DOCTOR OF NURSING RESEARCH PORTFOLIO

DIABETES: THE CHALLENGE IN BURNS UNITS

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PORTFOLIO INTRODUCTION

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Signed Statement

I certify that this doctor of nursing research portfolio entitled "Diabetes: the Challenge in Burns Units" contains no material which has been accepted for the award of any other degrees or diploma in any university or other tertiary institution and to the best of my knowledge and belief contains no material previously published or written by another person except where due reference has been made in the text.

I give consent for this copy of my portfolio, when deposited in the University of Adelaide Library being available for loan and photocopying.

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Overview of the Portfolio

This research portfolio contains the following sections:

- Introductory Chapter
- The Research Reports:
  - A Case Note Review Of Outcomes For Patients With Diabetes And A Foot Burn Injury Compared With Patients With A Foot Burn Injury Without Diabetes
  - Management Of Adult Inpatients With Diabetes: A Survey Of Burns Units
- Concluding Chapter
- Publications

Structure of the Portfolio

This portfolio contains five distinct sections; two of them are connecting chapters, another two are reports of studies conducted for the purpose of this doctoral portfolio. The fifth section includes publications originating from this work.

The connecting chapters are the introduction and conclusion of the whole portfolio. The introductory chapter provides the context of the topic. In this chapter, the topic is discussed from a theoretical point of view, followed by consequences of the association between diabetes mellitus and a burn injury. The effects on outcomes for patients are presented, leading to justification of the topic. The concluding chapter summarises the portfolio, and links the present research to clinical settings. Recommendations for further investigation of burn injuries among the population with diabetes mellitus are presented.

The research reports present two individual studies addressing two different aspects of the topic. Each study is reported in a separate section with its own structure in terms of page numbers, references and layout. The first study is a retrospective case note review describing outcomes for patients with diabetes and a foot burn injury. The second study is an electronic survey of burns units, featuring management of diabetes when the admission diagnosis is a burn injury.

Diabetes and Burns: A Theoretical Perspective

Diabetes and a burn injury are different conditions with different pathological changes, but people with diabetes are at a greater risk of burn injuries than those without diabetes.[1,2] The risk stems from the epidemiological profiles of these conditions and effects of complications associated with diabetes, as will be explained.

Several global reports have documented that the diabetes population is growing alarmingly because of urbanisation and ageing populations.[3-5] Simultaneously, data from developed countries suggest the older people are a risk group for burn injuries.[6-9] Finally, diabetes is often associated with poor vision and poor protective peripheral sensation, and therefore people with diabetes might not recognise the sources of burn injuries due to poor eyesight, and then, due to poor pain sensation, sustain a burn injury without realising it.

Poor peripheral sensation delays patients seeking treatment for a burn injury and may result in poor healing process,[1,10] which is further hindered by the presence of associated cardiovascular conditions. A further complex situation arises with hyperglycaemia, which is known to hamper the healing process.[11] As a result of these factors, it is reasonable to conclude that burn injuries among patients with diabetes are a challenging issue.

From another perspective, burn injuries are also a complex type of injury that affect a wide range of body systems such as the cardiovascular system, respiratory system, kidneys, immune system and metabolic processes. In other words, the effects of burn

injuries extend beyond the local burnt area to include multiple body systems and functions that are affected by diabetes. However, one should note that the effects on these systems resulting from diabetes and a burn injury take place because of different pathological changes occurring at different stages of each condition.

In particular, the cardiovascular and respiratory systems and the kidneys are affected in the early stages of a burn injury. In the case of diabetes, involvement of the cardiovascular system and kidneys is often associated with a long-standing disease process. However, the effects on the respiratory system appear in the form of symptoms such as Kussmaul's respiration in the early stages of ketoacidosis, which is an acute crisis of hyperglycaemia that often occurs in the presence of illness and infections in type 1 diabetes.[12] Accordingly, the effects on the body systems might not be identical.

For further explanation of these non-identical effects, the autonomic nervous system is stimulated as a stress response in the early stage of a burn injury, which results in tachycardia and hypotension. After two to three days the normal haemodynamic status resumes.[12] However, if the burn surface area is large, oedema develops as a result of fluid shifting from the intravascular to the interstitial space.[12,13] The degree of oedema is positively correlated with the size of burn surface area.[12]

Burn effects on the respiratory system elicit pathological changes. These changes may result from either inhalation of a burning substance, or burn injuries to body parts. Pneumonia is a common post burn complication.[14,15] Pulmonary oedema is common

in the case of chest and neck burn injuries while bronchospasm and lung collapse occur frequently in the case of inhalation burn injuries.[12] The kidneys may also be affected by burn injuries in the form of acute renal failure, either in the early stages of a burn injury due to fluid volume deficit or later as a result of secondary complications.[12,15] In summary, burn injuries cause physiological changes in the cardiovascular, respiratory and renal systems, which are often be self-limiting. However, it is necessary to stress the fact that the resulting haemodynamic instability is associated with electrolyte imbalance and poor blood supply to tissues,[12] similar to that which occurs as complications of diabetes.

Diabetes and burn injuries share some similarities. The two conditions are often associated with metabolic alterations and suboptimal immune functions, but the underlying mechanisms are different. In the case of a burn injury, the metabolic alteration occurs in two stages: the first one is hypometabolic state, which happens in the early phases. The second stage takes place later. The first stage is a phase of hypodynamic and hypometabolic changes where the blood leaks from the vascular lumen into the interstitial spaces, which reduces the circulating blood volume. Subsequently, the sympathetic nervous system is stimulated as a compensatory mechanism, where peripheral vascular resistance increases and the pulse rate accelerates. Thus, cardiac output is reduced, which further reduces the blood supply to the tissues; eventually organ hypofunction developes.[12,15]

In the second stage, the body demands an increase in nutrients.[16] Therefore, certain mechanisms are initiated to fulfil the demand. These mechanisms include alteration in carbohydrate, fat and protein metabolism. The alteration in carbohydrate metabolism

provides extra glucose requirements. The alteration in protein metabolism results in increased protein breakdown to support tissue repair,[17] while the alteration in fat metabolism is a complex process which ends with the accumulation of fat in the liver.[17,18] Similarly, these metabolic abnormalities are the underlying pathological changes in the case of diabetes.[19] However, in the case of diabetes, the stimulating factor for these changes is a lack or absence of insulin hormone rather than increasing nutritional demands, as is the case of burn injuries. In other words, in the case of diabetes and in the case of extensive burn injuries, there is an imbalance between insulin action or production on one side, and between body nutritional requirements on the other side, which suggests that the consequences of these two conditions would create similar effects.

Diabetes and Burns: Similar Consequences

Accepting that similar metabolic alterations occur in diabetes and burn injuries, logic suggests that the consequences of these alterations should be similar. Specifically, hyperglycaemia, which is the primary sign of diabetes, often occurs in patients with a large burn inury.[18,20] However, the hyperglycaemia is usually transient because it results from the stress of the injury, and so it should resolve when the stress subsides. Additionally, it is necessary to emphasise that hyperglycaemia, regardless of the underlying condition, slows the healing process due to the increase in blood viscosity and changes in white blood cells functions,[11] and there is an association between post burns hyperglycaemia and infections.[20,21] The association has been documented prospectively[20] and retrospectively[21] among patients with post burns hyperglycaemia compared with their normoglycemic counterparts. Accordingly, it is reasonable to suggest that, in the case of coexisting diabetes and a burn injury, burns-induced

hyperglycaemia could be exacerbated by diabetes-induced hyperglycaemia, which increases the individual's susceptibility to infection and poor wound healing.

Indeed, the likelihood of infection among people with a burn injury and diabetes could be exacerbated by other pathological changes. In the case of a burn injury, this starts by breaking the skin, which is the first line of defence against micro-organism invasion, and extends to suppression of the immune system.[15,22,23] In a similar way, patients with diabetes are more susceptible to infection and poor wound healing because of vasculopathy,[24-26] which reduces the blood supply to the injured area, and because of poor pain sensation, which delays the patient's recognition of an injury experience, and because of reduced immune responses, which is well documented in the diabetes literature.[11,27-29] In closing, diabetes and burn injuries pose significant challenges in the healing process including suboptimal immune function, blood hyperviscosity, poor tissue perfusion and skin breakdown. Therefore, the co-existence of these two conditions may result in poor patient outcomes.

Diabetes and Burns: Outcomes for Patients

Diabetes and burn injuries are both serious conditions and they affect many different body systems. Therefore, theoretically, the coexistence of these two conditions may worsen patient outcomes. The scenario of poor patient outcomes detailed in the previous paragraph is supported by clinicians' experiences in different independent settings.[24-26,30,31] Clinicians agree that foot burn injuries among patients with diabetes are a traumatic experience, particularly if the injuries are painless deep burns[24,26,30,31] that are discovered accidentally following prolonged contact with or scalds from household appliances.[24,25,31] Delay seeking health care is a common feature of such

injuries[24,25,31] and complex and prolonged treatment courses is often needed.[24-26,31] However, poor or inadequate wound healing was reported in many cases.[24,25,31]

However, one should note that clinicians mostly report their experiences of significant cases, which may not reflect the actual situation among the whole population. As such, it is necessary to verify anecdotal evidence with findings obtained from research. Searching the literature identified contemporary reports investigating burn injuries among patients with diabetes. For example, three American reports[1,10,32] documented that burn injuries sustained by patients with diabetes resulted mainly from domestic accidents . In particular, scalds resulting from bathing or showering and contact with heaters were the most frequent causes of burn injuries among sufferers of diabetes. Likewise, the American studies[1,10,32] reported the complexity of burn-related hospitalisation experienced by sufferers of diabetes such as the development of the high rate of both systemic and local post burns infections, the need for more surgical procedures and a longer duration of hospitalisation to treat burn injuries among those suffering from diabetes compared with those without diabetes.

The reports gave a wide range of explanations for the complexity of burn injuries among such a sub-population. However, these explanations were within the scope of the diabetes effects detailed in page 11-12, where diabetes causes delays in seeking health care, increases the risk of infection and hinders the healing process. As a result, complex management is needed to treat such injuries.

In fact, management of patients with diabetes hospitalised because of burn injuries should include optimal management of both diabetes and a burn injury. The reason why diabetes management is an integral part of burn management is that diabetes may exacerbate the primary condition of admission (a burn injury), which worsens the pre-existing condition of diabetes. The simplest explanation for this reciprocal effect is that the stress resulting from the primary illness aggravates pre-existing diabetes-induced hyperglycaemia, and therefore hinders the healing process.[33]

Caregivers may not treat burn-induced hyperglycaemia because they could consider this state a self-limiting physiological reaction. However, these caregivers may also ignore the glycaemic state even in diagnosed patients with diabetes, because they may consider diabetes management beyond their focus since it is a condition receiving long-term treatment. Yet, one should acknowledge that diabetes management is tailored to fulfil the daily individual needs of each patient. Such needs could change in the case of hospitalisation to the extent that could require adjustment to the pre-admission management plan.

Accordingly, it is not surprising to find several publications on inpatient management of diabetes.[34-38] Such publications have been growing significantly in the last few years, perhaps because studies have found the advantages of tight glycaemic control for inpatients. These advantages were noted as improvements in outcomes for patients hospitalised for conditions unrelated to diabetes, such as critical illness, myocardial infarction, stroke and cardiac surgery,[39] and this improvement is likely to be replicated for those with a burn injury.

However, it is necessary to document that, in spite of the advantages of tight glycaemic control for inpatients, several contemporary studies[40-42] have reported the commonality of suboptimal glycaemic control in general medical and surgical wards. These studies documented that under-management of diabetes was more likely to be observed in surgical wards than medical wards, in spite of the availability of guidelines for management of this disease. In other words, there was awareness of the importance of optimal inpatient management of diabetes, which may not always be translated into practice.

Within the context of such awareness, authors have stressed the importance of optimal management of diabetes for inpatients with a burn injury.[43] Additionally, the criteria of referral in different countries recommend treating patients with diabetes and a burn injury in specialised burns units.[44-46] However, these criteria do not indicate whether management of this pre-existing disease is an integral part of burns management. Furthermore, studies investigating burn injuries among sufferers of diabetes did not report the status of diabetes management.[1,10,32] In short, although authors and clinicians have recognised the seriousness of the coexistence of diabetes and a burn injury, little is known about management of diabetes during such coexistence. This lack of knowledge leads to presentation of the justification for the topic.

Justification of the Topic

In the light of theoretical assumptions of the seriousness of burn injuries among patients with diabetes, clinicians' experiences and the findings of the studies featured above,[1,10,32] it could be possible to say that, sadly, patients with diabetes are a challenging group to manage effectively in burns units.

The challenge stems from three complex perspectives: firstly, the possible combined effects of a burn injury and diabetes in terms of suboptimal immune function and metabolic alterations in addition to the involvement of the cardiovascular system. Such combined effects would complicate the course of hospitalisation for patients with diabetes and a burn injury. The second aspect in this challenge is the number of burns-related admissions among patients with diabetes. It is probable to say that despite the lack of data on these admissions, such patients might occupy large percentages of beds in burns units. This supposition is backed up by the fact that the diabetes population is at greater risk for burn injuries, and is in expansion.[3,5] Importantly, one in every two persons with diabetes may remain undiagnosed.[4] Additionally, diabetes is often missed as a secondary diagnosis in hospital settings.[47,48] Such a missed diagnosis may result in suboptimal management of this disease.

The challenge for optimal management of diabetes stems from the fact that the glycaemic state appears to be at greater risk of deterioration resulting from the possible combined effects of a burn injury and diabetes. This is in addition to the fact that burns unit staff may ignore such combined effects, leading to poor glycaemic control, which results in poor outcomes for patients. In other words, the link between poor glycaemic control and poor outcomes for patients is cyclical, in that deterioration in each aspect would cause a further deterioration in the other, and *vice versa*. Accordingly, the current inquiry was embarked on to address two aspects of inpatients with diabetes and a burn injury, namely, outcomes for patients with diabetes and foot burn injuries, and management of diabetes in burns units.

However, one could say that the theoretical profile of diabetes and burns suggests poor outcomes for patients suffering from these two conditions. Furthermore, this has been observed in clinical practice[24-26,30,31] and confirmed by findings of studies in different independent settings.[1,10,32] In fact, one should note that these studies are retrospective case note reviews of a relatively small number of patients hospitalised in a few independent settings in a single country over short periods. In other words, one may doubt whether the findings reflect the case in other countries. Accordingly, doing further studies in additional different settings would help to clarify the issue, and would also feature the local patterns of burn-related admissions among the population with diabetes. One perspective is that in doing so, the findings would highlight the issue, namely, burn injuries among patients with diabetes, to local authorities so they may be managed at the prevention level.

From another perspective, this portfolio focused on outcomes of a specific type of burn, which is a foot burn injury, and there were no previous studies located in the published literature that had investigated such injuries among sufferers of diabetes. This specific focus would take special importance if we accept the fact that foot problems are common among the population with diabetes. Therefore, investigating foot burn injuries among patients with diabetes would shed light on these injuries. Accordingly, the first study in this portfolio was conducted.

The second study was conducted because neither the results of the first study nor previous studies cited above,[1,10,32] reported the way diabetes was managed in burns units. Additionally, studies[40-42] investigating diabetes management in general medical

surgical wards have demonstrated that diabetes as a secondary diagnosis is often undermanaged and the problem is magnified in surgical settings. Simultaneously, poor management of diabetes is often associated with poor outcomes of the primary condition. Accordingly, the second study was conducted to feature management of diabetes in burns units.

