based adhesive at a temperature above ambient as to the effect of water.

The model used in this study investigated the penetration of single solutions but multiple solutions can be experienced in the workplace. The liquids tested, water, detergent solutions and cutting fluids containing mineral oil were selected as those most commonly reported by the respondents (Table 5, Chapter 2). Previous research by Turner, et al. (1986) investigated a similar range of hazards.

Water was selected for testing in the experiments as a universally used fluid found in every workplace at temperatures of 30°C, 50°C, 60°C and 70°C. The temperatures
were selected to identify to what extent penetration and adhesion were affected. An upper limit of 70°C was chosen as this temperature was thought to be the maximum encountered in normal working conditions and also allows direct comparison of results with Turner et al. (1986).

A 1% solution of detergent MP9 (Premiere Products, see data sheet Appendix F) was selected for investigation, which is commonly used throughout the University for cleaning purposes. MP9 is a concentrated multi-purpose cleaner and degreaser, containing a powerful organic solvent (propylene glycol ether solvent). A 1% v/v solution of MP9 in water at temperatures of 30°C, 40°C and 50°C was used in the experimental study.

Two cutting fluids (see Appendix F for details) containing mineral oil were selected which were discovered to be commonly used in the engineering maintenance workshops of the University as metal cutting lubricants. These cutting fluids were Ultracut 370 (Rocol), a water soluble semi-synthetic cutting and grinding fluid (thin) containing 25% mineral oil and Ultracut 390H (Rocol), a water soluble long-life cutting fluid (thick) containing 40% mineral oil before dilution with a final concentration of 0.625% and 1.33% respectively at temperatures of 30°C and 40°C.

The time span selected for testing the wound dressings for penetration of the liquids was 4 hours. 4 hours was chosen to cover the maximum period likely to be sustained by an average person returning to work before opportunity of renewing a dressing. However, during the 4 hour period, typical working conditions might only involve intermittent periods of contact with liquids and not continuous immersion for 4 hours. Although a temperature of 70°C was used in the experiments and would be too hot for any sustained period of immersion, it might be possible for employees to come into contact with this temperature for brief moments, for example, a hot water running tap. These temperatures allowed a direct comparison with Turner et al. (1986) study.
Detection of penetration — A pH indicator strip was used to detect penetration by water or aqueous solution of approximately neutral or alkaline pH which penetrated the dressing. The pH range of the indicator paper used was pH 5.2 - 6.8. The colour of the indicator strip changed from yellow to mauve on contact with water of approximately neutral or alkaline pH which penetrated the dressing. The detergent solution was alkaline pH. In the case of cutting fluids consisting of an emulsion of mineral oil and water, the indicator strip detected only the water content but not the penetration by oil. No separate indicating device was used for detecting the penetration of oil through the dressing and indicator strip. Indeed it is possible though the water penetrated the dressing, some or all of the oil component was absorbed and \textit{in vivo} may not reach the wound.

3.8.2. Results of experimental testing

The results from the testing of penetration and adhesion by water, detergent solutions and cutting fluids through dressings are analysed in terms of suitability to protect a wound from further damage in tables 8-15 and summarised in table 16.

\textbf{Gauze}: a dry dressing showed penetration by water, detergent solutions and cutting fluids containing mineral oil in all the experiments and it must be concluded that gauze is unsuitable to protect a wound from further damage in the workplace environment. Additionally, there are contra-indications for the use of gauze which may stick to the wound if exudate dries and on removal may tear the wound and cause bleeding.

\textbf{Melolin}™: a low-adherent pad made from an absorbent pad combined with a polythene backing, this showed no penetration by water or detergent solution but was penetrated by cutting fluids containing mineral oil and water. This dressing would therefore provide limited protection to a wound from further damage in the workplace
by water and detergent solution but should not be used with cutting fluids containing mineral oil.

**Airstrip™ waterproof adhesive island dressing** was not penetrated by water but was penetrated by detergent solutions and cutting fluids both thick and thin, which would limit its suitability to protect a wound from further damage in the typical workplace environment.

**Elastoplast™ fabric adhesive plaster**, (tape fastener) showed only complete adhesion to the underlying dressing with water at 30°C but against all the other experimental tests showed partial loss of adhesion (see table 16). It would therefore be unsuitable to secure a bandage (outer dressing attachment) in place for other than short periods of time.

**Opsite™**: although not identified as in use during the survey, this was included in the experimental tests as a potential alternative to gauze and Melolin™. Opsite™ which is a transparent semi-permeable film dressing showed no penetration by water, detergent solution and thin cutting fluid containing 25% mineral oil a low concentration diluted to the manufacturers recommendations (see Appendix F for details of the hazard data sheets). However, Opsite™ was therefore found to be a suitable dressing for use to protect against penetration by water, detergent solution and thin cutting fluid containing mineral oil, except for thick cutting fluid containing 40% mineral oil a higher concentration, which allowed penetration. It was the most versatile and effective of all the products tested although it was not found to be in use in the two A&E Departments surveyed.

A suggested hypothesis as to why thick cutting fluid allows penetration by the aqueous phase, whereas thin did not, may be that with thin cutting fluid, the low concentration of oil absorbed by the dressing created a barrier to water penetration.
But with thick cutting fluid, the higher concentration of oil may be too thick to penetrate and be absorbed by the dressing and therefore allows water to penetrate. Alternatively it may depend on a particular physiochemical characteristic of Opsite™ material which the manufacturers, Smith and Nephew Ltd., were unable to explain.

The overall findings summarised in table 16 have shown that none of the dressings applied in the two A&E Departments can be regarded as totally suitable for patients with hand and upper limb injuries returning to work where they are exposed to commonly occurring hazards. Other patients returning to work experienced a range of injuries, mainly lacerations and contusions to the feet and ankles and lacerations to the head and face, and the dressings applied cannot be regarded as totally suitable because these parts of the body may also occasionally be exposed to specified known hazards. This conclusion is discussed further, in more detail in Chapter 4.

3.9 Summary

1. The objectives of the laboratory experimental studies were to design a series of experiments based on environmental hazards reported in the survey (Table 5, Chapter 2) for penetration of fluids and the effects on adhesion of the tape fastener.

2. Three environmental hazards selected from the survey for testing were water, detergent solutions and cutting fluids (thick and thin) at temperatures ranging from 30°C to 70°C (Table 7).

3. The results were recorded with reference to the dressing combination code (Table 6) for penetration and the effects of adhesion by water, detergent solutions and thin and thick cutting fluids (Tables 8-15) and related to hazards as summarised in Table 16.
4. None of the dressings applied in the A&E Departments provided total protection against penetration by the hazards tested. However, another dressing, Opsite™, although it was not found to be in use, did give protection to a greater range of hazards.

5. Elastoplast™ fabric adhesive plaster (tape fastener) showed partial loss of adhesion in all the tests, only showing complete adhesion in water at 30°C.