Summary

In this section, the research portfolio was introduced in terms of the structure and context of the topic - the association between diabetes and a burn injury. In particular, a theoretical profile of the association was featured, and outcomes for patients were outlined supported by evidence from case note reviews and clinicians' experiences. As a result, a justification for the topic was developed from three standpoints. The first one is the increasing risk for burn injuries among the population with diabetes. Second, diabetes is often associated with poor outcomes for patients hospitalised in burns units. Third, the association between diabetes and a burn injury represents a management challenge because each condition has implications for the other, making management of such patients more complex.

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STUDY 1

A CASE NOTE REVIEW OF OUTCOMES FOR PATIENTS WITH DIABETES AND A FOOT BURN INJURY COMPARED WITH PATIENTS WITH A FOOT BURN INJURY WITHOUT DIABETES

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ABSTRACT

The purpose of the current study was to determine whether outcomes for patients with diabetes and a foot burn injury differ from outcomes for patients without diabetes and with a foot burn injury.

Sixty-four patients were included in the study. These were patients hospitalised with a principal diagnosis of a foot burn injury in the burns unit of a large tertiary hospital in South Australia from January 1, 1999 to December 31, 2004. Data were collected from the patients' case notes using a data collection tool and analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to describe the study variables and the population while non-parametric statistical tests were used to compare study groups. Comparisons were made by diabetes type and diabetes status (present or absent). Comparisons were also made within age groups by diabetes status.

Out of sixty-four patients hospitalised during the study period with a primary diagnosis of a foot burn injury twelve had diabetes. The highest proportion of patients with diabetes (58%, n=7) aged ≥ 56 years with a range of 37 to 73 years and a SD of 13.9 years. The highest proportion of patients without diabetes aged between 36 and 55 years with a range of 16 to 94 years and a SD of 19.9 years. Contact with a hot surface was a statistically significant cause of burn injuries among subjects with diabetes. There was a statistically significant association between diabetes and the experience of local post burn complications and longer hospital stays. There were no statistically significant differences within the group of subjects with diabetes when comparisons were made by diabetes type or diabetes control in terms of age, gender,

duration of hospitalisation, history of cardiovascular illnesses, diabetes-related retinopathy and neuropathy, documented causes of burn injuries, post burn complications. There were also no statistically significant differences between all study groups in terms of size and depth of burn injuries, treatment received and discharge status.

The present study showed an association between diabetes and poor outcomes for patients with diabetes hospitalised for a burn injury in terms of rates of local post burn complications, need for antibiotic therapy and longer duration of hospitalisation. Accordingly, a foot burn injury sustained by people with diabetes is a serious issue in terms of health and cost. Identifying patients at risk of a foot burn injury, and offering information on the appropriate preventive measures according to the individual needs of each patient is the strategy of choice to reduce the burden of a foot burn injury among patients with diabetes.

INTRODUCTION

Context of the Study

Diabetes is a progressive metabolic syndrome characterised by abnormally high blood glucose levels due to a lack of/ and or absence of effective insulin. It is a disease that could affect any one regardless of his/her age, gender or affluence. People with diabetes usually experience changes in their activities of daily living during the early stages of their disease such as eating, drinking and urination. Later, they may develop chronic conditions that could affect different parts of their bodies, such as heart, peripheral nerves, peripheral blood vessels, eyes, kidneys and feet.

Diabetes-related foot problems are a common diabetes-associated morbidity that affects about one fifth of people with diabetes, and could lead to a dramatic experience, which is amputation of the affected foot. There is no definite cause for the development of diabetes-related foot problems, but it is clear that the experience of a trauma, even a minor one, may lead to the development of such problems. This is because of poor peripheral sensory functions that delay the discovery of the injury, and also the presence of peripheral vascular disease worsens the situation. Eventually, chronic foot ulceration may develop. The situation becomes more complicated when the injury is serious, for example a burn injury.

Burn is a common type of injury that could affect any person. The burn injury may take place because of exposure to a thermal, chemical or electrical substance, and also because of prolonged exposure to the sun, contact with a hot object or friction with an object. The effects of a burn injury are usually damage in the immediate burned area.

In the case of a severe burn injury, these effects may extend to involve other body systems including metabolic and heamodynamic responses. These responses can be similar to and different from those experienced in the case of diabetes. Accordingly, the association of a burn injury with diabetes is a traumatic experience since the co-existence of the two conditions worsens outcomes for patients with diabetes compared with those without diabetes.

Anecdotal evidence suggests an association between diabetes and foot burn injuries. The association ranged from the need for prolonged treatment either in outpatients[1] or inpatients settings,[2-5] to the need for amputation.[2,4,5] The anecdotal evidence is supported by the findings of recent studies that show an association between diabetes and the development of post burn morbidities and longer duration of hospitalisation to treat a burn injury.[6,7]

Evidence mentioned in the previous paragraph is not enough to generalise an association between diabetes and outcomes for patients with a foot burn injury. Therefore, studies are needed to develop a better understanding of outcomes for these patients, particularly in developed countries where the possibility of association between diabetes and a burn injury is high because of ageing populations.

Purpose of the Study

The purpose of the study was to determine whether there were differences in outcomes for patients with diabetes hospitalised with a foot burn injury compared with patients with a foot burn injury without diabetes.

To understand the outcomes for patients with diabetes and a foot burn injury the following aims were outlined:

- determine whether the presence of diabetes affected outcomes for patients with a foot burn injury
- determine whether the outcomes for patients with diabetes and a foot burn injury differ according to the type of diabetes
- determine whether the control of diabetes had a role in the outcomes for patients with diabetes and a foot burn injury.

Statement of the Research Question/s

The research questions were:

- is there an association between diabetes and outcomes for patients with a foot burn injury
- do outcomes for patients with diabetes and a foot burn injury differ according to the type of diabetes
- do outcomes for patients with diabetes and a foot burn injury differ according to the control of diabetes?

Significance of the Study

Diabetes and a burn injury are complex conditions associated with poor wound healing. However, there is paucity of studies investigating the coexistence of these two conditions. The present study is significant as it fills a gap in what is known of diabetes. The findings of the current study will be used to obtain a better understanding of outcomes for patients with diabetes and a foot burn injury. These

findings will also provide rational bases for investigations of other aspects of outcomes for patients with diabetes and a foot burn injury.

Definition of Terms

Discharge status is a term used to describe patient's condition after hospitalisation that could be alive without complications, alive with complications or dead.

Diabetes status is a term used in this study to classify subjects as with or without diabetes.

Borderline cases: a term used in the current study to describe the patient condition when the medical officer is not able to decide whetter or not admission is necessary.

Summary

Diabetes is a multifaceted condition that causes deterioration in the overall wellbeing of sufferers of diabetes in both the short and long term. A burn injury also has multifaceted effects, particularly when it is severe. Therefore, the association of the two conditions is a traumatic experience because both conditions create somewhat similar effects that involve different body systems, such as metabolic alterations and suboptimal immune functions, leading to infection and prolonged costly treatment.

Despite, the seriousness of the association between the two conditions, very few reports have been published on this issue, and the available few have limitations. Therefore, it is timely to generate empirical evidence to achieve a better understanding of outcomes for patients with diabetes hospitalised because of a burn

injury. Thus, the descriptive study was conducted to collect a large amount of information from the real situation on different aspects of outcomes for patients with diabetes and a foot burn injury.

LITERATURE REVIEW

Introduction

In any discipline, the available body of knowledge results from the accumulation of research evidence or expert opinion in that field. Reviewing the literature is an essential part of any research project because it evaluates the knowledge of the proposed topic of research and provides a context for that study. In this chapter of the report, studies that investigated diabetes are discussed, followed by studies that investigated burns, and finally studies which investigated the association of a burn injury with diabetes are presented.

For the literature search, different combinations of terms such as diabetes, diabetes mellitus, prevalence, burn, burn injury, wound, healing and infection were used to search MEDLINE, CINAHL databases and Google. Relevant citations in the identified articles were also reviewed.

Diabetes Mellitus

Diabetes is a significant health problem in most countries and has serious and wide-ranging effects on those with the disease. There are reports from many different countries where estimates of the prevalence of diabetes have been attempted.[8-10] In the last decade of the twentieth century, researchers' attentions extended to estimating the prevalence of diabetes at the global level. These studies are reviewed here.

In one report, the World Health Organisation (WHO) Ad Hoc Diabetes Reporting Group[11] documented the estimated prevalence of diabetes and glucose intolerance in the age range of 30-64 years. The prevalence was estimated within this wide age range because the WHO Reporting Group considered age standardisation not suitable for the study population that had large differences in age. The Reporting Group utilised the raw data from surveys conducted between 1974 and 1989 in thirty-two countries to estimate the global prevalence of diabetes. More specifically, the Reporting Group[11] analysed data from population surveys that applied WHO criteria for screening and diagnosis of diabetes, in particular those surveys that measured blood glucose levels two hours after the administration of seventy-five milligrams of oral glucose.

The WHO Reporting Group[11] analysis showed that the variation in the prevalence of diabetes was not only different between countries but also between communities within the same country. Broadly speaking, the results indicated that the prevalence of diabetes increased with urbanisation. According to the WHO Reporting Group, the prevalence ranged from zero to 3% in the traditional communities, while it ranged from 3% to 10% in urbanised communities. However, the highest prevalence was among certain communities regardless of their state of development, such as Chinese and certain immigrants in the USA and South Africa, where the prevalence of diabetes ranged from 14% to 20%.[11]

The findings of the WHO Reporting Group highlighted the insidious nature of diabetes, that type 2 diabetes is asymptomatic in its early stages, and it was reported that one-fifth of people with type 2 diabetes were undiagnosed before the surveys

were undertaken. Accordingly, there was a lack of public awareness of the serious nature of diabetes, particularly in developed countries where the proportion of undiagnosed persons reached 50% and industrialised countries where the proportion was less than 50%, despite the availability of health care facilities.

Finally, the WHO Reporting Group was not able to draw a conclusion about the relationship between gender and the prevalence of diabetes; rather they found that in, some communities the number of men with diabetes was higher, while in others the number of women suffering from diabetes was greater. When the WHO Reporting Group[11] used data sets of sixteen communities to identify the relationship between ageing and the prevalence of diabetes, the prevalence was positively correlated with age in all populations. The WHO Reporting Group study provided a base for the comparison of percentages of the global prevalence of diabetes among adults within a specific age range.

A report from the International Diabetes Institute (IDI) Victoria, Australia,[12] which is the WHO Collaborating Centre for Diabetes in the Southern Hemisphere (L. Gray, personal email, October 25, 2005) documented the estimated global prevalence of diabetes in 1995, 1997, 2000 and 2010. The IDI estimated the prevalence from epidemiological studies conducted around the world between 1980 and 1997. In order to estimate the prevalence of type 2 diabetes, the IDI used studies that adhered to WHO diagnostic criteria, which in the Reporting Group study.[11] Where there were no studies that fulfilled the previous criterion, studies based on fasting blood glucose levels were included in the IDI report. To estimate the prevalence of type 1 diabetes, the IDI included studies that applied the standardised registry methods for type 1

diabetes. These methods consider that persons have type 1 diabetes if they are on insulin before the age of fifteen and on insulin at the time of registration.[13]

The IDI report showed that the prevalence of diabetes was continuously increasing on an international level.[12] The increase is illustrated in Table 1 that shows the estimated prevalence for the years 1995, 1997, and 2000 and projected for 2010.

Table 1 The Global Prevalence of Diabetes Towards 2010

Years	Type 2	Type 1	Total
1995	**115 m**	**3.5 m**	**118 m**
1997	**120 m**	**3.5 m**	**124 m**
2000	**146 m**	**4.5 m**	**151 m**
2010	**215 m**	**5.5 m**	**221 m**

m=million

According to the IDI[12] report, the dramatic increase in the prevalence of type 2 diabetes might be due to urbanisation and the ageing population. Consequently, the greatest increase in the prevalence of diabetes would occur in developing countries and newly industrialised countries because the life expectancy of people in developing countries usually increases, and it is expected that much urbanisation will take place in these countries.[14]

In fact, the IDI report provided updated information on the global prevalence of diabetes. It not only concurred with the finding of the WHO Reporting Group[11] that the prevalence of diabetes increases with urbanisation, but also predicted that the greatest increase will be in countries moving towards urbanisation. However, one should note that the methodology and studies included in the IDI report were different from those in the WHO Reporting Group report.[11] IDI[12] used reported findings while

the WHO Reporting Group used raw data, therefore, the documented results were based on the accuracy of the previously reported findings. In the case of the unavailability of data from certain countries, the IDI study considered data from a comparable country. The countries were considered similar if they had a similar ethnic background and economic development. Additionally, the findings may not reflect the real situation in all countries because of variations among the primary studies in the definition of type 1 and type 2 diabetes.

Another report by King *et al* [15] documented the use of raw survey data from thirty-seven countries. These surveys were the same ones included in the WHO Reporting Group report[11] plus surveys from five additional countries that fulfilled WHO criteria for diagnosing and screening for diabetes. King *et al*'s report moved beyond estimating and projecting the prevalence of diabetes to determine the variations in the prevalence in terms of age, gender and urbanisation. There was an expectation that the prevalence of diabetes among adults would increase more than one-third at the international level within the first quarter of the twenty-first century because of urbanisation and the expected increasing age of the population. According to King *et al*'s report,[15] the adult population would increase from 2.5 billion to more than 4 billion in 1995 and 2025, respectively, and the prevalence would be as much as 135 million, and 300 million in 1995 and 2025, respectively. The increase occurs in most countries because of urbanisation.

King *et al*'s findings support those of the WHO and IDI groups[11,12] that diabetes is a associated with urbanisation and is more prominent among the older age group in developed countries, while it is a disease of the middle-aged group in developing

countries. The number of women with diabetes is greater than the number of men because life expectancy for women is higher than that for men in most countries, and ageing is a risk factor for diabetes.

King *et al*'s report considered the estimated prevalence to be below the actual prevalence of diabetes both at the national and international levels because firstly, some of the surveys included had been conducted twenty years previously. Secondly, the data were applied from countries to other similar countries and therefore, the findings of a survey might not represent the situation in the whole country; for example King *et al* indicated that, according to an Australian survey, the number of males with diabetes was triple that of females, was not considered to be representative of the male/female diabetes ratio in Australia and New Zealand. However, King *et al*'s report supports the proposition that the prevalence of diabetes is continuously increasing.

The latest estimation of the global diabetes prevalence was published recently in a report by Wild *et al*.[16] WHO criteria for diagnosing and screening for diabetes, used by the WHO Reporting Group[11] and King *et al*[15] were applied by Wild *et al* to include surveys from forty countries in order to estimate the prevalence of diabetes in 2000 and to predict that for 2030. An exception was given to include a survey from China and another one from Tanzania because of a lack of studies from these countries. The principle of similarity between countries was applied in Wild *et al*'s study to guess the prevalence of diabetes in the countries that had no data on the prevalence. In particular, countries were considered similar if they were neighbours and had ethnic and socio-economic similarities. The estimation and prediction in Wild *et al*'s report

were based, not only on the demographic changes in the world, but also included all age groups. The report supports earlier ones that there is a steady increase in the prevalence of diabetes.

More specifically, Wild *et al*'s report supports the findings of King *et al*[15] in that the number of women with diabetes is greater than that of men, and the assertion that the prevalence will double within a period of thirty years. However, the estimated prevalence in Wild *et al*'s report differs from those in King *et al*'s report. In Wild *et al*'s report, the estimated prevalence for 2000 and for 2030 were 171 million and 366 million respectively, whereas the prevalence in King *et al*'s report for 1995 and for 2025 were 135 million and 300 million, respectively. This variation is perhaps because the estimated population size in Wild *et al*'s report was higher than that in King *et al*'s report; thus the prevalence in Wild *et al*'s report were considered more accurate.[16]

In conclusion, it seems clear that diabetes is a pandemic health problem that is positively correlated with urbanisation and female gender. The conclusion is reached even when we compare studies that used different methodologies and from different countries, conducted at different times. Therefore, it is necessary to prevent and manage diabetes, particularly since the prolonged disease duration is associated with complications resulting in poor quality of life.