6. The dangers of penetration by water are:
   a) the wound is too moist, hypotonic,
   b) reduces the air/oxygen permeability,
   c) allows strike through by bacteria,
   additionally cutting fluids containing mineral oil also delay and interfere with wound healing
IMPLICATIONS OF RESULTS

4.1 Summary of results

1. Chapter 2 has reported on:-
   a) 50 patients attending 2 A&E Departments
   b) Their injuries
   c) treatments and dressings provided
   d) whether they returned to work
   e) their occupations and the hazards they anticipated being exposed to.

   These findings are summarised in Tables 3, 4 and 5.

2. Chapter 3 describes a series of experiments to investigate, under controlled laboratory conditions:-
   a) the extent to which dressings may be penetrated by fluids likely to be exposed to in the workplace
   b) the adhesiveness of the tape fastener.

   These findings are summarised in Table 16.

3. Of 50 patients, 30 returned to work. Of these, 15 had injuries to the hand and upper limb which are the parts of the body most likely to be exposed to environmental hazards. For these patients, it is therefore possible to relate the dressings with which they were provided to the hazards they would be likely to encounter on their return to work, combining data from Tables 16 and 17, so as to assess the suitability of the dressings to provide protection from further damage and to provide suitable conditions for healing. This comparison is provided in Table 17.
### Table 17

The occupations of the 15 subjects with hand and upper limb injuries, who returned immediately to work following treatment.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Number</th>
<th>Occupation</th>
<th>Injuries</th>
<th>Hazards</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Suitability Evaluation**

- **Puritan** self-adhesive plaster sheeting (TM)
- **Estafoplast** tubular bandage (TM), self-adhesive
- **Tubigrip** (TM)
- **Tubestrip** (TM)
- **Tubetie** (TM)
- **Elastoplast** Fabric adhesive plaster
- **Elastoplast** (TM)
- **Conforming bandage** PEA
- **Creppe Bandage** (TM)

**Wound Management Product Provided**

- **Adhesive Dressing**
- **Wound Care Solution**
- **Oval Dressing**
- **Circular Dressing**
- **Tubular Bandage**
- **Conforming Bandage**
- **PEHA Crepe** (TM)
- **Tampon**
- **Finger dressing**

**Hazard**

- **H** = Hazard
- **He** = Hazard - Extreme Heat
- **Hc** = Hazard - Extreme Cold
- **D** = Dressing
- **X** = Unsuitable

(Appendix A Glossary for definition of suitable and unsuitable)
<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Operating Theatre</th>
<th>Porter</th>
<th>Machine/Furnace Operator</th>
<th>Policeman</th>
<th>Plumber</th>
<th>Electrician</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 17 - Continued**
Discussion of Table 17

Three patients did not report that they were exposed to any hazards at their place of work. Therefore the dressings applied may be considered to be suitable to provide protection to the wounds from further damage. In one case no dressing was provided. But, protection from non-industrial hazards, for example, hand washing in normal 'domestic' situations would not be provided, allowing exposure to water and detergent solutions.

Twelve patients were exposed to the hazards as summarised in Table 17, and in every case were provided with dressings which can be regarded as unsuitable in that they would not provide protection to their injuries from further damage caused by the specific hazards they experienced in the workplace. There is a need to provide either more resistant dressings or to supplement dressings with fingerstalls and/or gloves for impermeability.

Furthermore, because of the lack of availability of First Aid support, 4 of the patients, if they required re-dressing in the workplace would be restricted solely to the contents of a first aid box (see Appendix B). First aid dressings may be unsuitable to work in because they afford less protection than those provided by A&E or Occupational Health Nurses, other than to aid the healing of minor injuries.

Although this research has investigated three frequently encountered hazards, water immersion, detergent solutions and cutting fluids for the effects of penetration and adhesion at varying temperature over 4 hour continuous periods, it has not investigated the effects of moisture, intermittent water exposure at normal ambient
temperatures, organic solvents, dry heat, dry cold, abrasive materials and dust penetration, which are hazards also reported by the patients in this survey.

Although only one week was spent in each A&E Department, and only 50 patients in all participated in the survey which might be held to affect the generalizability of the conclusions, the patterns of injuries and dressings used were similar in the two hospitals.

4.2. General Discussion

Wound healing is dependent on a number of factors in different environments (Chapter 1). In a hospital and community environment it is dependent on the creation of the optimum micro-environment and the selection of a suitable dressing in relation to the type of wound requiring treatment.

At work the prime function of a wound dressing is to protect the wound from further damage and infection and this protection must be maintained for the full working period, for example, on 8-hour shifts. The selection of wound dressing and its suitability for the treatment of work-induced injuries in A&E Departments, should be based on the evidence from the results of the testing of dressings against the penetration and loss of adhesion by these hazards which injured employees come into contact with in their workplace. This survey has demonstrated some failures to achieve this objective.

There is no legislation which states that a nurse must be employed in industrial organisations, only legislation for the provision of first aiders who are restricted solely to the contents of a first aid box (see Appendix B). Therefore, there could usefully be a greater demand from nurses in the A&E Departments to recognise the
problems posed by patients returning to work, and to provide the appropriate
treatment for patients attending with work-induced injuries.

The suitability of wound dressings applied to patients with work-induced injuries
and the decisions made by nurses in A&E Departments, will depend on what
questions the nurse

asks at the time of treatment, regarding occupation, the hazards encountered in the
workplace to which the patient may be returning.

4.2.1. Implications for nurses
During the survey of injuries presenting in A&E Departments, it was observed that
there was a lack of information on the details of the accident recorded on the
admissions cards used by the hospitals. The first hospital recorded only the
patient's occupation but not specific hazards, and the second hospital only whether
the accident occurred at work or elsewhere. The researcher observed in the second
hospital during treatment that the nurses did not ask any questions; nor list any
hazards that the patients were likely to be exposed to in the workplace. Given the
lack of detail that is recorded regarding work-induced injuries, a supplementary
medical record form has been designed for use in A&E Departments (see Appendix
D). If added to existing admission cards to identify hazards encountered in the
workplace, this form would provide nurses in A&E Departments with additional
information to assist them in the selection of a suitable dressing and dressing
protection. Key points would be to record the patient's occupation, type of
industry and work-induced injury incurred, and if the patient on returning to work
will be working with any of the following: machinery, chemicals, extreme cold or
heat, radiation, and if they will come into contact with moisture, water through
immersion, detergent solutions, organic solvents, lubricant oils or abrasive materials.

Nurses in A&E Departments who treat patients with work-induced injuries need to consider the environmental hazards encountered in industry, to enable the selection of a suitable dressing which will afford protection in the workplace against penetration by any of these hazards. If a hazard exists the dressing must act to protect as far as is possible the wound. Standard dressings for example cannot protect against most forms of radiation. This information would enable nurses to provide advice about further patient care of the injury and redressing. Similar considerations should apply to Occupational Health Nurses although they ought to be more aware of the hazards and need for protection.

The responsibility to ensure that patients with work induced injuries receive appropriate treatment and advice is a shared one, by the nurse, the manufacturer of wound dressings and by the patient and employer. Nurses, however, are bound by the Code of Professional Conduct for Nurses, Midwives and Health Visitors, United Kingdom Central Council (UKCC, 1992) which states that:

"All registered nurses, midwives or health visitors, are personally accountable for practice and, the exercise of professional accountability must: ensure that no action or omission on their part, or within their sphere of responsibility is detrimental to the interests, condition or safety of patients and clients".

In the matters relating to the use of wound dressings, nurses are accountable for their decisions and for the manner in which they execute them, and must justify the decisions they reach. Nurses could be said to be acting negatively if they do not ask the right questions. For example, is the wound dressing suitable for the
treatment of identifiable work-induced injuries? Will the dressing applied protect the wound from environmental hazards encountered in the workplace or will deleterious fluids penetrate through the dressing on to the wound surface? Reasonable practice carried out by nurses should be informed and supported, by taking into account research results and asking these questions regarding the use of wound dressings for the treatment of workplace injuries. Acceptable practice according to Tingle (1992), is whether nurses' decisions would be supported as reasonable by a responsible body of nurses in the relevant speciality.

Nurse education needs to cover the broader aspects of nursing and take a more comprehensive approach, to promote the physical, mental and social well-being of patients [Joint Committee of the International Labour Organisation (ILO) and World Health Organisation (WHO) 1990]. The objective should be to consider the lifestyle of the patient as well as the specific injury being treated. Nurses working in A&E Departments, Community, General Practitioner Practice Nurses and Occupational Health Nurses have overlapping concerns in all areas of health and should adopt similar policies. To provide a wider approach to the health problems of patients as a functioning whole, education should include the treatment of work-induced injuries in industry whether undertaken by nurses in A&E Departments or by nurses in the Community, Practice Nurses in General Practitioner surgeries and Occupational Health Nurses.

Many Occupational Health Nurses work in isolation which poses problems of how effectively to disseminate information, which requires a good communication network. This could be achieved partly, for those nurses able to attend, by the organisation of joint conferences, study days, lectures and visits to industry and the companies manufacturing wound dressings. This practice takes place in Holland,
and can help to improve communications between manufacturers, suppliers and nurses - the main users of wound dressings (Caudwell, 1981).

4.2.2. Summary

1. Nurses need to question the patients about the hazards they encounter in the workplace.

2. Nurses need to use a medical record form in A&E Departments designed to record types of work-induced injuries such as lacerations and contusions to the hands and fingers and infection and to note environmental hazards encountered in the workplace, for example, water, detergent solutions and cutting fluids (see Appendix D) for specimen form.

3. Where the patient is to return to work, nurses need to be able to select a dressing which is appropriate for use in the workplace, including the possible hazards, for example a transparent semi-permeable film dressing with further impermeable covering, example fingerstall, if needed.

4. Nurses need to know what is a suitable dressing as a result of further education and training, based on relevant research findings.

5. Nurses need to be able to advise the patient on good practice on return to work.

4.2.3. Implications for employers/employees

Another point to be taken into account is the education of employees by their employers. Each employee must be informed about the environmental hazards
he/she is liable to be exposed to at their place of work by their employer, (Control of Substances Hazardous to Health, COSHH Regulations, 1988). It is the duty of the employer to ensure compliance and an obligation on the employees to comply with the regulations. Under the COSHH Regulations (1988) it is the employers' duty to assess the risks which must be controlled, and information and training provided for the employees.

The number of work hours lost by employees requiring treatment for injuries sustained at work in A&E Departments is very costly to industry and the nation. The survey of two A&E Departments (chapter 2) showed that 62% (n = 31) of injured employees referred themselves to A&E Departments and only 14% (n = 7) were treated by first aiders prior to attending A&E Departments. In a previous survey, Caudwell (1990) reported similarly that 59% of injured employees treated and referred themselves to A&E Departments and only 2% were treated by first aiders. However, these samples exclude those who were treated by first aiders at work, and for whom a visit to an A&E Department was unnecessary. These findings may imply some costly, time consuming and unnecessary visits to A&E Departments. There is a need for revision of the statutory contents of First Aid boxes. The implementation of research results however, would need to be extended into the community services because of the changes to community care brought about by the White Paper "Health of the Nation", (1992). This document focuses on value-for-money and places the emphasis of Care in Community Care - General Practitioner Services and Practice Nurses away from hospital-based services.
4.2.4. Summary

1. There is a need for emphasis on the education of employees by employers to ensure compliance with the Control of Substances Hazardous to Health, COSHH Regulations (1988).

2. Employers should be encouraged to avoid unnecessary costly and time consuming visits of injured employees to A&E Departments, by the adequate provision of First Aid support.

4.2.5. Implications for manufacturers

Manufacturers have responsibilities during the design of new products, to confirm both the safety and efficacy of their products, to monitor and control the quality of products and to identify the 'shelf-life' of the product and the stated optimum storage conditions (Turner, et al., 1986). In order to provide appropriate information on these dressings for use in A&E Departments for the treatment of work-induced injuries, manufacturers should be able to provide the written evidence for the users from the results of the testing of the products they produce. Manufacturers must be accountable for product liability in specified circumstances. Some manufacturers are showing an awareness and have started to conduct such tests, for example DuoDERM Bordered\(^R\) (Convatec Ltd). This dressing is a hydrocolloid, occlusive dressing, reported on by Hermans and Wingerden (1990) for the treatment of patients with industrial wounds, predominantly partial thickness burns to hand and upper limbs. They report that the outer layer of the dressing is impermeable and forms a barrier against contact with the environment, contamination with dirt or microorganisms and water. The authors reported that patients with minor injuries who were treated with DuoDERM bordered were able to return to their work place after treatment.
As far as it has been able to ascertain, only one report in recent scientific literature relating to clinical testing of wound dressings on human subjects has been undertaken in an industrial environment.

4.2.6. Summary

1. Manufacturers of wound dressings must be accountable for product liability in specified circumstances.

4.2.7. Implications for Managers

The decisions made on the selection of wound dressings for use in A&E Departments are based on general wound policy for each hospital, formulated by committees with variable representation including A&E consultants, nurses, pharmacists and representatives from wound dressing manufacturing companies. It is not known whether protection from environmental hazards is taken into account when formulating these policies. But the responsibility for making these decisions for selection of suitable dressings for treatment of patients with work-induced injuries must be shared between the medical consultant, the nurse, the manufacturer of wound dressings and the patient.

The management of wounds can be costly (Flanagan, 1992). The introduction of a wound care nurse advisor, similar to infection control nurses, who can assist nurses throughout the health authority or trust, could be extended into industry to identify environmental hazards and extend knowledge into the area of patients with work-induced injuries. Patients with work-induced injuries receiving treatment in A&E Departments will
benefit from the selection of suitable wound dressings by better informed staff who could develop a broader approach to wound management by the knowledge extended by a wound care nurse advisor. A link could be established between A&E Department nurses, infection control nurses, occupational health nurses and practice nurses in G.P. practices, facilitated by a wound care nurse advisor resulting in improved patient care and cost-effective wound management for the benefit of the patients.