Diabetes complications are chronic conditions associated with longstanding diabetes and hyperglycaemia that usually start as degenerative changes in the endothelial layer of blood vessels and predispose the person to the development of diabetes-associated

complications.[17] These complications usually affect the blood vessels that supply the peripheral nerves, kidneys, eyes, heart and cerebrum. Such complications may increase the possibility of injury. Retinopathy reduces patients' ability to recognise the sources of harm while peripheral neuropathy delays their recognition that they have developed an injury, because people with diabetes often have poor pain sensation. As a result, the person would seek treatment after the development of infection.

The likelihood of infection among people with diabetes is high because of changes in the immune system due to hyperglycaemia. The vulnerability to infection is intensified with peripheral vascular disease, which reduces blood supply to the injured organ. Subsequently, poor healing is expected among such patients. Evidence that extends from the third decade of the twentieth century to the current time supports the notion that diabetes alters the healing process because it is very difficult to maintain blood glucose levels with normal range during the stage of acute illness. Accordingly, one can say that, within the context of wound healing, diabetes delays inflammatory reaction, inhibits granulation formation, and inhibits collagen formation as well. In brief, the experience of an injury by a person with diabetes is a serious issue because of poor healing and infection. The seriousness of this issue may well increase if the injury is a burn injury that creates changes in metabolism and the immune system.

Burn Injuries

Burn is an injury that breaks the skin or mucous membrane as a result of an exposure to a source of heat or a contact with a hot surface or a chemical substance.[18] A burn injury might be simple or severe depending on a wide-range of factors that are related to the individual with a burn injury such as their age and history of cardiovascular

diseases; and related to the aetiology of that injury such as the causative agent, duration of exposure to that agent and the depth of the burn injury. These factors may extend the effect of a burn injury beyond the local burned area to involve other body systems where serious consequences may develop such as shock, sepsis or even death.[18]

Because most burn injuries are preventable conditions, it is necessary to identify the people at risk and the aetiological factors of such injuries. Studies from different countries have investigated the epidemiology of burn injuries,[19-26] but not at the international level, as in the case with diabetes, perhaps because of variations in the nature of the problem between developing and developed countries.

Developing countries are still at the stage of recognising people at risk of burn injuries and causes of these injuries,[19] while developed countries have moved well beyond this stage to the implementation of preventive measures, which have reduced the incidence of burn injuries.[27,28] Additionally, people at risk of burn injuries and causes of these injuries in developing countries are different from those in developed ones.[29] Thus, the studies reviewed from developed countries are presented separately to those from developing countries.

Burn Injuries in Developing Countries

Because the present study was undertaken in a developed country, it was decided to include studies from only two developing countries, namely, Iran and India, since there were many contemporary studies from these countries. Studies were considered contemporary if they were published after 1994.

Two reports from the capital of Iran demonstrated that burn injuries resulted mainly from home accidents caused by flames and scalds.[25,26] Flame burn injuries were a result of using petrol derivatives in heating, cooking and even in cleaning.[25] Most burn injuries were sustained by children younger than age fifteen years, whereas a low incidence of these injuries in older people was noted in both reports perhaps because of age distribution in the Iranian community. The percentages of the age group over sixty years were 14.6%[25] and 7% in the study.[26]

In the context of family structure, one of the reports found that the high incidence of burn injuries was among children of typical Iranian families included a large number of children who usually play in the house, particularly in the kitchen, which is a major source of scalds.[25] This explanation seems reasonable, given that 63% of burn injuries among children younger than six years were caused by boiling water,[25] 31% of injuries were scalds, and the mean age of patients with these injuries was 9.5 years.[26]

Another point of agreement between the two Iranian reports is the positive correlation between the death rate and flame burn injuries, which lead to a large 'Total Burn Surface Area' (TBSA). Hence, low death rates in children were reported because a small number of children sustained flame burn injuries in comparison with adults.[25] A high mortality rate among females was reported because adult females were the most common victims of flame burn injuries.[26] One study documented a positive correlation between the duration of hospitalisation and the mortality rate because of the difficulty implementing isolation techniques for hospitalised patients.[26] However, an inverse relationship was noted between the duration of hospitalisation and

mortality rate, when TBSA was more than 60%. There was a positive correlation between age and mortality rate.[25]

The main difference between the Iranian reports[25,26] is the percentages of death rates. The difference is due to variations between these reports in the included population. One report described patients with severe burn injuries resulting in a death rate of 59.5% (n=737),[26] while the other report[25] described males and children under the age of fifteen years, where flame was not the prominent cause of burn injuries resulting in a death rate of 19.6% (n=656). These two reports highlight the evidence that burn injuries are indoor accidents; children and adults are the vulnerable groups for these accidents. The scenario in Iran could be applicable to other developing countries because of similarities between developing countries in terms of lifestyle. In other words, the causes of burn injuries and at risk groups might be similar among developing countries. However, these reports described the hospitalisation status in two burns centres over short periods of time in the last decade of the twentieth century. Thus, reviewing reports from other countries may help in gaining a better understanding of the epidemiological characteristics of burn injuries in developing countries.

A report by Ahuia *et al*[19] illustrated similar epidemiological characteristics of burn injuries in northern India to those in Iran. Specifically, females in the 16 to 55 year age group were the main victims of burn injuries resulting from cooking flames, house fires and lamps. Consequently, Ahuia *et al*[19] documented a high death rate among females in that age group because they sustained large TBSA. Children were

the second group of victims who experienced burn injuries because of hot water, and people aged over fifty-six years had the lowest rate of burn injuries.

Another similarity with the scenario in Iran, in Ahuia *et al*'s[19] report a direct relationship was documented between TBSA over 60% and death rate. However, this relationship was not applicable when patients were admitted to the burns centre within six hours of the accident. Additionally, the initiation of a new protocol in that centre reduced the total mortality rate in the last two years of the report. Finally, most burn injuries were accidental injuries affecting females in their homes. Suicidal and homicidal burn injuries were also reported by Ahuia *et al*.[19]

Another Indian report, Kumar *et al*[24] documented more deaths among newly married women aged below twenty-five years. Also, 65% of women sustained burns when preparing meals. Of note is that many of women were living in joint families in rural areas. Using wood and Kerosene as the main sources of energy predisposed young women with a low level of education who wore synthetic or semi-synthetic clothes to flame burn injuries. Therefore, it appears that the person's socio-cultural background plays a crucial role in determining groups at risk of burn injuries and to a great extent the aetiological factors of these injuries. It seems that women in India are the major victims of burn injuries and children are the next most common group.

Given the findings from these reports, it is reasonable to conclude that women and children are the main groups at risk of burn injuries in developing countries, and that flame is the prominent cause of burn injuries among females, while scald is the prominent cause among children. It is necessary to remember that the size and

significance of the problem varies from country-to-country because of variations in social and economical structures. This assertion is supported by studies from other countries, such as Egypt,[30] Liberia[31] and Kuwait.[32,33] Accordingly, it is expected that risk groups and aetiological causes of burn injuries are different in developed countries from those in developing ones; thus the severity of burn injuries could vary.

Burn Injuries in Developed Countries

In developed countries, the focus of burn epidemiological studies has moved beyond reviewing patients' files in a local burns centre to investigating the problem at state or national levels in order to evaluate the effectiveness of preventive strategies and burns management in hospitals, in the USA and the UK.

A report by Brigham *et al*[34] described the epidemiology of burn injuries in the USA at the national level within a period of twenty years in order to track the burn incidence and medical care. Data were collected from three sources, namely, governmental and independent publications, six public and private burns organisations, and two burns centres in two states that had comprehensive hospital discharge data systems. These data showed a significant positive change in the epidemiology of burn injuries following the implementation of preventive strategies and improvements in the management of burn injuries, which achieved a 40% reduction in burn-related deaths. A similar decline was also noted in burn-related hospitalisations.

These improvements were seen, in Brigham *et al*'s report, as a drop in burn-related deaths from 9000 in 1971 to 5500 in 1991, and a fall in the number of patients who

were discharged from general hospitals with a principal diagnosis of a burn injury from 90,000 in 1970 to 46,000 in 1992. However, Brigham *et al*'s report indicated that admissions to burns centres increased to 8,000 from 1976. At the same time, burn-related admissions to general hospitals without burns units reduced by 40,000 because of changes in practice. Advanced burn care facilities became easily accessible to most patients with burn injuries, management on outpatient basis rather than in hospital became a philosophy of burns care, and the improvement in triage reduced the rate of burn related-admissions to general hospitals. However, Brigham *et al*'s noted a slight decline in admissions to burns centres in 1994 because there was a sharp reduction in the incidence and severity of burn injuries.[34]

According to Brigham *et al's*[34] report, the annual incidence of burn injuries in the USA dropped from 1,973,000 in the late 1950s and early 1960s to 1,129,000 in the early 1990s. However, Brigham *et al*[34] indicated that there were sampling errors in the primary surveys reviewed because a sharp reduction in the incidence occurred within a short period of time. Therefore, Brigham *et al*[34] combined data from national governmental surveys undertaken in 1973 and 1987, to estimate 1.25 million burn injuries in 1992. It was noted that most of these injuries were scalds or contact burn injuries rather than flame burn injuries, which were more prevalent in developing countries. Brigham *et al*'s[34] added that in 1992, Accident and Emergency Departments saw 500,000 people with scald or contact burn injuries, and 3000 people with flame burn injuries. Flame burn injuries were responsible for 1000 deaths per year, whereas scald and contact burn injuries were responsible for 125 deaths per year. These data support findings from developing countries that a high death rate was associated with flame burn injuries.[19,25,26]

In short, Brigham *et al*'s[34] report demonstrated the importance of preventive measures in reducing the incidence and the severity of burn injuries. However, the report represented the epidemiological profile of burn injuries in a single country. Accordingly, it is necessary to review reports from other developed countries in order to conceptualise the value of burn prevention.

A report from Scotland[35] documented a yearly significant reduction in burn-related admissions to all Scottish hospitals between 1970 and 1992 because of preventive strategies and treating burns in outpatient settings. The reduction occurred in all age groups, particularly among children under fifteen years. As a result of the decline in burn-related admissions and improvements in inpatient management, the number of burn-related deaths decreased. The Scottish report showed that the highest incidence of death was among people aged over sixty-five years followed by people in the 16 to 64 year age group, and lastly, children. The highest incidence of burn injuries was among children and persons over 80 years of age, while the lowest incidence was among the 16 to 64 and 65 to 80 age groups. In short, the report supports the notion that prevention is a crucial factor in reducing the incidence of burn injuries and subsequent deaths. Improvements in the quality of burns management play a pivotal role in reducing mortality among patients with burn injuries, in contrast to what was reported from the Birmingham Burns Centre.[36]

A report from the Birmingham Burns Centre[36] documented a comparison in mortality rates between two periods of time, in order to determine whether the improvements in management of burn injuries improved the survival rate of patients. Outcomes, death

or survival, for patients who had been hospitalised in the centre from 1979 to 1988 were compared according to age and TBSA with those for patients who had been hospitalised from 1989 to 1998.

A 0.5% reduction in mortality rate in was documented in 1989 to 1998 compared to the earlier decade. At the same time, a 17% reduction in the admission rate was documented. Thus, the Birmingham Centre's report suggests changes in management of burn injuries did not significantly affect survival particularly in regard to the mortality rate of people older than sixty-five years, which was 100% when the TBSA was equal to or more than 50%, as found in the second period. In the first period of the report,[36] the 100% mortality rate was documented if the TBSA was equal to or more than 40%.

The report claimed that this surprising result could be attributed to the fact that no new drugs were introduced in the treatment of burn injuries during the second decade of the study. New drugs could significantly reduce the death rate similar to that which occurred after the introduction of Silver Nitrate.[36] More importantly, the data from the Birmingham Centre did not specify the severity of a burn injury in terms of depth and did not indicate whether or not they were inhalation burn injuries, which may have affected the results. Additionally, using observed means, rather than the mean of each age group, underestimated the lethal area 50 value in the Birmingham Centre's report.[36] This lethal value represents the TBSA where the patients' chance of survival is 50%.[37] Thus, no significant difference in mortality rate was noted between groups of the same age ranges.

In the Birmingham Centre report, the highest incidence of death occurred among people over sixty-four years. A decline in burn-related admissions was also noted in all age groups, similar to that reported in Scotland.[35] However, reported percentages of this decline in Scotland vary greatly from those reported from the Birmingham Burns Centre, where the decline in such admissions was as 22.8%, 16.7% and 12% among age groups: 65 or over, 15-64 and 0-14 years, respectively. In Scotland, the documented decline was 0.81%, 28.8% and 58% among age groups: 65 or over, 16-64 and 0-15 years, respectively.[35]

These differences could be attributed to the fact that the Scottish report was concerned with burn-related admissions to all hospitals in Scotland from 1972 to 1992,[35] while the Birmingham Burns Centre's report[36] was concerned with admissions from 1979 to 1998 to that centre only. Furthermore, in Scotland, the number of older people increased by 13%, and the number of children decreased by 26% during the period of study.[35] These groups are at risk of burn injuries in developed countries.

Another British report by Rajpura[21] described the epidemiology of burns that documented inpatient episode statistics of four health authorities in the north-west of England. Data collected included age, gender, admission and discharge of all burn-related admissions from 1997 to 1998, which were analysed to identify groups at risk of burn injuries. The analysis showed that the highest incidence of burn injuries, admissions and deaths resulting from burns occurred among children younger than five years old, followed by people over seventy-five years. The mortality rate among the older people was higher than that among the children, perhaps because the documented incidence of smoke inhalation injuries among the older people was

higher than that in children, in addition to the debilitating health status of the older people in general.

In Rajpura's,[21] most children younger than five years were males and the predominance of male gender continued until the age of sixty-five years. After that, there was no gender difference until the age of seventy-five years, after which, males had a slightly incidence of burns than females. The number of children admitted on weekends was slightly higher than on weekdays, possibly because on weekends, children were exposed to accidents because of domestic appliances, or the staff who were on duty admitted the borderline cases. Finally, Rajpura documented a positive relationship between the incidence of burn injuries and low socio-economic status, similar to that reported from India.[19,24]

The last British report is by Wilkinson[38] that documented somewhat similar trends in the epidemiology of burn injuries in the Midlands of the UK to that in the north-west of England. Wilkinson[38] reported that people aged between 16 and 64 years attended Accident and Emergency Departments proportionally more than children and the older people, because people aged between 16 and 64 years were the working group and the largest one in the population, which is similar to the Scenario in the north-west of England. However, like Rajpura's[21] findings in the north-west of England, Wilkinson[38] indicated that most admissions were children younger than five years and people over seventy-five years. Again, male gender was a risk factor for hospitalisation, but after the age of sixty-five years the risk of gender was not applicable because of the long life expectancy for females. Finally, patients with burn injuries utilised 1% of resources of Accident and Emergency Departments.

To conclude, the epidemiological profile of burn injuries in the UK similar to that in the USA in terms of a reduction in burn-related admissions and deaths. These reductions are the consequence of burn prevention strategies. A similar profile was reported in a review of admissions to all Canadian burns centres between 1966 and 1991.[39] The profile may also be applicable to other developed countries because of similarities between these countries in terms of health care and social systems. Similar findings were reported in Greek[40] and Spain[41] where studies focused on specific burns units, similar to studies from developing rather than developed countries that investigated the epidemiology of burn injuries at the national or state levels.