4.2.8. **Summary**

1. When formulating general wound policy, protection from environmental hazards must be taken into account.

2. Wound care nurse advisors should be appointed to act as facilitators between A&E Department nurses, Infection Control nurses, Occupational Health nurses and Practice nurses in G.P. practices.

4.2.9. **Liaison between suppliers, pharmacists and hospital managers.**

Evaluation and auditing of A&E Departments and continued updating of the equipment and wound dressing products used, would be likely to make the NHS a more cost-effective service. However, the National Audit Office (1991) reported chaotic buying across a whole range of hospital supplies which showed large price differences in items bought by the NHS, for example, bandages showed differences of 33%. The auditors found that managers had so little information that they were unable to identify suppliers. The National Audit Office reported that the absence of readily available information about purchases from individual major suppliers weakens the negotiating position of the NHS both in regions and
nationally. If all wound dressings conformed with British Pharmacopoeia standards (1980 and 1988), this would achieve a common position for all manufacturers of wound dressings by producing products conforming to a minimum standard. There is however a need for the standards to be extended into the protection against environmental hazards in the workplace.

4.2.10. Summary

1. Improved liaison and communication between suppliers, pharmacists and hospital managers.

2. The British Pharmacopoeia (1980 and 1988) standards need to be more precisely specified and extended for protection against environmental hazards.

4.2.11. Shared obligations — nurses and employers

The prevention of further damage to an injury is 'better' than the cure. The prevention from injury in the first instance is ideal, but protection after the injury from further damage is essential to the patient. Industrial gloves or finger stalls can be worn in most situations with the exception of working with moving machinery (Hamilton, 1988). Gloves cannot prevent an accident, but when an accident happens they can often prevent an injury. Gloves of a suitable type could also protect the dressing applied to injuries encountered at work to the hands and fingers from the penetration of environmental hazards if they were readily available and worn. But during the survey (chapter 2) where treatment given by nurses was observed in the A&E Department by the researcher, no provision of protective gloves or finger stalls was made nor any advice given to the patients returning to work with hand and finger injuries. This is a failure in nursing, and employer
responsibility, both sides being irresponsible and negligent. When an injured employee receives treatment in the A&E Department it is the nurse's responsibility to provide advice and protective gloves or fingerstalls where appropriate, but in the treatments observed, this did not happen. Once the employee returns to work after receiving treatment in A&E Departments it is the employers responsibility to provide protective gloves or fingerstalls for protection against damage to an injury. Legislation (The Health and Safety at Work etc. Act, 1974 and The Control of Substances Hazardous to Health, COSHH Regulations, 1988) require the use of gloves in particular industries and processes therefore the employer must be legally responsible. Employers should not allow injured employees to return to work unless protection from workplace hazards is provided. Before selecting the appropriate glove or fingerstall there is a need for the testing of fingerstalls and gloves and to assess operating procedures, factory conditions, the severity and combination of hazards. The British Standards Institute (BSI) provides standards, classified current hand protection in 15 types of gloves and recommends the appropriate wear in 14 hazard groups of work (BSI 1651: 1986). Therefore, in relation to injury, gloves would also provide protection against damage to an injury if the employee returns to work.

4.2.12. Summary

1. The provision of gloves or fingerstalls by nurses in A&E Departments for employees returning to work in hazardous circumstances after receiving treatment for hand and finger injuries.

2. The availability of gloves and fingerstalls in the workplace made by the employer to protect employees with hand and finger injuries from further damage on return to work.
4.2.13. *Future Research*

In order to assist in the future research and development of suitable wound dressings for use in A&E Departments, Occupational Health Services and First Aid, it would be useful to widen the present survey which represents a pilot and set-up a nation-wide survey to:

a) identify the nature and site of work-induced injuries commonly treated in a larger sample of A&E Departments,

b) identify the wound dressings generally in use in A&E Departments,

c) identify the environmental hazards encountered in the workplace, and

d) to record and compare the differences in prevalence of injuries and practice/policies in A&E Departments.

Subject to these future findings (from a nation-wide survey) ideally, *in vivo* clinical trials of wound dressings to assess the products in use for their suitability for treatment of work-induced injuries could be commenced in A&E Departments and followed through in conjunction with Occupational Health Nurses in industry. However, *in vivo* models might not be possible because it could be thought unethical, but no more so than any other clinical trial. Therefore, *in vitro* laboratory models need to be developed and improved on. More work might to be done in exploring the possibility of developing *in vitro* pigskin models which are more like human skin, as an alternative to *in vivo* animal experiments which may be considered unethical to test the penetration of wound dressings by environmental hazards. The results of these experiments would be important to nursing staff by influencing the policy and purchasing of suitable dressings to protect wounds from
environmental hazards in the workplace. Manufacturers of wound dressing must be accountable for product liability. The results of the testing could be reported to the manufacturers to be taken into account for new developments in manufacturing suitable dressings. This would provide better protection to the wounds sustained by injured employees in the workplace. A list of suitable wound dressings could be compiled for use in A&E Departments for the treatment of work-induced injuries, based on results from tests carried out by manufacturers.

The specification of hazards to which dressings give protection would alert nurses to the need to question patients about workplace hazards. Another neglected but important subject is the provision of a suitable dressing to cover injuries to the hands and fingers of those employees handling food. Food handlers employed in food manufacturing industries, restaurants and in workplace canteens require a protective dressing which will protect the product and the worker, (for example, if plasters fall off into the product such as frozen peas or meat products). These dressings should be sufficiently adhesive to the skin and be impermeable to liquids and abrasives for example, sugar and flour. The Food Hygiene (General) Regulations 1970 (S.l. 1970 No. 1172) state that "Any accidental cut or scald should be immediately covered with a protective waterproof plaster". A further problem area, is the detection of a dressing if lost in a food product. Turner, et al. (1986) showed that Airstrip™ Detectable Dressings, Airstrip™ Detectable Strapping (Smith and Nephew Ltd), Eyetec™ Detecable Dressings (Robinson and Sons Ltd) and Safaplast™ Waterproof Blue Detectable Dressings (SAFA Ltd) were not detected when placed in and under meat products packaged in aluminium containers. At present, dressings for food handlers have an aluminium strip beneath the dressing pad to assist in electromagnetic detection and are blue in colour to assist in visual detection in all situations. But, currently there is no standard test
for the detection of contaminants in food, which would provide a common position for all manufacturers of wound dressings to build on. Therefore there is a need to pursue this area of research.

4.2.14. Summary

1. A need for more information and research and changes to new dressings.

2. Devise new and suitable dressings for use in A&E Departments, workplace and in the home.

3. Use an established test procedure, a need for such dressings also to meet standards for fluid penetration and strike through.

4. Rewrite nursing practice, in-service training and a code of practice to include Casualty Officers in A&E departments.

5. Compilation of a list of suitable dressings, categorised for use in A&E Departments, for the treatment of employees with work-induced injuries, based on results from tests carried out by researchers and manufacturers, which will protect a wound from penetration through a dressing by specific environmental hazards encountered by an employee in the workplace.

4.3 Summary

The overall results of this study were:-

1. Within two A&E Departments, half of the work-induced injuries were predominantly lacerations and contusions to the hands and fingers. 50% of
the patients with such injuries, after receiving treatment, returned immediately to their workplace.

2. Dressings most commonly used in both A&E Departments were dry gauze, Tube gauze tubinette™ and Elastoplast™ fabric adhesive plaster.

3. Environmental hazards in the workplace were identified as extreme cold, extreme heat, moisture, detergent solutions, organic solvents, lubricant oils, abrasive materials and radiation. Employees often encountered multiple hazards.

4. A series of laboratory experiments were designed to test wound dressings for penetration and the effects of adhesion of water, detergent solutions and thin and thick cutting fluids. The results are set out in Tables 8-15 Chapter 3 (summarised in Table 16).

5. Dry gauze which was commonly used showed penetration in all the tests and would be unsuitable for use in the workplace. In comparison Opsite™, a transparent semi-permeable film dressing which was not used, showed no penetration in all the experimental tests, with the exception of penetration following exposure to thick cutting fluid.

6. Elastoplast™ fabric adhesive plaster (tape fastener) was tested for the effects on adhesion and showed partial loss of adhesion in all the tests except in water at 30°C.
7. None of the patients with hand and upper limb injuries who returned to a workplace in which specific hazards were present were provided with a dressing which can be regarded as being totally suitable for preventing further damage from penetration by those hazards (Table 17, Chapter 4).

8. Recommendations have been made for further research and for changes in nursing education and practice.
APPENDICES
APPENDIX A

Glossary
APPENDIX A

GLOSSARY

Injuries
A disruption of the integrity or function of a tissue or organ by extended means, which are usually mechanical but can also be chemical, electrical, thermal or radiant. A mechanical injury produced by the impact of a blunt instrument that tears, shears or crushes tissue in contrast to an incision injury. The three basic forms are lacerations, contusions and abrasions. (Churchill's Medical Dictionary, 1989).

Occupational injuries
An occupational injury is any condition, major or minor, such as a cut, fracture, sprain or amputation which results from a work accident or exposure involving a single incident in the work environment. (Brown, 1981).

Non-reportable injuries are recordable in the Accident Book (The B1 510 Social Security Act Book, 1975) by the employer or employee.

Severe Injury
Disabling injury (often called a lost-time injury) – A work injury that results in death, permanent disability, or inability of the injured worker to return to work on the day following the injury.

Major injury – An injury where there is loss of time to the injured person at medical expense.

Under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 1985 (RIDDOR), severe injuries are all injuries resulting from accidents at work
which cause incapacity for more than three days and which must be reported direct to the enforcing authority.

a) The death of any person as a result of an accident arising out of or in connection with work:

b) any person suffering any of the following injuries or conditions as a result of an accident arising out of or in connection with work:

- fracture of the skull, spine or pelvis;
- fracture of any bone;
  in the arm or wrist, but not a bone in the hand; or in the leg or ankle, but not a bone in the foot.
- amputation of;
  a hand or foot; or a finger; thumb or toe, or any part thereof if the joint or bone is completely severed.
- the loss of sight of an eye, a penetrating injury to an eye, or a chemical or hot metal burn to any eye.
- either injury (including burns) requiring immediate medical treatment, or loss of consciousness, resulting in either case from an electric shock from any electrical circuit or equipment, whether or not due to direct contact.
- any other injury which results in the person injured being admitted immediately into hospital for more than 24 hours.

A person at work (ie. an employee, a self-employed person, or a person receiving training for employment) is incapacitated for his or her normal work for more than three days as a result of any injury (an 'over-three day' injury) caused by an accident at work.
The death of an employee if this occurs sometime after reportable injury which led to that employee’s death, but not more than one year afterwards.

**Minor Injuries**

Injuries which would otherwise receive no treatment or which do not need treatment by a medical practitioner or nurse. Minor injuries are the sort casualties would attend themselves, if at home may wash their hands and apply a small sterilised dressing if necessary. (Health and Safety Commission, 1990).

**Treatment**

"The objects of treatment in a case of industrial injury should be to secure the repair of the damaged part as quickly and completely as possible, and to do what may be necessary to replace the workman in remunerative employment at his former job, if possible, or in some other occupation; for which he may need training and assistance in placement." (Hunter, 1969).

**Description of adhesive island wound dressing**

"An adhesive wound dressing shall consist of a pad fixed to a piece of plaster, waterproof or otherwise, as centrally as possible so as to leave an adequate margin of adhesive surface all round. The pad and margin of adhesive surface shall be protected by muslin or other suitable material for removal before use. The pad shall be of absorbent lint or other suitable material which, in either case, shall be unmedicated or contain medication specified for surgical dressings in the British Pharmaceutical Codex and any supplement thereto. Each dressing shall be put in an individually sealed pack marked clearly to indicate its contents." The materials are required to conform to the following descriptions set out in the B.P.C. (1973).
Description of 'standard' adhesive dressing

"The dressing is one of two types: wound dressing is circular, square or rectangular. The pad is substantially the same shape as the dressing and is fixed as centrally as possible to a piece of plaster, which complies with the standard for Extension Plaster; except that it may be perforated or ventilated, so as to leave a margin of adhesive surface surrounding the pad. (Extension plaster consists of elastic cloth which stretches in the direction of the weft, spread evenly with a self-adhesive plaster mass containing zinc oxide). The width of the adhesive margin is not less than 5mm or not less than 15% of the overall dimensions of the dressings; whichever is the greater, and the width of the margin on the opposite side.

Rectangular dressings may have an adhesive margin of not less than 1.5mm on each of one pair of opposite sides provided that the adhesive margin on each of the other two sides is at least 25% of the overall dimension of the dressing in that direction. If, for convenience in use of the dressing, the corners of the plaster are cut to a radius, this is ignored in defining the shape and dimension of the dressing. The pad and the margin of the adhesive surface are covered by a suitable protector. The pad does not become detached from the plaster when the protector is removed." British Pharmaceutical Codex Standards, 1973 (B.P.C.).

Description of 'standard' first-aid dressing

Standard Dressing No. 14.
SYNONYM: Medium Plain Wound Dressing

Standard Dressing No 14 consists of an unmedicated pad, of absorbent cotton wool enclosed in absorbent gauze, attached to an open-wove bandage; the dressing is sterile.