In Australia, the focus of epidemiological studies of burn injuries was different from those in other developed and developing countries. The Australian studies focused firstly on burn injuries as part of injuries in general, as in the case of one study from the state of Victoria, Australia,[42] and secondly, a specific population.[43-48] Similar studies were reported from developing[49] and other developed[50-52] countries, but as reviewing of such studies would not serve the purpose of the current study, they were excluded.

The epidemiological statistics of injury-related hospitalisation rates in the state of Victoria, Australia, over a period of ten years showed that the rates of burn-related hospitalisations were lower than those for other injuries.[42] Specifically, in the extremes of the study period, from 1987 to 1992 and from 1995 to 1997, there was a yearly reduction in burn-related admissions, whereas fluctuations were noted between

1992 and 1995 following the implementation of a new payment system for public hospitals in 1992.

The Victorian[42] study indicated that males outnumbered females in all age groups throughout the study period. In particular, children younger than five years were the group most vulnerable to burn injuries, followed by people over seventy-five years; this is similar to the scenario in developed countries. In brief, males are at high risk of burn injuries in the state of Victoria, Australia.

In New South Wales, it was reported that burn-related admissions among males outnumbered females in all age groups,[53] similar to that reported from Victoria, Australia.[42] However, one should note that the focus of the Victorian study was broader than the New South Wales study. In particular, the Victorian study included injury (not only burns)-related hospitalisation in all public hospitals, while the New South Wales study included burn-related admissions to a single burns units in the state. According to data reported from New South Wales, males were represented more frequently in all burn injuries. Most burn injuries were due to flames, followed by scald injuries; similar to developing countries, rather than developed ones.

Recently, the Royal Australasian College of Surgeons published their policy on trauma (injury). This publication indicated that 1% of Australians experience a burn injury each year.[54]

A paper published by the Research Centre for Injury Studies, Flinders University, Australia indicated that since the middle of the last decade of the twentieth century,

there was a regular reduction in the rate of burn injuries among males and females.[27] However, burn-related admissions were more common among males than females, and children were more frequent victims. Burn-related deaths represented a small proportion of all injury deaths and the highest rate of these deaths was among the older people.

Burn injuries are common in developing and developed countries. However, the epidemiological profile of these injuries in developing countries is different from that in developed ones in terms of risk groups and causes. There is a wide range of burn causes, and the effect of a burn injury may extend to create serious systemic effects. The severity of a burn injury depends on a number of factors such as the causative agent, size and depth of a burn injury, and also the presence of systemic diseases such as diabetes, which may intensify the severity of the burn.

Diabetes Mellitus and Burn Injuries

Diabetes and burn injuries are complex conditions that affect body systems in different ways because they are caused by different aetiologies, and the pathological changes in each condition are different. However, they both exhibit effects on certain body systems that eventually lead to poor healing, but these effects take place at different stages in each condition. In the case of diabetes, they usually occur after a prolonged disease process with persistent hyperglycaemia, while, in the case of burn injuries, they happen if the burn is severe. Thus, it is expected to find poor outcomes among patients with both diabetes and burn injuries.

The tragic experience of a burn injury by patients with diabetes is clearly reflected in case reports that have shown that such patients sustain painless foot burn injuries.[1,2,4,5] These injuries are often complicated by infections, which require extended hospitalisation from four to eight weeks for systemic antibiotics and wound management.[2,4] Moreover, vascular insufficiency worsens the situation,[2,4,5] to the degree where amputation is sometimes necessary.[2,5] The paucity of research to inform practice is problematic here; however this has also been the impetus for researchers to identify the characteristics of patients with diabetes and burn injuries. These reports are analysed here.

Shalom *et al*[55] compared the outcomes for patients with (n=73) and without (n=150) diabetes admitted to a burns unit in the USA between 1995 and 2000. Patients with diabetes were more likely to stay longer in hospital and experience more operations, although both groups had similar burn injuries in terms of TBSA. Shalom *et al*[55] attributed these findings to the fact that diabetes hinders the healing process, and also sufferers of this illness were more likely to sustain burn injuries to the feet, which is considered to be a complex type of burn[56] because of the anatomical structure and functions of the foot.[57] Furthermore, patients with diabetes were older than those without diabetes, and had many risk factors that complicated their hospital course. Shalom *et al* concluded that patients with diabetes are a unique group in burns units and require complex management.

However in Shalom *et al*'s study,[55] the patients with and without diabetes were not matched in terms of age, gender and date of admission. Accordingly, it was necessary to analyse other reports in order to verify whether the established association between

diabetes and poor outcomes for patients with burn injuries is real or resulted from the extraneous variables.

A report by McCampbell *et al*[7] documented a case comparison between patients with (n=181) and without diabetes (n=190) matched by gender and date of admission in the largest burns centre in the USA between January 1996 and May 2000. The comparison between age groups showed that there was a comparable number in these two groups in the age range 18 to 65 years (n=98 with diabetes and 93 without diabetes). However, there were twenty-seven times more patients without diabetes younger than eighteen, whereas the incidence was five times greater in those over 65 years in patients with diabetes. These findings were not surprising, because the incidence of diabetes increases with age. Moreover, diabetes complications increase the risk of injury. Accordingly, McCampbell *et al*[7] did not consider the number of patients with diabetes among the older people group congruent with the prevalence rate in the general population.

The role of peripheral neuropathy was shown clearly in McCampbell *et al*'s report. In particular, the delay in presentation increased infections rates resulting in long treatment in hospital, more surgical management and a high death rate among patients with diabetes in comparison with those without diabetes in the same age, despite similar TBSA. Therefore, diabetes complicates the status of burn injuries in terms of recovery and treatment. However, because the sample size was small, McCampbell *et al*[7] did not conclude that delay in seeking health care contributes to poor outcomes for patients with diabetes hospitalised for a burn injury, particularly since more deterioration was noted among patients with poorly controlled diabetes compared

with those with blood glucose levels in the normal range. McCampbell *et al*[7] postulated that this was due to hyperglycaemia increasing infections among patients with poorly controlled diabetes. One can conclude that hyperglycaemia worsens the outcomes of burn injuries, an assertion that is supported by the next report.

A report from one of the largest burns centres in the USA documented a comparison between patients with (n=68) and those without (n=995) diabetes who were hospitalised between 1999 and 2003.[6] The comparison was undertaken in two stages: first, a general comparison (all patients with diabetes vs. all patients without diabetes), while the second compared outcomes according to age between patients with and without diabetes. Two age groups were compared: 'adults' 15-55 years and 'senior adults' older than 55 years.

In Memmel's study,[6] the general comparison revealed that patients with diabetes were older and had larger TBSA than those without diabetes. The delay in presentation was prominent among the majority of those with diabetes, similar to a previous report.[7] A high readmission rate was documented among patients with diabetes in general and among senior adults with diabetes in particular, compared with those without diabetes. This high rate was attributed to the fact that those with diabetes developed infections, particularly cellulitis caused by multiple organisms rather than a single organism. Most infections among those without diabetes were caused by a single organism.

Therefore, patients with diabetes are more vulnerable to burn injuries, and more liable to develop post burn complications that require longer duration of hospitalisation and complex management. Thus, more research is required to obtain a comprehensive

picture of outcomes for patients with diabetes and burn injuries, particularly in developed countries where those at risk of diabetes and burn injuries are similar, and 50% of patients with diabetes remain undiagnosed. The literature documents descriptive studies that used records as a source of data and therefore, the accuracy of the findings depend on the accuracy of records. Additionally, they are retrospective studies, and therefore the possibility of alternative explanations is high. Moreover, their sample sizes were too small to generalise their findings to all patients with diabetes.

Summary

Urbanisation and ageing populations make diabetes a global health problem with the older people at risk of burn injuries in developed countries. Thus, the coexistence of diabetes and burn injuries is expected, particularly as diabetes complications, (retinopathy) reduces the ability to recognise the sources of harm, and (peripheral neuropathy) diminishes protective pain sensation.

The association of diabetes with a burn injury is a traumatic situation for two main reasons. Firstly, peripheral neuropathy delays the presentation at hospital after a burn injury. At the same time, macrovascular disease reduces blood supply to peripheral organs, and hyperglycaemia suppresses immune reaction in the injured area, and therefore the possibility of infection is very high. Secondly, burn injuries breach the physical barrier against micro-organisms and suppress the immune system. However, there is not enough research evidence that verifies this traumatic situation, thus research is needed to determine outcomes for patients with diabetes hospitalised because of burn injuries.

METHODS

Introduction

This chapter outlines how the study was conducted and how the study plan was implemented in terms of data collection and data analysis. Information is presented on the research design outlining its advantages and appropriateness to address the study question, and describes data collection tools, subjects, ethical concerns, process used to access confidential patient notes and data analysis procedures.

The Design of the Study

A descriptive retrospective design was used to determine whether the outcomes for people with diabetes and a foot burn injury differ from those for people with a foot burn injury without diabetes. The retrospective design is classified as an empirical non-experimental design[58] where there is no manipulation of study variables, but the relationship between the variables is investigated retrospectively.

The fundamental principle of the chosen design is using outcomes to understand antecedent events.[58] In retrospective research, data about both dependent and independent variables are collected at the same time in order to determine whether the dependent variable(s) is/are related to the independent variable(s). As such, retrospective studies are those in which people who have been exposed to a condition or disease in the past are studied by linking the outcomes to the previous exposure. Comparisons are made between people who have been exposed to the condition or disease and people who have not, in order to determine whether there is a difference

between these two groups, and if there is, whether the difference is related to the condition or disease.[59]

The retrospective design is useful when there is a paucity of evidence about the issue under study and where few people are affected by the condition.[60] Hence, it is helpful to study new and rare issues[61,62] and therefore, can be the basis for subsequent investigations into the issue of interest.[62]

Generally, in retrospective designs, data are obtained either from the people or available records that document the past events. This highlights the economic advantages of retrospective research because few resources are required.[60] Importantly, no interruption to an individual's treatment schedule is required to collect the data, and the researcher does not need to wait for availability of the appropriate subjects to be identified.[62] Additionally, the retrospective design uses data from real situations to understand clinical issues.

However, this understanding is inclusive because it is established on an 'ex post facto' basis, and hence outcomes could be the result of confounding variables rather than exposure to the condition of interest.[59,60] For example, the presence of pre-existing differences among people may affect the outcomes, rather than the independent variable alone. In addition, the sources of data, either people or documents, are not an absolute reflection of events, because people need to recall their past, which is affected by their personal preferences and their ability to remember. In other words, asking people to recall events is a source of recall bias.[62] Likewise, retrieving documents can introduce bias from two perspectives, firstly the degree of accuracy

and completeness is not known, and secondly the researcher may misinterpret the documents.[62]

Appropriateness of the Retrospective Design

In order to conduct a successful study, it is necessary to use the appropriate design to answer the research question, in doing so one enhances the rigour of the study.[58] Selecting an appropriate design requires considerable thought because many factors should be taken into account, primarily the research question and the ethical concerns, but also the availability of funds, time and researcher experience are pivotal factors.

The descriptive retrospective chart review design was considered appropriate for the current study because little literature was available on outcomes for patients with diabetes and a foot burn injury. Hence, such a design enabled the researcher to collect a large amount of information that would increase understanding about the possible outcomes for people with diabetes and a foot burn injury. As such, retrospective studies are appropriate in preliminary areas of research.

The purpose of the retrospective chart review design is to use routinely documented information to answer the research question and determine what if any relationships exist among study variables. Data can be collected within a relatively short period of time with minimum costs[60,61] and without interruption to treatment plans.[62]

For the purpose of the current study, the retrospective case note review was preferred over prospective follow up. A retrospective design was chosen because prospective studies require large sample sizes,[58] usually continue over a long period of time and

require a good estimate of the potential sample size. The number of people with diabetes and a foot burn injury was not known at the outset of the study. In addition, prospective studies are costly in terms of time and money[60,61] which were not available for the study. Moreover, the presence of the researcher in the study hospital to collect data may alter the treatment of patients, which has ethical implications.

In order to overcome the limitations of the retrospective review, the researcher retrieved the files of all patients admitted to a large tertiary hospital in South Australia with a principal diagnosis of a foot burn injury from the January 1,1999 to December 31, 2004. This time frame was chosen because it was considered that the care received was based on contemporary practice. Also, the involvement of one hospital gave the researcher some assurance that subjects received the same quality of care. Subsequently, heterogeneity among subjects in terms of the care received was reduced.

Data Collection Tool

A tool for data collection (Appendix 1) was developed based on the available diabetes and burns literature. The tool was designed to collect information on a large number of variables and was grouped into seven major sections. Collecting large amounts of data is necessary in descriptive studies to formulate the basis for new areas of research. Data were also used to determine how or when stratifying the data for the purpose of analysis is required.

The tool was developed to collect demographic and diabetes-related data. Subjects' past health history was of interest because the person's general health status can affect

wound healing process. Data collected included how the burn occurred, burn-related complications, inpatient management and discharge status. Identifying the history of the burn injury was necessary to determine the severity of that injury, which is a major determinant of outcomes along with the management of the burn injury. Burn-related complications and discharge status were considered to be primary indicators of outcomes for patients with diabetes and a foot burn injury.

Before commencing the study, the data collection tool was checked for its validity and reliability. The tool was examined to establish face and content validity. A review for face validity was sought from the Research and Higher Degree Sub-committee (RAHDS) of the Department of Clinical Nursing, the University of Adelaide, and as a result modifications were made. A review for content validity was sought from the Clinical Nurse Consultant in the Diabetes Centre and from the Clinical Nurse Consultant of the Burns Unit in the study hospital. Each Clinical Nurse Consultant provided a letter of support for the study. The researcher piloted the tool on a sample of the case notes, and no modifications were considered necessary.

Typically, reliability represents the consistency and the accuracy of a tool designed to measure an attribute. In the current study, the data collection tool was considered reliable because the Clinical Nurse Consultants reviewed its accuracy, while its consistency in application was ensured because the researcher collected the data, rather than others. In other words, only one person used the data collection tool.

Subjects

Subjects were selected from a large tertiary hospital in South Australia with a specialised burns unit. For the purpose of the current study study, a meeting was held with a staff member from the diabetes centre who revealed that hospitalisation for those with diabetes because of a burn injury is an alarming issue in the study hospital. Another meeting was held with the Clinical Nurse Consultant of the burns unit, who dictated that a foot burn injury is usually associated with graft failure and recurrent admissions. Accordingly, it was decided to compare outcomes for patients with diabetes and a foot burn injury with patients with a foot burn injury without diabetes. This comparison enabled the researcher to determine whether the outcomes of a foot burn injury differ in the presence of diabetes. In short, the target population for the present study were case note of patients with diabetes and a foot burn injury.

Inclusion Criteria

Subjects' case notes were included if they:

- had a documented diagnosis of a foot burn injury
- were admitted to the burns unit of the study hospital between January 1, 1999 and January 31, 2004. it was assumed that the five-year period enabled the researcher to identify subjects with a foot burn injury who had been managed according to contemporary practice. Subjects were considered to have been admitted to the burns unit if they received care from the burns team in any ward of the study hospital.

Subjects were divided into two groups according to the presence or absence of diabetes before hospitalisation, because literature documents that diagnosis of

diabetes is difficult during hospitalisation for a burn injury.[63] The group of subjects with diabetes included all patients who had a diagnosis of diabetes prior to their burn-related admissions. The second group included patients with a foot burn injury and no history of diabetes.

Exclusion Criteria

Subjects were excluded from the study if they:

- had a foot burn injury in association with a burn injury in another body site because the presence of a burn injury to multiple body sites increases the severity of a burn injury and impacts on patient outcomes.
- had a documented indication of non-compliance with the treatment regimen, which therefore may impact on their outcomes.