Standard:
Standard Dressing No 14 is prepared from:
Absorbent cotton wool approximately 12g
Absorbent gauze 25cm by 15cm

or

Tubular absorbent gauze 23cm in circumference by 15cm

Open-wove bandage 7.5cm by 2.5cm

Description:
A pad measuring 15cm by 10cm, attached lengthwise, by continuous stitching across its narrow ends, to the outer surface of the rolled open-wove bandage, which complies with the standard for Open-wove Bandage, page 614, approximately 30cm from one end. The pad consists of the absorbent cotton wool, which complies with the standard for Absorbent Cotton Wool, page 618, enclosed in a piece of absorbent gauze, woven tubular or single width, which complies with the standard for Absorbent Cotton Gauze (13 Light), page 626, with the exception that the weft has an average of not less than 45 threads per 10cm and the weight per unit area has an average of 13g per M².

Sterility:
It complies with the test for sterility described in Appendix 28, page 917.

Sterilisation:
It is sterilised by one of the methods described for surgical dressings in Appendix 29 (page 926) or by any other suitable process.

Packaging:
It is packed as described under Standard Dressing No. 13.

Labelling:
It is labelled in the general monograph (page 611).

Uses:
Standard dressing No 14 is used as a sterile, absorbent and protective dressing for wounds of medium area. British Pharmaceutical Codex (BPC) 1973.

Definition of:
Complete adhesion:
Adherent over total surface area applied. No liftage at the edges of the adhesive plaster.

**Partial loss of adhesion:**
Adhesion over less than total surface area of application – some areas of liftage at the edges of the adhesive plaster.

**Non-adhesion:**
Total loss of adhesion over surface area of application.

**Suitable:**
No penetration by water, detergent solution and oil through wound dressings.

**Unsuitable:**
Penetration by water, detergent solution and oil through wound dressings.

**Cleansing agent:**
A broad definition used to describe a variety of solutions sterile or unsterile for cleaning wounds. Some cleansing agents can be antiseptic and used for dual purpose.

**Antiseptic:**
An antiseptic is a chemical germicide formulated for use on skin or tissue and should not be used to decontaminate inanimate objects. (Rutala, 1990).

**Disinfectant:**
A disinfectant is a germicide that inactivates virtually all recognised pathogenic microorganisms but not necessarily all microbial forms (e.g. bacterial endospores) on inanimate objects. (Rutala, 1990). Disinfectants are toxic to the skin. (Not used on skin due to toxic properties).

**First aid:**
An initial assistance or treatment given to a casualty for any injury or sudden illness before the arrival of an ambulance, doctor or other qualified person or prior to attending an A&E Department.

**Care:**
In the workplace refers to first aid rendered.
APPENDIX B

First-Aid Boxes and Kits
APPENDIX B


First-aid boxes and kits

First-aid boxes and travelling first-aid kits should contain a sufficient quantity of suitable first-aid materials and nothing else.

Contents of the boxes and kits should be replenished as soon as possible after use in order to ensure that there is always an adequate supply of all materials. It is therefore, essential that first-aid equipment be checked frequently, to make sure there are sufficient quantities and all items are usable.

First-aid boxes should be made of suitable material designed to protect the contents from damp and dust and should be clearly identified as first-aid containers: the marking used should be a white cross on a green background in accordance with the Safety Signs Regulations, 1980.

First-aid boxes which are to form part of an establishment's permanent first-aid provision should contain only those items which a first aider has been trained to use.

Sufficient quantities of each item should always be available in every first-aid box or container. In most cases these will be:

a) one guidance card;

b) twenty individually wrapped sterile adhesive dressings (assorted sizes) appropriate to the work environment (which may be detectable for the catering industry);

c) two sterile eye pads, with attachment;

d) six individually wrapped triangular bandages;
e) six safety pins;
f) six medium sized individually wrapped sterile unmedicated wound dressings (approx 10cm x 8cm);
g) two large sterile individually wrapped unmedicated wound dressings (approx 13cm x 9cm) and
h) three extra large sterile individually wrapped unmedicated wound dressings (approx 28cm x 17.5cm).

Sterile first-aid dressings should be packaged in such a way as to allow the user to apply the dressing to a wound without touching that part which is to come into direct contact with the wound.

That part of the dressing which comes into contact with a wound should be absorbent. There should be a bandage or other fixture attached to the dressings and consequently there is no reason to keep scissors in the first-aid box. Dressings, including adhesive ones, should be of a design and type which is appropriate for their use.

**Travelling first-aid kits**

The contents of travelling first-aid kits should be appropriate for the circumstances in which they are to be used. At least the following should be included:

a) card giving the general first-aid guidance;
b) six individually wrapped sterile adhesive dressings;
c) one large sterile unmedicated dressing
d) two triangular bandages;
e) two safety pins and
f) individually wrapped moist cleansing wipes.
APPENDIX C

Industrial Accidents Survey Interview Checklist

Consent Form
## APPENDIX C

### INDUSTRIAL ACCIDENTS SURVEY

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Study subject number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Hospital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Date of data collection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GENERAL PATIENT INFORMATION

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Sex</td>
<td>Male 1</td>
</tr>
<tr>
<td>5.</td>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Occupation</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Employer</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Type of industry</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>With which of the following do you work?</td>
<td>Machinery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extreme cold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radiation</td>
</tr>
<tr>
<td>10.</td>
<td>Do you come into contact with any of the following?</td>
<td>Moisture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organic solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abrasives</td>
</tr>
</tbody>
</table>
## ACCIDENT DETAILS

11. Date of accident
12. Time of accident
13. Diagnosis given in workplace

<table>
<thead>
<tr>
<th>Person giving workplace:</th>
<th>Diagnosis</th>
<th>Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Self</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. First aider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Occupational H D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Nurse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Doctor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Ambulance service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Not known</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## ADMISSION DETAILS

15. Date of admission
16. Time of admission
17. A & E diagnosis

## DETAILS OF INJURY

18. Site
19. Cause

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Laceration</th>
<th>Burn</th>
<th>Contusion</th>
<th>Other</th>
<th>Not known</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Type of injury</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity</th>
<th>Severe</th>
<th>Minor</th>
<th>Trivial</th>
<th>Not known</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Severity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skin broken</th>
<th>Yes</th>
<th>No</th>
<th>Not known</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. Skin broken</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount of tissue loss</th>
<th>Surface area</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Amount of tissue loss</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Treatment Details

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24. Predressing treatment</td>
<td></td>
</tr>
<tr>
<td>25. Topical application</td>
<td></td>
</tr>
<tr>
<td>26. Dressing</td>
<td></td>
</tr>
</tbody>
</table>

## Discharge Information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>27. Outcome</td>
<td></td>
</tr>
<tr>
<td>Discharged</td>
<td>1</td>
</tr>
<tr>
<td>Returned to work</td>
<td>2</td>
</tr>
<tr>
<td>Referred to GP</td>
<td>3</td>
</tr>
<tr>
<td>Referred to occupational H D</td>
<td>4</td>
</tr>
<tr>
<td>Referred to other department</td>
<td>5</td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
</tr>
<tr>
<td>Not known</td>
<td>9</td>
</tr>
</tbody>
</table>

28. **IF RETURNING TO WORK** will you be working with any of the following?