The exclusion criteria enabled the researcher to select subjects with burn injuries of comparable sizes who received comparable treatment. Thus, the heterogeneity of the severity of burn injuries and the treatment among subjects was reduced.

Ethical Considerations

The Research Ethics Committee of the study hospital approved the research proposal (Appendix 2). Subjects' anonymity and confidentiality were assured. In order to maintain anonymity, subjects' names were not collected and a code number was given to each subject's case note. Therefore, subjects' consents were not sought. The codes were documented on a separate sheet together with subjects' hospital unit record numbers (UR). The code allocated to each case note was written against its UR, to enable the researcher to find a specific case note to collect missing data or verify the

data. Data were collected from records using the approved data collection tool without direct contact with the subjects.

Confidentiality was maintained by collecting the data in a viewing room in the Medical Records Department of the study hospital. Data collection sheets will be kept in the Department of Clinical Nursing, the University of Adelaide in a locked cabinet for five years.

Accessing Patients' Case Notes

The study proposal, together with the data collection tool approved by the Research Ethics Committee, was submitted to the Director of Medical Records in order to facilitate access to case notes. The director then requested the statistical department of the study hospital to prepare a list of patients who had been hospitalised within the study period and met the inclusion criteria. Staff of the statistical department used the Australian Patient Management System (APMS) to identify patients who were hospitalised between January 1, 1999 and December 31, 2004 with a principal diagnosis of a foot burn injury.

Over a period of two months, the researcher reviewed the case notes in the Medical Records Department during business hours using the approved data collection tool. The review of each case note started by assigning a code for that case note, then documenting the UR and the code in the subjects' list; next the eligibility of that case note for inclusion in the study was checked. In the case of inclusion, the code was initially written on the data collection tool and then grouped either with or without

diabetes. Next, the rest of the data collection tool was completed according to the documented information.

The "Patient Registration-inpatient" sheets in the case notes were used to collect demographic data, whereas the "Casemix Summary" sheets were the primary source of the rest of the data. The Casemix Summary sheet was adopted by the South Australian government from the Victorian Health Care System-Victoria, Australia, in 1993 in order to standardise the codes South Australian hospitals used to compute their annual budgets. (C. Russell, personal communication, May 13, 2005). The sheet codes and describes eight aspects of an admission episode, namely, principal diagnosis, complications, comorbidities, procedures and operations, other management, admission to critical care units, external cause of the injury, and any plan for readmission. The researcher collected the required data, and checked data against discharge letters.

In the case of unavailability of data in "Casemix Summary" sheets and discharge letters, other sheets were reviewed. Examples of these sheets are progress notes, laboratory reports and referral letters from the emergency department, outpatient clinics and other health care institutions. Previous admissions were also reviewed if there was a need to confirm data such as date of diagnosis with diabetes and past medical history.

At the end of each reviewing day, the researcher coded and entered data onto a data set created in the Statistical Package for the Social Sciences (SPSS) version 11.5. This daily activity helped the researcher to verify the completeness of data collected from

the case notes. If data were missing, subjects' codes and UR numbers were used to identify the case notes in order to obtain missing data.

Data Analysis

The accuracy of data, which were coded and entered into the data set, was checked before proceeding with data analysis using version 11.5 of SPSS. Statistics used to analyse the data were descriptive statistics and non-parametric statistical tests. Descriptive statistics were used to describe the study population and variables. The level of measurement of each variable determined the appropriate statistical procedure for that variable. Percentages and frequency distributions were used to describe nominal variables, while mean and standard deviation were used to describe continuous variables.

Statistical tests were used to answer research questions, and in doing so, they described the relationships between diabetes and outcomes following a foot burn injury. Typically, statistical tests are divided into two main groups, namely, parametric and nonparametric tests. Parametric tests are preferred to nonparametric ones because of their power.[58] However, their use is governed by five assumptions: level of variable measurements, normality of variables, homogeneity of variance, randomisation and equality of sample size in each group. If these assumptions are not met, parametric tests are not appropriate and nonparametric tests should be. There is much debate in the literature on the degree of breach of these assumptions.[58] To use parametric test, authors emphasise the necessity of advance levels of measurements or variables from interval and ratio levels of measurements, randomisation and normality.[58] In the current study, parametric statistical tests were not to be considered

appropriate because a lack of randomisation and the low level of measurements. Therefore, nonparametric tests were used.

Nonparametric tests or "distribution free statistics" are less powerful than parametric tests, but they are good alternatives if parametric tests were not appicable.[58] Generally, there is at least one nonparametric alternative for each parametric test, which enables the difference between distinct groups or differences within the group to be tested.[58] In the current study, Chi-square (a nonparametric statistical test) was used to test the difference between study groups when variables were at the nominal level.[58] when the Chi-square was not applicable, Fisher's exact test was used. Fisher's exact test is used with small samples or cells with low frequency. In the literature, there was no agreement on which sample is small and which cell has low frequency. In order to address the disagreement, it was decided to apply Polit and Beck[58] conditions that considered the sample small, if it was < thirty, and cells to have low frequency if the frequency was zero. However and by default, the statistical package used to analyse the data considers the frequency of a cell to be low, if it is < five. Thus, Polit and Beck's criteria were not applicable in the current study because the sample size was > thirty and the statistical package computes the frequencies. Accordingly, Fisher's exact test was used if there was a cell with frequency < five. Mann Whitney U test, a non-parametric version of student-t test used to compare between two distinct groups, was used when the independent variable was nominal and the dependent variable was continuous.[58]

Summary

The case notes of patients with a foot burn injury were reviewed retrospectively to determine whether the outcomes for patients with a foot burn injury differ in the presence of diabetes. The review was undertaken in a viewing room in the Medical Records Department of the study hospital using an ethics approved data collection sheet (Appendix 1). Descriptive statistical procedures and nonparametric statistical tests were applied to analyse the data using SPSS version 11.5.

RESULTS

Introduction

This chapter of the report outlines the results of the study. The results are presented in two parts reflecting the statistical analyses undertaken. The first part describes the study population and variables, while the second part presents analysis of relationships among study variables.

Study Population and Variables

The sampling population was all case notes of patients with foot burn injuries who had been hospitalised in the study hospital within the study period. Eighty-two patients with a principal diagnosis of a foot burn injury fulfilled the study inclusion criteria.

Eighteen subjects were excluded because their foot burn injuries were associated with burn injuries to other parts of their bodies. Non subjects were excluded because of non-compliance with the treatment protocol. However, it was documented in one of the case notes that a patient did not comply with the management of his/her diabetes. The case note was reviewed because the non-compliance was not with the treatment of the burn injury, which was the focus of the exclusion criteria. Therefore, sixty-four case notes were included in the study.

Demographic Characteristics

Sixty-four case notes were reviewed, 70% of them were male patients, and 30% were females. There were fifty-two patients without diabetes, eight with type 2 diabetes,

and four had type 1 diabetes (Figure 1). The duration of diabetes ranged from one to thirty-three years with a $\bar{\chi}$ of 13.4 years and a SD of 8.7 years. Eight subjects had diabetes for more than ten years. The duration of diabetes was not recorded in one case.

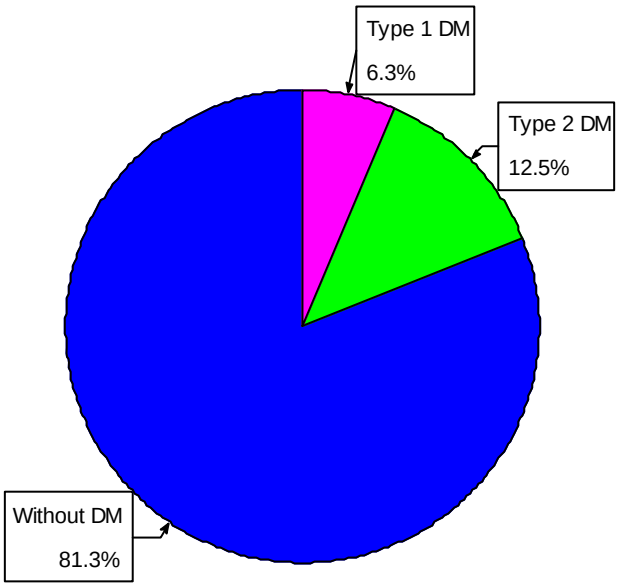

Figure 1 Subjects' Groups by Diabetes Status

Subjects with diabetes were from a narrower age range and were older than those without diabetes (Table 2). Most subjects with diabetes (83%, n=10) were > forty-five years old, whereas the highest proportion of those without diabetes were in the middle-age group.

Table 2 Subjects' Age Distribution

Group	$\bar{\chi}$	Range	SD
Total population	44.97 years	From 16 years to 94 years	20.12 years
Diabetes group	59.17 years	From 37 years to 73 years	13.9 years
Non-diabetes group	41.69 years	From 16 years to 94 years	19.9 years

The duration of hospitalisation of each subject was calculated by subtracting the date of admission from the date of discharge identified in the casemix summary sheets. If a patient died in hospital, the date of death was taken as the discharge date. In the case of readmission for the same burn injury, the duration of hospitalisation was considered the sum of length of stay of all admission periods. Subjects with diabetes experienced longer durations of hospitalisation than those without diabetes (Table 3).

Table 3 Subjects' Length of Stay

Group	$\bar{\chi}$	Range	SD
Total population	15.1 days	From 1 day to 154 days	22.14 days
Diabetes group	32.17 days	From 3 days to 154 days	43.30 days
Non-diabetes group	11.67 days	From 1 day to 67 days	10.80 days

Past Medical History

Most subjects (75%, n=48) had a history of previous medical conditions, and 25% had no documented previous illnesses. Previous illnesses were grouped according to the affected body systems. These groups were previous surgery and accidents, eye, cardiovascular, respiratory, musculoskeletal, psychiatric, digestive, cancer microvascular (retinopathy or neuropathy) conditions; miscellaneous conditions were grouped into one group called other illnesses. Three-quarters of subjects with diabetes had a history of cardiovascular conditions or retinopathy and/or neuropathy. They also had other eye problems, for example cataract; Table 4 illustrates percentages of these conditions among the study groups.

Table 4 Subjects' Past Medical History

Affected system	Freq	%	Freq	%	Freq	%
	Total population		Diabetes group		Non-diabetes group	
Surgery & accidents	17	27	6	50	11	21
Eye	8	13	4	33	4	8
Psychiatric	7	11	2	16	5	10
Cardiovascular	16	25	9	75	7	14
Respiratory	7	11	1	8	6	12
Cancer	5	8	1	8	4	8
Gastrointestinal	11	17	3	25	8	15
Neurological	21	33	9	75	12	23
Musculoskeletal	9	14	1	8	8	15
Other illnesses	13	20	5	42	8	14

History of the Burn Incident

Statistical analysis revealed that scalds were the most common documented cause of burn injuries among the study population, followed by contact with hot surfaces, flames, then chemicals and friction, and lastly the sun (Figure 2).

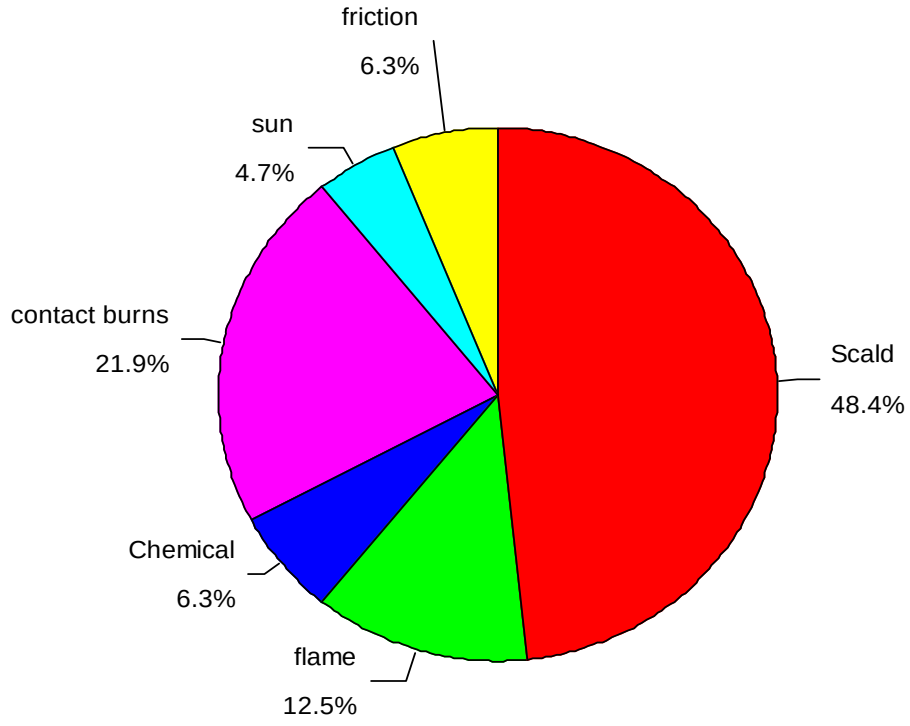

Figure 2 The Documented Causes of Burn Injuries Among Overall Subjects

Among subjects with diabetes, these causes were in a different frequency; contact with hot surfaces was the most frequently documented cause (58.3%) followed by scalds (16.7%) and flames (16.7%), and then chemicals (8.3%). Among subjects without diabetes, the most common causes of burn injuries were scalds (55.8%), followed by contact with hot surfaces (13.5%), then flames (11.5%), next friction (7.7%) and finally, both the sun (5.8%) and chemicals (5.8%).

Of the 23% (n=15) of subjects who received first aid prior to hospitalisation, two had diabetes. The most frequently used first aid management was cold water.

It was noted that 67% (n=43) of case notes did not contain documentation of the time interval between the occurrence of the burn injury and seeking health care. Twenty-one case notes contained documentation of the presentation time. Two subjects attended hospital immediately. For the remaining nineteen subjects, presentation times were estimated in hours (Table 5). Presentation time was documented in seven case notes out of the twelve for subjects with diabetes. One presented immediately and the time was estimated in hours for the remaining six (Table 5). For subjects without diabetes, fourteen case notes out of the fifty-two documented the presentation time. It was estimated in hours for thirteen of these patients (Table 5), but in the case of the fourteenth patient presentation was immediate.

Table 5 Presentation Time to Hospital Following Burn Injuries

Group	$\bar{\chi}$	Range	SD
Total population	63.42 hours	From 1 hour to 504 hours	114.92 hours
Diabetes group	72 hours	From 24 hours to 168 hours	52.53 hours
Non-diabetes group	59.46 hours	From 1 hour to 504 hours	59.46 hours

Regarding the total body surface area (TBSA) of burn, all but two case notes had documentation of the TBSA, seven case notes had narrative descriptions of the TBSA while fifty-five case notes had percentages of the TBSA. The most frequent burn size among the study groups was 1% of the body surface area, this percentage was reported in 67% (n=8) of case notes for subjects with diabetes and 52% (n=27) of case notes for those without diabetes. The statistical analysis showed that subjects with diabetes had a narrow range of TBSA and small burn size in comparison with those without diabetes (Table 6).

Table 6 Total Burn Surface Area

Group	$\bar{\chi}$	Range	SD
Total population	1.63%	From 1% to 8%	1.3%
Diabetes group	1.20%	From 1% to 2%	0.42%
Non-diabetes group	1.72%	From 1% to 8%	1.37%

Among the study population, full thickness burn injuries were the most frequent, followed by partial thickness and, finally, superficial burn injuries (Table 7).

Table 7 Depth of Burn Injury

Depth of burn injuries	Freq	%	Freq	%	Freq	%
	Total population		**Diabetes group**		**Non-diabetes group**	
Full thickness	40	63	8	67	32	62
Partial thickness	18	28	2	17	16	31
Superficial	5	8	2	17	3	6
Not recorded	1	2	-	-	1	2
Total	64	100	12	100	52	100

Most subjects sustained burn injuries to one foot: 67% (n=8) of subjects with diabetes and 81% (n=42) of those without diabetes.

Complications

Statistical analysis showed that complications were mainly local at the burn site. Wound infection was the most frequent complication followed by cellulitis, in the total study population and subjects without diabetes. Among subjects with diabetes, wound infection and the frequency of cellulitis occurred with the same frequency (Table 8).

Table 8 Burn Local Complications

Complication	Freq	%	Freq	%	Freq	%
	Total population		Diabetes group		Non-diabetes group	
Wound	29	45	9	75	20	39
Cellulitis	19	30	9	75	10	19

Other complications occurred less frequently and included: urinary tract infection, sepsis, pneumonia, gangrene, foot abscess, herpes simplex, agitation, anaemia, viral infection, upper respiratory tract infection and gastrointestinal tract bleeding.

Inpatient Management

General Management

There was no fasting for pure burns management purposes, and all cases of fasting were related to surgical purposes. The duration of fasting was calculated as the difference between the time of breaking the fast post operatively and the time of commencing of fasting preoperatively. Of the fifty-four subjects (total n=64) who

fasted, forty-four were without diabetes and ten were patients with diabetes. Subjects with diabetes were fasted for shorter time than those without diabetes. However, other measures of central tendency were comparable among the study groups (Table 9).

Table 9 The Duration of Fasting

Group	$\bar{\chi}$	Range	SD
Total population	20.57 hours	From 6 hours to 83 hours	12.38 hours
Diabetes group	19.1 hours	From 6 hours to 38 hours	9.4 hours
Non-diabetes group	20.9 hours	From 11 hours to 83 hours	13 hours

No subjects received resuscitation fluids or were admitted to ICU. Closed dressing was policy in the burns unit of the study hospital. All subjects received wound care (dressing) that was changed either once per day, twice per day or other intervals (Table 10).

Table 10 Dressing Change Frequencies

Frequency of dressing change	Freq	%	Freq	%	Freq	%
	Total population		**Diabetes group**		**Non-diabetes group**	
Once per day	28	44	4	33	24	46
Twice per day	2	3	0	0	2	4
Others	34	53	8	67	26	50

Most subjects received antibiotic therapy. The percentages of those with and without diabetes who received antibiotics were 92% (n=11) and 56% (n=29), respectively. Subjects with diabetes received antibiotic therapy for longer periods in comparison with those without diabetes (Table 11).

Table 11 The Duration of Antibiotic Therapy

Group	$\bar{\chi}$	Range	SD
Total population	14.74 days	From 1 days to 154 days	24.27 days
Diabetes group	26.64 days	From 3 days to 154 days	43.22 days
Non-diabetes group	10.07 days	From 1 days to 39 days	7.55 days

All but two subjects (those without diabetes) received topical antimicrobial therapy. Blood was transfused for two subjects both without diabetes. The volumes of the transfused blood were 1000 ML and 1500ML.

Surgical Management

Grafts were applied for 67% (n=43) of the study population, 75% (n=9) of subjects with diabetes and 65% (n=34) of subjects without diabetes. The grafts were applied at different time intervals after the foot burn injuries were sustained. The earliest and the latest grafts were applied to subjects without diabetes (Table 12).

Table 12 Time Intervals Between the Burn Incident and the Application of Graft

Group	$\bar{\chi}$	Range	SD
Total population	11.74 days	From 1 days to 90 days	16.87 days
Diabetes group	12.11 days	From 4 days to 30 days	9.03 days
Non-diabetes group	11.65 days	From 1 days to 90 days	18.51 days

Most grafts were applied on single sites; grafts were applied on multiple sites for three subjects with diabetes and six subjects without diabetes. Sizes of the grafts were not recorded in the case notes. Regrafting was done for five subjects without diabetes.

Debridement was done for 84% (n=54) of the total study subjects, 92% (n=11) of those with diabetes and 83% (n=43) of subjects without diabetes. Four subjects (two with diabetes and two without diabetes) under went amputations. One subject without

diabetes under went excision, another under went excision and direct closure and a third had a cystoscopy. No subjects with diabetes under went these surgical interventions.

Preoperative systemic antibiotics were administered to three subjects without diabetes and one subject with diabetes.

Blood Glucose Management

The statistical analysis revealed that 48% (n=31) of the case notes contained documentation of patients' admission blood glucose levels. High values of blood glucose levels on admissions were noted among subjects with diabetes in comparison with those without diabetes (Table 13).

Table 13 Blood Glucose Levels on Admission

Group	$\bar{\chi}$	Range	SD
Total population	9.0 mmol/L	From 4 mmol/L to 21 mmol/L	4.922 mmol/L
Diabetes group	13.82 mmol/L	From 5 mmol/L to 21 mmol/L	4.567 mmol/L
Non-diabetes group	6.01 mmol/L	From 4 mmol/L to 11 mmol/L	1.651 mmol/L

For all subjects with diabetes, blood glucose levels were closely monitored at a minimum of every six hours for subcutaneous sliding scale insulin coverage. The documented results of blood glucose levels were collected to determine whether patients had either controlled or uncontrolled diabetes. Subjects were considered to have uncontrolled diabetes if either their case notes contained documentation of uncontrolled diabetes or the values of their glucose levels were more than 10 mmol/L in at least half of the documented readings.

Follow up

All but one subject who did not have diabetes were discharged without complications, one subject died in hospital. All but three subjects who did not have diabetes were given referral letters for follow up care. Most of these letters (91%, n=58) were for follow up in outpatient clinics (Table 14).

Table 14 Destination of Referral

Destination	Freq	%	Freq	%	Freq	%
	Total population		Diabetes group		Non-diabetes group	
Outpatient	58	91	10	83	48	92
G.P	2	3	1	8	1	2
Burns Unit	1	2	1	8	0	0
No-referral	3	5	0	0	3	2
Total	64	100	12	100	52	100

Statistical analysis revealed that 14% (n=9) of the study population were readmitted because they either developed complications or required surgical interventions (
Table 15). More than one third of subjects with diabetes (n=4) were readmitted, whereas less than one-tenth of those without diabetes (n=5) were readmitted (
Table 15).

Table 15 Reasons for Readmission among Study Groups

The reason	Freq	%	Freq	%	Freq	%
	Total population		Diabetes group		Non-diabetes group	
Necrosis	1	2	0	0	1	2
Infection	3	5	2	17	1	2
Graft failure	2	3	0	0	2	4
Procedure	3	5	2	17	1	2
Total	9	14	4	33	5	10

Relationships among Study Variables

Non-parametric statistical tests were used to determine whether there was an association between diabetes and outcomes for patients with a foot burn injury. Comparisons were made firstly between subjects with and without diabetes, and secondly within the group of subjects with diabetes. The comparisons between subjects with and without diabetes were undertaken by diabetes status (present or absent), type of diabetes ([type 1 or type 2 diabetes] vs. no diabetes) while the comparisons within the group of subjects with diabetes were made by diabetes type (type 1 vs. type 2 diabetes) and diabetes control (controlled vs. uncontrolled). Conventionally, a p-value of < 0.05 is regarded as statistically significant and was applied in this analysis.

The comparisons by diabetes status were made firstly between outcomes for all subjects with diabetes and outcomes for all subjects without diabetes, and secondly between outcomes for subjects with and without diabetes when the data were stratified by age. For the purpose of analysis, subjects were stratified into three age groups: 16-35, 36-55 and 56 years or over. It was noted that subjects with diabetes were either from 36-55 years age group or 56 years or over age group (Table 16).

Therefore, outcomes for subjects with and without diabetes in these age groups were compared. Thus, comparisons by diabetes status were made firstly when age was not controlled and secondly when age was controlled.

Table 16 Subjects' Age Ranges

Age group	Freq	%	Freq	%	Freq	%
	Total population		Diabetes group		Non-Diabetes group	
16-35 years	24	38	0	0	24	46
36-55 years	23	36	5	42	18	35
=>56 years	17	27	7	58	10	19
Total	64	100	12	100	52	100

There were three comparisons made by diabetes type. In the first, outcomes for subjects with type 2 diabetes were compared with outcomes for those without diabetes, in the second comparison, outcomes for subjects with type 1 diabetes were compared with those for subjects without diabetes, and thirdly outcomes for subjects with type 2 and type 1 diabetes were compared.

There was also one comparison by diabetes control. In this comparison outcomes for subjects with uncontrolled diabetes were compared with those for subjects with controlled diabetes. Subjects were considered to have uncontrolled diabetes if their case notes contained documentation of uncontrolled diabetes or the values of their blood glucose levels were more than 10 mmol/L in at least half of the number of the documented results. This principle was applied because, currently, diabetes is considered uncontrolled if hyperglycaemia persists for a period of two months.[64] The amount of glucose in haemoglobin (the value of A1C test) is often used to measure the average blood glucose levels over the preceding three months;[64] A1C test values were not recorded for subjects of the current study.

Chi-square and Fisher's exact test were used to test differences between the study groups for nominal variables; Fisher's exact test was used if the cells had a frequency of less than five. Mann Whitney U test was used to test differences between the study groups when the independent variable was nominal and the dependent variable was continuous.

Differences among Groups

Demography

The comparisons by diabetes status revealed that there were no statistically significant differences between groups in gender. Subjects with diabetes were statistically significantly older than those without diabetes, U = 133, p = 0.002. However, there were no statistically significant differences in age between subjects with and without diabetes when the comparisons were within the 36-55 and 56 years or over age groups. The comparisons by diabetes type and the comparisons by diabetes control revealed no statistically significant differences between groups in terms of gender or age.

The Duration of Hospitalisation

The comparisons of the duration of hospitalisation, which was considered the total number of days of hospitalisation attributed to a foot burn injury, revealed a statistically significant relationship between diabetes and the length of stay. This statistically significant relationship was found when subjects with diabetes were compared with those without diabetes (Table 17), and also noted when the comparison was between subjects with diabetes, aged 56 years or over, and their peers

in the group of those without diabetes (Table 17). There were no statistically significant differences between subjects with diabetes of the 36-55 years age-range and their peers who had no diabetes in terms of the duration of hospitalisation (Table 17).

Table 17 Length of Stay among Study Groups

Age group	Groups of comparisons	U	p
All	Diabetes vs. non- diabetes	169	**0.014**
36-55 years	Diabetes vs. non- diabetes	34	0.410
56+ years	Diabetes vs. non- diabetes	14	**0.040**

Subjects with diabetes had a longer length of hospital stay than those without diabetes. The mean length of stay and the range of length of stay for subjects with diabetes in total and for those with diabetes, aged 56 years or over, were longer than those without diabetes (Table 18).

Table 18 Length of Stay among Study Groups

Diabetes status	Age group	$\bar{\chi}$	Range
Present	**All**	32.17 days	From 3 days to 154 days
	36-55 years	10.60 days	From 3 days to 19 days
	56+ years	47.57 days	From 8 days to 154 days
Absent	**All**	11.15 days	From one day to 67 days
	36-55 years	8.83 days	From one day to 28 days
	56+ years	18.90 days	From 5 days to 67 days

The comparisons of the duration of hospitalisation by diabetes type identified different relationships between diabetes and length of stay. The duration of

hospitalisation for subjects with type 2 was not statistically different from that for subjects without diabetes, U = 137, p = 0.125. Subjects with type 1 diabetes had a statistically significant longer duration of hospitalisation than those without diabetes, U = 31.5, p = 0.021. The mean duration of hospitalisation for subjects with type 1 diabetes and subjects without diabetes were 55.75 days, range 9 to 154 days and 11.15 days, range 1 to 67 days, respectively.

There were no statistically significant differences in duration of hospitalisation between those with type 1 and type 2 diabetes, and between those with controlled and uncontrolled diabetes.

Past Medical History

Subjects' past medical history was compared firstly by the presence or absence of a history of previous illnesses and secondly according to the affected body systems. In the first stage, the comparisons by diabetes type showed no statistically significant differences in their medical history between subjects with and without diabetes.

As past medical history was a constant variable among all subjects with diabetes, no statistics were computed when subjects with type 1 and type 2 diabetes were comapred, and when subjects with controlled diabetes were compared with those with uncontrolled diabetes.

The comparisons by diabetes status revealed that subjects suffering from this illness had a statistically significant past medical history, $\chi^2 = 4.923$, p = 0 .028, when all subjects with diabetes were compared with all subjects without diabetes. However, there were no statistically significant differences in the presence of a past medical

history between those with and without diabetes when comparisons were within the age groups 36-55 and 56 years or over.

In the second stage of comparison which was undertaken according to the affected body systems, subjects with diabetes were more likely to have cardiovascular, neuropathy, retinopathy and other eye conditions than those without diabetes. These were statistically significant differences when all subjects with diabetes were compared with all subjects without diabetes (Table 19). When the data were stratified by age the presence of cardiovascular disease or microvascular condition (retinopathy and peripheral neuropathy) were statistically significant amongst subjects with diabetes, aged 56 years or over, compared with their peers without diabetes (Table 19). On the other hand, there were no statistically significant differences between subjects suffering from the disease, aged from 36-55 years, and their counterparts without diabetes in terms of a history of cardiovascular, microvascular or a history of other eye conditions (Table 19).

Table 19 Cardiovascular, Eye and Microvascular Conditions among Study Groups

Age group	Groups of comparisons	Cardiovascular disease		Microvascular conditions		Other eye Conditions	
		χ^2	p	χ^2	p	χ^2	p
All	Diabetes vs. non- diabetes	19.692	**0.000**	11.92	**0.001**	5.861	**0.035**
36-55 years	Diabetes vs. non- diabetes	2.273	0.194	2.638	0.142	3.764	0.217
56+ years	Diabetes vs. non- diabetes	4.958	**0.044**	5.130	**0.050**	0.014	1.000

Cardiovascular conditions were more common amongst subjects with type 1 diabetes than those without diabetes and the difference was statistically significant, $\chi^2 = 9.589$, $p = 0.016$. Cardiovascular, microvascular conditions and previous surgery and accidents were statistically significant amongst subjects with type 2 diabetes

compared with those without diabetes, the computed χ^2 values were 15.470, 8.901 and 6.061, respectively, and the computed p-values were 0.001, 0.007 and 0.026, respectively.

The only statistically significant difference within the group of subjects with diabetes was a history of gastrointestinal tract conditions amongst those with controlled diabetes compared with those with uncontrolled diabetes, $\chi^2 = 12.000$, $p = 0.005$.

History of the Burn Incident

Comparisons between groups were undertaken according to each documented burn cause. Contact with hot surfaces accounted for the highest proportion of burn injuries among those with diabetes. This was statistically significant when all subjects with diabetes were compared with all subjects without diabetes (Table 20), and when those with diabetes, aged 56 years or over, were compared with those without diabetes in the same age group (Table 20). Scalds accounted for the highest proportion of burn injuries among subjects without diabetes. This was statistically significant when all subjects with diabetes were compared with all subjects without diabetes, and when the comparison was between subjects with type 1 diabetes and those without diabetes (Table 20). However, when the data were stratified by age, there were no statistically significant differences between those with and without diabetes in terms of scald burn injuries.

Subjects with type 2 diabetes were more likely to sustain burn injuries caused by contact with hot surfaces. This was statistically significant when subjects with type 2 diabetes were compared with those without diabetes (Table 20).

There were no statistically significant differences between subjects with type 1 and type 2 diabetes in terms of the documented causes of burn injuries. Likewise, there were no statistically significant differences between subjects with controlled and uncontrolled diabetes.