- Machinery
- Chemicals
- Extreme cold
- Extreme heat
- Radiation
- None of above

29. **IF RETURNING TO WORK** will you come into contact with any of the following?

- Moisture
- Detergent solutions
- Organic solutions
- Lubricant oils
- Abrasives
- None of above
CONSENT FORM

A survey of wound dressings used to cover industrial injuries treated in Accident and Emergency Departments:

Miss Caudwell has explained to me the nature and purpose of the research and I am happy to participate. I understand that the information provided will be kept confidential.

Signed ..................................................

Dated ..................................................

120
APPENDIX D

Medical record form for use in A&E Departments for recording industrial injuries
APPENDIX D

Medical record form which could be used in A&E Departments for recording industrial accidents.

<table>
<thead>
<tr>
<th>1. Date of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Patient name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Sex</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. DoB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. Type of industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7. Details of injury site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. Type of injury</th>
<th>Laceration</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burn</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Contusion</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9. Indication of severity of injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
</tr>
<tr>
<td>Minor</td>
</tr>
<tr>
<td>Trivial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. When does patient expect to return to work?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately</td>
</tr>
<tr>
<td>-------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11. ON RETURNING TO WORK will you be working with any of the following?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery</td>
</tr>
<tr>
<td>Chemicals</td>
</tr>
<tr>
<td>Extreme cold</td>
</tr>
<tr>
<td>Extreme heat</td>
</tr>
<tr>
<td>Radiation</td>
</tr>
<tr>
<td>None of above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. ON RETURNING TO WORK will you come into contact with any of the following?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
</tr>
<tr>
<td>Detergent solutions</td>
</tr>
<tr>
<td>Organic solvents</td>
</tr>
<tr>
<td>Lubricant oils</td>
</tr>
<tr>
<td>Abrasives</td>
</tr>
<tr>
<td>None of above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. Selection of a suitable dressing to afford protection in the workplace against penetration from any of the above environmental hazards encountered based on the results from tested wound dressings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which dressing applied?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14. Person completing report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
</tr>
<tr>
<td>----------------</td>
</tr>
</tbody>
</table>
APPENDIX E

List of subjects' occupations
### Appendix E

**List of subjects, occupations in Site A and B with work-induced injuries attending for treatment in A&E Departments**

<table>
<thead>
<tr>
<th>Site A Occupations</th>
<th>Site B Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor driver/farm worker</td>
<td>Haulage contractor</td>
</tr>
<tr>
<td>Carpenter</td>
<td>Secretary (F)</td>
</tr>
<tr>
<td>Motor mechanic</td>
<td>Plasterer</td>
</tr>
<tr>
<td>Machine operator/printer</td>
<td>Labourer</td>
</tr>
<tr>
<td>Fireman</td>
<td>Warehouse manager</td>
</tr>
<tr>
<td>Garage door fitter</td>
<td>Parts person</td>
</tr>
<tr>
<td>Woodwork machine operator (F)</td>
<td>Plumber</td>
</tr>
<tr>
<td>Welder</td>
<td>Scientist</td>
</tr>
<tr>
<td>Self-employed builder</td>
<td>Policeman</td>
</tr>
<tr>
<td>Drainage operative</td>
<td>Mechanic (F)</td>
</tr>
<tr>
<td>Mill attendant</td>
<td>Motor mechanic</td>
</tr>
<tr>
<td>Labourer</td>
<td>Painter</td>
</tr>
<tr>
<td>Mechanic</td>
<td>Glazier</td>
</tr>
<tr>
<td>Coil winder</td>
<td>Carpenter/joiner</td>
</tr>
<tr>
<td>Driver</td>
<td>Window fixer</td>
</tr>
<tr>
<td>Scaffoldler</td>
<td>Carpenter/apprentice</td>
</tr>
<tr>
<td>Mechanic</td>
<td>Machine operator/furnace operator</td>
</tr>
<tr>
<td>Trainee gardener</td>
<td>Pizza delivery man</td>
</tr>
<tr>
<td>Labourer</td>
<td>Plumber</td>
</tr>
<tr>
<td>Dry lining operative</td>
<td>Theatre porter</td>
</tr>
<tr>
<td>Delivery driver</td>
<td>Assistant manager-jewellers (F)</td>
</tr>
<tr>
<td>Driller</td>
<td>Installation engineer</td>
</tr>
<tr>
<td>Computer services manager</td>
<td>Dustman</td>
</tr>
<tr>
<td>Electrician</td>
<td>Assistant technician</td>
</tr>
<tr>
<td>Labourer</td>
<td>Mechanic</td>
</tr>
</tbody>
</table>

(F) = female
APPENDIX F

Hazard Data Sheets
# HEALTH AND SAFETY DATA SHEET

**Product Name and Trademark**

| M.P.9 (00002) |

**Use**

- Multi-purpose cleaner and degreaser

**General Chemical Composition**

- Propylene Glycol Ether Solvent
- Anionic Surfactant
- Non-Ionic Surfactant
- Alkali Builder
- Water

**EEC Composition Requirement 89/642/EEC**

- Less than 5% Anionic Surfactants
- Less than 5% Non-Ionic Surfactants
- 5% but less than 15% Aliphatic Hydrocarbons

**Physical Properties**

- **Physical Nature:** Royal blue mobile clear liquid
- **pH of Concentrate under typical analysis:** 11.5 - 12.0
- **Solubility:** Miscible with water

**Hazards**

- Keep out of reach of children
- * Irritant to skin and eyes
  * In case of contact with eyes rinse immediately with plenty of water and seek medical attention
  Under the CPL Regulations 1984, M.P.9 carries the 'Irritant' Saint Andrews cross symbol

**Recommended Precautions for Handling and Storage**

- Avoid skin and eye contact. Rubber gloves give best protection. Storage should be at ambient temperature though not essential. Extremes of temperature should be avoided

**Recommended Procedures In the Event of Emergency**

- Dispense small quantities with water, alternatively contain with absorbent material and dispose of in an authorised manner

**Fire Spillage Toxicity**

- Non Flammable

---

Premiere Products, Bouncers Lane, Cheltenham, Gloucestershire GL52 5JD
Telephone: 0242 243421 (14 lines) Fax: 0242 528445
**First Aid/Medical**

**Recommended Treatment For:**

<table>
<thead>
<tr>
<th>Ingestion:</th>
<th>Wash mouth with copious amounts of water. Seek immediate medical attention. Do NOT induce vomiting.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Contact:</td>
<td>Remove contaminated clothing and wash with soap and water</td>
</tr>
<tr>
<td>Eye Contact:</td>
<td>Irrigate with water for at least 10-15 minutes and seek medical attention.</td>
</tr>
<tr>
<td>Inhalation:</td>
<td>Remove to fresh air. Seek medical attention</td>
</tr>
</tbody>
</table>

**Results of any Relevant Tests**

M.P.9 is non-flammable as classified under the requirements of the CPL regulations i.e., Flash Point $>55^\circ\text{C}$

**Additional Information**

**Details of Container:**

| Type: | Polythene |
| Size: | 5 Litre |
| Standard Pack Size: | 4 x 5 Litre in Cardboard Carton |

**NOTE**

All Premiere products are registered with the National Poisons Information Service (NPIS), New Cross Hospital, London. If professional advice regarding First Aid is urgently required ring the Poisons Unit on Tel: 071 635 0191.