There was an association between diabetes and a delay in presentation. This was statistically significant, when all subjects with diabetes were compared with all subjects without diabetes (Table 20), and secondly when subjects with diabetes, aged 36-55 years, were compared with their peers who had no diabetes (Table 20). Subjects with type 2 diabetes had a statistically significant delay in presentation when compared with subjects without diabetes (Table 20). There were no statistically significant differences between those with type 1 diabetes and subjects without diabetes in terms of presentation time.

Table 20 History of Burn Injury among Study Groups

Principle	Age group	Groups of comparisons	Contacts@		Scalds		Pt*	
			χ^2	p	χ^2	p	U	p
Diabetes status	**All**	Diabetes vs. no- diabetes	11.487	**0.002**	5.969	**0.023**	16.500	**0.046**
	36-55	Diabetes vs. no- diabetes	NS*	NS*	NS*	NS*	0.500	**0.021**
	56+	Diabetes vs. non- diabetes	6.804	**0.035**	NS*	NS*	NS*	NS*
Diabetes type	**All**	Type 1 vs. no-diabetes	NS*	NS*	4.627	**0.048**	NS*	NS*
	All	Type 2 vs. non-diabetes	15.470	**0.001**	NS*	NS*	11.500	**0.036**

NS*= not statistically significant
*=Presentation time
@=Contact with a hot surface

There were no statistically significant differences in terms of presentation time between type 1 and type 2 diabetes subjects or those with controlled and uncontrolled diabetes.

All comparisons either between subjects with and without diabetes or within the group of subjects with diabetes revealed that there were no statistically significant differences in terms of seeking and receiving first aid management, TBSA, depth of burn injuries and the involvement of one foot or both feet in burn injuries.

Complications

There was an association between diabetes and the development of cellulitis, which was statistically significantly different when all subjects with diabetes were compared with all subjects without diabetes (Table 21), and when those with and without diabetes, aged 56 years or over, were compared (Table 21). However, there were no statistically significant differences in the development of cellulitis between those with and without diabetes aged 36-55 years (Table 21).

There was a statistically significant relationship between diabetes and the development of a wound infection, when a comparison was made between subjects with and without diabetes (Table 21), but there was no statistically significant difference between these groups when the data were stratified by age.

The rate of cellulitis was statistically significantly different between subjects with type 1 and type 2 diabetes, when each group was compared with subjects those without diabetes (Table 21).

The rate of wound infection was statistically significantly different among subjects with type 1 diabetes compared with subjects without diabetes (Table 21). However, the rate of wound infection was not statistically significantly different when those with type 2 diabetes were compared with subjects who had no diabetes (Table 21).

Table 21 Complications Rates among Study Groups

Principle	Age group	Groups of comparisons	Cellulitis		Wound infection	
			χ^2	p	χ^2	p
Diabetes status	**All**	Diabetes vs. non- diabetes	14.527	**0.00**	5.253	**0.028**
	36-55 years	Diabetes vs. non- diabetes	4.480	0.056	NS*	NS*
	56+ years	Diabetes vs. non- diabetes	10.119	**0.003**	NS*	NS*
Diabetes type	**All**	Type 2 vs. non- diabetes	11.027	**0.003**	NS*	NS*
	All	Type 1 vs. non- diabetes	6.481	**0.035**	5.744	**0.029**

NS*= not statistically significant

There was no statistically significant difference when subjects with type 1 and type 2 diabetes were compared, and when subjects with controlled and uncontrolled diabetes were compared for cellulitis and wound infection.

All comparisons between subjects with and without diabetes and within the group of subjects with diabetes showed no statistically significant differences in terms of the development of other post burn infections or other post burn complications.

Management

As mentioned in the descriptive statistics section, the management of all subjects (with and without diabetes) was similar. There were no statistically significant differences in terms of the duration of post burn fasting, the frequency of dressing, receiving antibiotic therapy, the duration of antibiotic therapy, graft application, time interval between sustaining burn injury and the application of grafts, the application of either single or multiple grafts, regrafting, debridement rates, other surgical procedures or receiving preoperative systemic antibiotics.

However, those with diabetes were more likely to require antibiotic therapy and the difference was statistically significant when firstly all subjects with diabetes were compared with all subjects without diabetes, $\chi^2 = 5.361$, $p = 0.023$. Secondly, when those with and without diabetes, aged 36-55 years, were compared, $\chi^2 = 5.856$, $p = 0.037$. Also, subjects with diabetes, aged 36-55 years, had a statistically significant delay in graft application compared with their counterparts without diabetes, $U = 4.500$, $p = 0.025$.

All comparisons between subjects with and without diabetes showed an association between diabetes and high blood glucose levels on admission. There were statistically significant differences in blood glucose levels on admission when all subjects with and without diabetes were compared, and when the data were stratified by age (Table 22) and when subjects with type 1 and type 2 diabetes were compared with those without diabetes (Table 22).

There were no statistically significant differences in blood glucose levels on admission between subjects type 1 and type 2 diabetes (Table 22).

Table 22 Blood Glucose Levels on Admission

Age groups	Groups of comparisons	U	p
All	Diabetes vs. no- diabetes	21.00	**0.000**
36-55 years	Diabetes vs. no- diabetes	0.000	**.004**
55+ years	Diabetes vs. no- diabetes	7.000	**0.046**
All	Type 2 diabetes vs. no-diabetes	21.000	**0.003**
All	Type 1 diabetes vs. no-diabetes	0.000	**0.002**
All	Type 2 vs. Type 1 Diabetes	15	0.865

Subjects with uncontrolled diabetes had a statistically significant higher admission blood glucose levels in comparison with those with controlled diabetes, U = 1.000, p = 0.021.

Follow up

Discharge status, the referral destination or burn-related readmissions between subjects with and without diabetes and within the group of subjects with diabetes were not statistically significantly different.

Summary

In this analysis twelve subjects with diabetes (eight with type 2 and four with type 1 diabetes) and fifty-two subjects without diabetes were compared on a range of variables. The data were initially analysed using descriptive statistics, followed by the appropriate non-parametric statistical analysis. The main findings were that there were slightly more male subjects with diabetes (58%, n=7) and 56 years old or over and the highest proportion of subjects without diabetes (46%, n=24) was in the age range 16-35 years.

There was an association between diabetes and the frequency of contact burn injuries. In spite of there being no statistically significant differences between subjects with and without diabetes in terms of TBSA, depth of burn injuries, and received burns management, subjects with diabetes were more likely to develop cellulitis and wound infection compared with those without diabetes.

DISCUSSION

Introduction

This chapter of the report interprets the findings of the study within the context of the available literature about diabetes and burn injuries taking into account the methods used to conduct the study. The discussion begins with a brief overview of how the study was conducted, followed by a summary of the main results, then an evaluation of the results is presented. The implications for practice are outlined, and finally the limitations of the study are discussed.

Overview of the Study

This retrospective study was conducted to determine whether there were any differences in outcomes for patients with diabetes and a foot burn injury compared with patients with a foot burn injury without diabetes. The data were obtained by case note review using an ethics approved data collection tool. Sixty-four out of eighty-two patients, who had been hospitalised with a principal diagnosis of a foot burn injury in the study hospital within the study period, were included in the review.

Key Results

Subjects with diabetes and a foot burn injury ranged in age from 37-73 years, and 58% (n=7) of them were 56 years or over, while subjects without diabetes were within the age range of 16-94 years with the highest proportion of them in the middle-age group. Subjects with diabetes appeared to have a higher risk of a foot burn injury, and also they were more likely to sustain burn injuries as a result of contact with a hot

surface; those without diabetes were more likely to sustain burn injuries that resulted from hot liquids. There was a statistically significant association between diabetes and the development of local post burn complications, namely, cellulitis and wound infection. Subjects with diabetes had a statistically significant longer duration of hospitalisation compared with subjects without diabetes.

Context of the Results

In order to provide meaning to the results, it is necessary to discuss these findings within the context of the available body of knowledge of diabetes and burn injuries.

Demography

The results of the study showed a statistically significant relationship between the rate of diabetes in the admission group and age which clearly supports data reported in other studies that type 2 diabetes is a disease of the older age group in developed countries.[11,12,15] King *et al*[15] suggested the association between diabetes and female gender is because the life expectancy for females is greater than males, whereas in the current study males with diabetes outnumbered females. The straightforward explanation for the difference is the methodological differences between the current study and King *et al's*[15] study (which reviewed primary population studies to estimate the prevalence of diabetes). The present study retrieved case notes to determine what were the outcomes for patients with diabetes and a foot burn injury.

The methodological differences explain the presence of a large proportion of subjects with diabetes (19%, n=12) in the current study in comparison with the prevalence of diabetes in the community, which was estimated at 2.7% for Australia in the year

2000.[15] Hospitalised patients do not represent the entire population in the community, but frequently do reflect risk groups.

Accordingly, the presence of a large proportion of subjects with diabetes may suggest that people with diabetes are at risk of a foot burn injury or other types of problems due to complications associated with diabetes. This explanation is supported by the findings of earlier case note reviews in the USA that documented relatively large numbers of people with diabetes sustaining burn injuries compared with those without diabetes.[6,7,55] In particular, Memmel's study[6] showed foot burn injuries occurred in 38% (n=49) of patients with diabetes compared with 15% (n=173) of those without diabetes. However, Memmel[6] did not clarify whether the foot burn injuries were associated with burn injuries to other parts of the body or not. Similarly, a study by Shalom *et al*[55] showed 59% (n=43) of patients with diabetes sustained foot burn injuries while 44% (n=66) of patients without diabetes had foot burn injuries. Specifically in Shalom *et al*'s[55] study, isolated foot burn injuries were documented among 33% (n=24) of patients with diabetes while 15% (n=23) of patients without diabetes. The study being reported and the Memmel[6] and Shalom *et al*'s[55] studies shed light on burn injuries as sources of trauma that may lead to the development of foot problems among people with diabetes.

Duration of Hospitalisation

The results from the present study suggest people with diabetes require a longer stay in hospital to treat a foot burn injury. This is not surprising because diabetes is associated with poor wound healing due changes in the immune system and

circulation to the injured area secondary to hyperglycaemia and diabetes-related complications. A foot burn injury is also a complex type of injury.

The burn itself is a serious injury that not only affects the local burned area but also elicits systemic effects where metabolic[65,66] and haemodynamic[18,67] changes take place in a series of events that slow the wound healing process especially when the burn is large. Diminished wound healing is partially because of skin breakdown, which is the physical barrier against micro-organisms, and partially because of the hypofunction of the immune system, as in the case of poorly controlled diabetes.[68-70]

A foot burn injury is also complicated by the anatomical structure of the foot that contains different types of tissues covered by a thin layer of skin and performs a wide range of motions including weight-bearing.[57] Accordingly, the American Burns Association considers a burn injury to the foot to be a serious injury, and recommends treatment in a specialised burns unit.[56] Additionally, in the case of diabetes, particularly longstanding diabetes, evidence suggests that structural changes in the foot, which develop secondary to diabetes, increase the chance of skin breakdown.[71,72] Thus, people with diabetes have an increased chance of developing serious complications if they sustain a foot burn injury.

It appears that people with diabetes require a longer length of stay in hospital to treat a foot burn injury than those without diabetes. The association between diabetes, a foot burn injury and a longer duration of hospitalisation is consistent with anecdotal evidence reported by clinicians.[4] However, additional evidence is required to determine whether or not diabetes is the only factor contributing to the longer length

of stay. Likewise, unknown interactions between diabetes and foot burn injuries and hospital environment could have been operating that influenced the results? Therefore, further research is needed to compare the duration of hospitalisation required to treat non-burn foot injuries among patients with diabetes with that patients without diabetes.

Generally, patients with diabetes require a longer length of stay to treat their injuries compared with those without diabetes because of the multifaceted effects of diabetes that hinder the healing process. Therefore, people with diabetes are more likely to require complex management, for example extended hospitalisation and antibiotic therapy. The current study indicates that subjects without diabetes were more likely to experience regrafting than those with diabetes possibly because delayed graft application and multiple sites of grafting were more likely to occur among subjects without diabetes. However, these differences were not statistically significant. Additionally, the findings revealed no statistically significant differences in the duration of hospitalisation when subjects with diabetes in the age range of 36-55 years were compared with those without diabetes in the same range of age. One explanation for this finding is that diabetes per se is a risk factor for longer hospital days, but other factors increase the need for longer duration of hospitalisation such as age, presence of other illnesses and hyperglycaemia.

In the current study, subjects with diabetes in the age range 36-55 years were not statistically significantly different from their counterparts who had no diabetes in terms of cardiovascular conditions and age, factors which increase the need for longer hospital stays. However, there were no statistically significant differences in the

duration of hospitalisation between subjects with type 2 diabetes and those without diabetes, but those with type 2 diabetes were statistically significantly older, and had a statistically significant history of cardiovascular, retinopathy, peripheral neuropathy and other illnesses compared to subjects without diabetes. It is possible to relate the lack of differences in the duration of hospitalisation between those with type 2 diabetes and subjects without diabetes to the fact that there were no statistically significant differences between these two groups in wound infection rates.

In a previous review of burns and diabetes, Memmel[6] found no statistically significant differences in duration of hospitalisation for patients with diabetes compared with those without diabetes, whereas longer hospital stays were required to treat burn injuries among patients with diabetes aged 15-54 years compared with their peers who had no diabetes. An explanation for Memmel's[6] findings is that 31% (n=49) of patients with diabetes in aged 15-54 years had foot burn injuries and cardiovascular comorbidities.

Local Burn Complications

In the current study, most complications were local to the burned area, namely cellulitis and wound infections. As one would expect, there was an association between diabetes and the development of cellulitis and the development of wound infection. Diabetes is a condition that causes deterioration of general wellbeing, and therefore increases the risk of complications by slowing the initial inflammatory reaction process, and hindering epithelisation in the injury.

Indeed, the susceptibility to infection among people with diabetes is not new information. It is well documented in the literature that such people are at risk of infection due to hyperglycaemia which affects the functions of many body systems. Long standing Hyperglycaemia increases the likelihood of infection in a complex manner that starts by a weakness in the inflammatory reaction to an injury, coupled with poor sensory functions that delay seeking treatment, which is aggravated by poor blood flow to the injured area that results from peripheral vascular disease.

In the case of the present study, subjects with diabetes had another risk factor for infection: a burn injury in the foot. Foot burn injuries are serious, because of the anatomical and functional characteristics of this part of the body, and because burns an injury create somewhat similar effects to diabetes on the immune system. In other words, infections developed because of joint risk factors from diabetes and from foot burn injuries.

Therefore, it is not surprising to find an association between diabetes and the development of cellulitis. However, in the age range of 36-55 years, there were no statistically significant differences in the rate of cellulitis between subjects with and without diabetes. It is possible to relate this lack of statistical significant to the fact that these two groups were not statistically significantly different in terms of gender, or past medical history in general, and cardiovascular illnesses in particular, which are known to affect general health status.

In the context of the association between diabetes and other risk factors for infection such as age and past medical history, other researcher such as Memmel[6] and

McCampbell *et al*[7] who examined the relationship between diabetes and burns showed that patients suffering from this illness were older and more likely to have cardiovascular comorbidities compared with those without diabetes who matched their age groups. Patients with diabetes in the 15-54 years age group and those in the 55-91 years age group were more susceptible to develop cellulitis.[6] These findings also emerged in the current study.