No liability is accepted for any loss or damage arising directly or indirectly from the use of the Company’s products, or from the use of the information given in its publications; neither is any warranty given or implied of freedom from patent rights. Prospective users should, therefore, satisfy themselves by appropriate trials that the product to be used is suitable for the intended use and that such use will not infringe any patent.
HIGH DILUTION SEMI-SYNTHETIC CUTTING AND GRINDING FLUID

Rocol NEW Ultracut 370 is a water soluble semi-synthetic cutting and grinding fluid, formulated to provide optimum performance at high dilutions, whilst remaining resistant to bacterial and fungal attack.

Outstanding Features:
- Compatible with hard and soft water
- High dilution
- Low in sump cost
- Improved resistance to bacteria and fungus
- Suitable for most materials
- Suitable for both cutting and grinding operations
- Tolerant to tramp oil
- Low Foaming
- Outstanding corrosion resistance
- Pleasant and clean to use

Directions For Use:
Add the concentrate to water until selected dilution rate is achieved, stirring continuously. For large volumes use a Rocol Automatic Fluid Mixer to give accurate and rapid mixing. Rocol NEW Ultracut 370 will form a clear, fluorescent green emulsion when mixed with water.

Recommended Dilutions:
Cutting and grinding – minimum 40:1
maximum 70:1.

Dilution ratio dependent on water hardness, workpiece material and severity of machining operation. Care must be taken to maintain correct dilution.
Technical Data (Typical):

Appearance: Clear fluorescent green liquid
Odour: Slight
pH: 9.4 at 15:1 dilution
Specific Gravity: 1:0
Storage: 0 to +30°C. Do not allow to freeze
Mineral Oil: Contains 25% refined mineral oil
Nitrites: Contains no nitrites
Flammability: Non-flammable
Viscosity: 197 cSt at +21°C

Precautions:

- Do not take internally.
- Skin contact with concentrate should be avoided.
- In case of contact with eyes, flush immediately with water - seek medical advice.
- Spillage should be mopped up with absorbent material.

Health & Safety:

Rocol NEW Ultracut 370 requires no hazard labelling under the 1984 Classification, Packaging and Labelling of Dangerous Substances Regulations.

Further Health & Safety Information should be obtained from Technical Services Department, Metal Working Division, Rocol Limited, Rocol House, Swillington, Leeds LS26 8BS.
Long-Life Cutting Fluid

Description
Rocol Ultracut 390H is a uniquely formulated cutting fluid designed to give extremely long life without the need for biocide additions. Whilst Rocol Ultracut 390H is particularly attractive in machine shops with advanced high production systems where downtime through unpredictable or frequent cutting fluid failure cannot be tolerated, it is equally cost effective in use with conventional machine tools.

Outstanding Features
★ Long and predictable sump life
★ Unique corrosion safety factor
★ Exceptionally resistant to bacterial and fungal growth
★ Compatible with hard and soft water
★ Suitable for most materials
★ Tramp oil tolerant
★ Keeps machines clean
★ Pleasant and safe to use
★ Low foaming
★ Extends tool life

Directions for use
To ensure dilution accuracy it is preferable to use the Rocol Automatic Fluid Mixer. For manual mixing, add the concentrate to water at the recommended dilution rate, stirring continuously.

It is preferable to use water at a temperature greater than 10°C and for the concentrate to be stored for 24 hours at shop floor temperature prior to use.

Rocol Ultracut 390H forms a translucent fluorescent green micro-emulsion when mixed with water.

Whilst the long life of Ultracut 390H is not dependent on biocide additions, as with all water based cutting fluids, it is advisable to use the appropriate Rocol "Ultraguard" Machine Tool Care Product at fluid changeovers.

Optimum fluid life is obtained by correct dilution control and regular maintenance of sump level, particularly prior to weekends and shutdown periods.

Recommended Dilutions
Rocol Ultracut 390H should be maintained between 30:1 and 40:1 dilution.
Refractometer calibration factor: 1.0.
First Aid/Medical

Recommended Treatment For:

Ingestion: Wash mouth with copious amounts of water. Seek immediate medical attention. Do NOT induce vomiting.

Skin Contact: Remove contaminated clothing and wash with soap and water.

Eye Contact: Irrigate with water for at least 10-15 minutes and seek medical attention.

Inhalation: Remove to fresh air. Seek medical attention.

Results of any Relevant Tests:

M.P.9 is non-flammable as classified under the requirements of the CPL regulations i.e., Flash Point >55°C

Additional Information

Details of Container:

Type: Polythene

Size: 5 Litre

Standard Pack Size: 4 x 5 Litre In Cardboard Carton

NOTE

All Premiere products are registered with the National Poisons Information Service (NPIS), New Cross Hospital, London. If professional advice regarding First Aid is urgently required ring the Poisons Unit on Tel: 071 633 9191.

No liability is accepted for any loss or damage arising directly or indirectly from the use of the Company's products, or from the use of the information given in its publications; neither is any warranty given or implied of freedom from patent rights. Prospective users should, therefore, satisfy themselves by appropriate trials that the product to be used is suitable for the intended use and that such use will not infringe any patent.
APPENDIX G

Sources of Reference
APPENDIX G

Sources of reference used:
Libraries – University and local.
Periodicals, books and reports.
International Nursing Index – Nursing Citation Index™, 1984 – 1992.

Data Bases searched:
CINAHL (Cumulative Index to Nursing and Allied Health) from 1983 – 1992.
CDROM (Compact disc read only memory) from 1986 – 1992.

Key Words used:
Testing or evaluation of:
BANDAGES, DRESSINGS, PLASTERS, WOUND HEALING.
Particularly for wounds caused by industrial/work injuries and treated in Hospital Accident and emergency Departments.
Any Standards on: BANDAGES, DRESSINGS, PLASTERS, including British Pharmaceutical Codex (BPC) and European Codex.
Accidents at work, Trauma, injuries in Hospital Accident and Emergency Departments.
WOUNDS - EMERGENCY
SURGICAL DRESSINGS - CASUALTY
INJURY - INDUSTRIAL
TRAUMA - OCCUPATIONAL
LACERATION - FINGERS, THUMBS, HAND
CUT - BANDAGES, TAPES, PLASTERS, DRESSINGS
PROTECTIVE USES OF DRESSINGS, BANDAGES, TAPES
REFERENCES