The findings of the current study also support the findings of earlier studies[6,7] in relation to wound infections. Subjects with diabetes in all age groups had higher frequency of wound infections compared with those without diabetes regardless of diabetes type. However, the current study showed that wound infection was not statistically significant among subjects with diabetes compared with those without diabetes when the data were stratified by age, and also when subjects with type 2 diabetes were compared with subjects without diabetes. The lack of statistical significance may be due to small group sizes when the data were stratified by age. Similarly, McCampbell *et al*[7] considered small sample as the reason for the absence of statistically significant differences in terms of wound infection and cellulitis rates among patients with diabetes. In the current study, the small group size also prohibited stratifying the data by age when comparisons were undertaken according to diabetes type. In short, patients with diabetes have many risk factors for post burn infections, such as peripheral vascular disease, immune system changes and high blood glucose levels.

Literature data suggest that the experience of hyperglycaemia, which is a common post burn hypermetabolic response, increases the tendency towards infection because

of the hyperviscosity of the blood,[73] which reduces blood flow to the burned area, subsequently infection and poor healing may develop.

A study in 2005 documented an association between post burn hyperglycaemia and death rate,[74] as well as poor blood glucose control among patients who developed post burn sepsis, particularly among children.[75] Accordingly, it is possible to say that patients with uncontrolled diabetes are more likely to have post burn infections in comparison with those with controlled diabetes.

McCampbell *et al*[7] reported a statistically significant association between the development of post burn morbidities and the uncontrolled diabetes. McCampbell *et al's*[7] findings contrast the results of the current study that revealed no statistically significant differences between those with controlled and uncontrolled diabetes in terms of cellulitis and wound infection rates.

A possible explanation for difference between the current study and McCampbell *et al*'s[7] study is that McCampbell *et al*[7] investigated patients with burn injuries of different size and depth; whereas in the present study all subjects either with controlled and uncontrolled diabetes had similar burn injuries in terms of depth and size. Additionally, in the current study subjects in both groups (with controlled and uncontrolled diabetes) were susceptible to infection as a result of other diabetes complications. The justification seems fitting, particularly since the relationship between hyperglycaemia and infection is not a cause and effect relationship. In review, the findings of the study underreporting suggest an association between

diabetes and the development of post burn local complications, and these finding are consistent with previous studies.[6,7,55]

The present study identified that subjects with diabetes had three major risk factors for the development of local post burn complications, namely, diabetes (hyperglycaemia and diabetes-related complications), the burned area (the foot) and the type of injury (burn), whereas subjects without diabetes had the last two factors out of the three. Therefore, it is necessary to determine whether these statistically significant differences between subjects with and without diabetes would be similar if the injury happened to be a non-burn foot injury. Such information is required to determine whether there is an interaction between diabetes and a foot burn injury that affects outcomes for patients suffering from both conditions. In doing so, the seriousness of burn injuries among people with diabetes would be identified, and therefore, may highlight the necessity of preventing such injuries.

History of the Burn Injuries

Contact burn injuries accounted for the highest proportion of injuries among subjects with diabetes in the current study. In particular, contact with hot surfaces was a statistically significant cause of burn injuries among those with diabetes. This finding is different from previous studies[7,55] that found scalds were the most commonly documented causes of burn injuries among patients with diabetes, whereas Memmel[6] found scalds and contact with a hot surface were the most common causes of burn injuries among patients with diabetes.

Possible explanations for differences among the studies are that the present study focused on foot burn injuries while Memmel's,[6] McCampbell *et al's*,[7] and Shalom *et al's*[55] studies included burn injuries to other body parts. Subjects with diabetes became close to hot surfaces, for example heaters, to warm their cold feet, which is common among people with diabetes because of peripheral neuropathy[76] leading to prolonged contact causing unrecognised contact burn injuries. This explanation seems reasonable because the analysis of data of the present study identified contact with hot surfaces as a statistically significant cause of burn injuries among subjects with type 2 diabetes, and also among subjects with diabetes aged 56 years or over compared with those without diabetes. These two groups (subjects with type 2 diabetes and subjects with diabetes aged 56 years or over) had history of peripheral neuropathy and retinopathy. Subjects with type 1 diabetes, and subjects with diabetes in the 36-55 years age range with no statistically significant history of peripheral neuropathy and retinopathy, contact with hot surfaces was not a statistically significant cause of burn injuries.

In the present study, it is worth noting that subjects with diabetes delayed presenting to a health care facility following the burn injury. Similar delays in seeking health care were reported in other studies,[6,7] and also reported in clinicians' anecdotal reports[1,2,4,5] that documented either a delay in presentation or a delay in discovering foot burn injuries. In the study underreporting, presentation time was estimated for six subjects out of twelve with diabetes, and estimated for thirteen subjects out of fifty-two without diabetes. Documentation of the presentation time of such a few subjects may suggest that staff in the study hospital documented time to presentation only when it was significant.

It is possible to argue that people with diabetes are more likely to delay seeking health care following a foot burn injury because they have poor pain sensation due to peripheral neuropathy that may have delayed the discovery of injuries. In fact, pain is a prime reason for seeking health care, yet pain sensation is often diminished among people with diabetes and peripheral neuropathy. In the present study, 75% of subjects with diabetes had a history of peripheral neuropathy conditions that could be attributed to diabetes. These conditions were statistically significant among subjects with diabetes compared to those without diabetes, as one would expect given the effect of the condition.

A delay in presentation may have a role in increasing post burn complications, especially infection, among patients with diabetes due to worsening of the condition and therefore complicating of treatment. Accordingly, it is possible to say that patients with diabetes who delay seeking health care are more likely to experience poor outcomes compared with those who receive early treatment.

McCampbell *et al*[7] reported that post burn morbidity and mortality were more common among patients with diabetes who delayed seeking health care compared to those with diabetes, who did not delay seeking health care, although patients with a delay in presentation had a smaller TBSA of burn injuries. McCampbell *et al's*[7] findings contrast the results of the current study that showed no statistical significant differences between subjects with diabetes who sought medical attention early and those who delayed seeking heath advice, in terms of size and depth of wound injuries, treatment course and outcomes.

A possible explanation for the variation in findings is that in the present study these two groups (those with diabetes and delay seeking health care vs. those with diabetes and no delay seeking health care) had other risk factors that could worsen the outcomes of a burn injury. For instance, past medical history, age, gender, duration of diabetes, admission blood glucose levels and the development of post burn complications, which all influence the outcomes of a burn injury.

Implications for Practice and Further Research

Since the study was conducted in a large tertiary hospital in South Australia, it would be useful to replicate the study to determine whether the results are consistent in other tertiary hospitals. Such replication would provide credibility for research findings, and therefore increase the possibility of generalising the findings, if confirmed, among different patients in other settings at different times. It would be also useful to determine whether the outcomes can be attributed to the presence of diabetes or extraneous variables such as different treatment protocols or different populations. This type of information could provide strong research-based evidence to promote changes in practice using consistent research evidence accumulated from different places.

The present research indicates that subjects with diabetes need a longer hospital stay to treat a foot burn injury, perhaps because of the effects of diabetes that cause delay in seeking health care and because the disease process slows healing. The longer length of stay comes at a cost to both the patient and the health care facility. There is growing evidence that a large proportion of health care budgets is assigned to diabetes

of which most is spent on management of the associated conditions, particularity foot problems that may eventually lead to amputation.[77]

It is well established in literature that diabetes is a risk factor for lower limb amputation. A report by Reiber *et al*[78] identified three causal pathways for the development of diabetic foot ulceration, namely, diabetic neuropathy, minor trauma and foot deformity. Therefore, prevention of diabetic foot ulceration should be directed toward this causal pathway, particularly trauma because in many cases it could be prevented.

Burn injuries cause trauma, and they are complex injuries. Therefore, it is necessary to manage a foot burn injury firstly and most importantly at the prevention level, secondly early detection and proper management. In this context, the recommendations of McCampbell *et al*[7] are important, as they advocate the implementation of a new approach to assess the depth of a burn injury other than visual estimation, from which a new aggressive approach should be developed to treat a burn injury among patients with diabetes. However, the development of such an approach would require multidisciplinary efforts.

Foot care is widely recommended for people with diabetes, and there are many foot care education programmes offered to help sufferers of this illness to manage their diabetes and maintain healthy feet. Substantial evidence suggests the value of foot care education in the short-term.[79] Perhaps, a special emphasis should be given to a foot burn injury, particularly since in previous studies[6,7,55] and case reports,[2-4] as well as in the current study, most subjects with diabetes sustained burn injuries from

ordinary household appliances. Thus, a foot burn injury or for that matter any injury should be of concern in diabetes education programmes. However, there is no standard model for foot care education programmes.[79] These programmes have to move beyond the mere delivery of information to behavioural modification and including all aspects of patient daily life in the education process.

In fact, foot care education is part of a comprehensive foot care strategy that includes monitoring, education and clear referral pathways for the appropriate level of care. Therefore, foot care and education should be personalised according to individual patient needs and level of risk for the development of diabetes-related foot problems. Hence, the initial step in diabetic foot care is identifying cases at risk in order to provide the appropriate care for each case. Foot screening is a widely recommended technique for identifying cases at risk and triage of these cases. In other words, foot screening is an integral part of any foot care programme. Accordingly, national guidelines for the management of diabetic foot problems recommend foot examination at least annually.[80-84]

Ideally, annual foot screening should be done for all people with diabetes. However, evidence from different countries shows that health care personal do not give much attention to feet during routine follow up of people suffering from this illness, although national plans for foot screening have been initiated.[85-88] This negligence of foot screening could be attributed to the fact that there is no clear delineation of who should be the primary provider of foot screening. Additionally, preventive foot care programmes are mainly delivered in hospitals where it is difficult to screen all people

with diabetes, particularly since a large proportion of them may have functional limitations on access to these secondary health care facilities.

Limitations

The results of the study showed that there was an association between diabetes and outcomes for patients with a foot burn injury. However, these results were generated retrospectively using data retrieved from admission case notes. Therefore, extraneous variables might have affected the generated results. That is, the retrospective nature of the established the association between diabetes and outcomes for patients with a foot burn injury threatens the accuracy of this association.

The retrospective nature of the data collected in the current study is a limitation. The data were collected from patients' case notes, rather than recorded at the time the episode occurred, and hence the accuracy and completeness were not known. It is also possible that the researcher may have misread the case notes. There is always the possibility that missing data, which could not be collected because the health care team at the time may no longer be available, and if they were, one would question their ability to accurately recall the particular events, especially if some considerable time has elapsed. As such, the association between diabetes and outcomes for patients with a foot burn injury is open to alternative explanation because of the limitations of using retrospective data.[89]

Moreover, selection bias can occur in descriptive retrospective designs.[58,89] In the current study, patients who were selected from the study hospital might not represent people with diabetes and a foot burn injury in the community, because there was a

trend to treat patients with burn injuries in outpatient rather inpatient settings. Importantly, the sample size in the present study was also small (n=64, 52 without diabetes and 12 with diabetes).

An inadequate or small sample has also potential to distort the results. As examples of this, 75% (n=9) of subjects with diabetes under-went graft application while 65% (n=34) of those without diabetes experienced grafting. These differences may suggest that people with diabetes were more likely to sustain deep burn injuries. Subjects with diabetes 67% were more likely to experience full thickness burn injuries than those without diabetes 62%. At the same time, subjects with diabetes were more likely to have small TBSA in comparison with those without diabetes. However, these differences were not statistically significant, and this lack of statistically significant differences may be due to sample size. In short, the main limitation of the current study is the sample size that prohibited matching subjects in terms of age, gender and date of admission.

The possibility is open to relate the results to the confounding variables rather than diabetes, particularly if these variables were unrecognised. Pre-existing differences could be attributed to many factors, for example gender or age variations between subjects. In the current study, subjects without diabetes were younger than those with diabetes. It is well established in the body of literature that people at extremes of age have poor wound healing in comparison with those in middle-age, and wound healing in females is poorer than males. Additionally, the presence of pre-existing medical conditions, such as cardiovascular and respiratory conditions, may also alter the

healing process. As a result outcomes could vary. Therefore, the results of the present study are not reliable for generalisation.

Summary

The study demonstrated that patients with diabetes are more likely to sustain foot burn injuries as a result of contact with hot household devices, perhaps because of their poor sensory functions. Cellulitis and wound infection were statistically significant complications among patients with diabetes compared with those without diabetes. The presence of diabetes was also associated with a statistically significant longer duration of hospitalisation to treat a foot burn injury.

Outcomes for patients with diabetes and a foot burn injury did not differ statistically according to diabetes type or diabetes control. All comparisons between patients with and without diabetes or within the group of patients with diabetes revealed no significant statistical differences between groups in terms of TBSA, wound depth and received treatment.

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Appendix 1

Data Collection tool

Subject Code	

Subject Group		
With diabetes		Without diabetes
Type 1	Type 2	

I- Demographical data

1-Gender

- ❑ Female
- ❑ Male

2-age---------- years

3-Date of admission

Day	Month	Year

4-Date of discharge

Day	Month	Year

5- the duration of hospitalisation ---------- days

II- Past Health History

The patient has history of: -

1) ----------
2) ----------
3) ----------
4) ----------
5) ----------
6) ----------

III- History of the Burn Incident

1- the documented cause of burn injury

- ❑ Scald Injury
- ❑ Flame Injury
- ❑ Electrical Injury
- ❑ Chemical
- ❑ Others

2- the patient received household burn management

- ❑ Yes ----which was ----------
- ❑ No

3-Time interval between the accident and seeking health care was---------- hours

4- the Total Burn Surface area was ---------- %

5- the degree of burn was

- ❑ First Degree
- ❑ Second Degree
- ❑ Third Degree

6- the burn injury affected:

- ❑ One foot
- ❑ Two feet

IV- Complications

1- Infection

- ❑ Urinary Tract infection
- ❑ Thrombophlebitis
- ❑ Cellulitis
- ❑ Sepsis
- ❑ Wound Infection
- ❑ Bacteraemia
- ❑ Fungaemia
- ❑ Pneumonia

2- Contractures

- ❑ Yes
- ❑ NO

3- other complications

V-Pre admission diabetes data

If the subject has no history of diabetes go to section VI

1- the duration of diabetes ……years

2- Prior admission diabetes management

- ❑ Diet
- ❑ Exercise
- ❑ Oral hypoglycaemic agents
- ❑ Insulin

VI-In hospital management

a- General management

1-the patient was kept NPO for ---------- days

2- the patient received resuscitation fluid

- ❑ Yes
- ❑ No

3- dressing was done

- ❑ Every other day
- ❑ Once per day
- ❑ Twice per day
- ❑ Other

4- the dressing strategy was

- ❑ Open method only
- ❑ Closed method only
- ❑ Both

5- antibiotics therapy

- ❑ Yes ------ for---------- days
- ❑ No

6-topical antimicrobial therapy

- ❑ Yes
- ❑ No

7-Blood transfusion

- ❑ Yes ---------- ML of blood or its derivatives
- ❑ No

8-Admission to ICU

- ❑ Yes for --------- days
- ❑ No

b-Surgical management

1-Grafting

- ❑ Yes ---------- days after burn injury
- ❑ No ---------- go to question number 5

2- graft was applied on

- ❑ One site
- ❑ More than one site

3-size of Graft--------- CM

4- regrafting

- ❑ Yes ---------- because ----------
- ❑ No

5- other surgical interventions

- ❑ Yes ----------
- ❑ No

6- preoperative systemic antibiotics

- ❑ Yes
- ❑ No

c-glucose level management

1- Patient's blood Glucose level on admission to the hospital was----------mg/dl

2- Method of glucose monitoring

- ❑ Blood testing
- ❑ Urine testing
- ❑ Both
- ❑ No testing.

3-Blood glucose levels during hospitalisation

Day post admission	Time	Blood glucose level	Insulin	
			Dose	Route
			Unit	
			Unit	
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			Unit	

VII-Follow up

1- Discharge status

- ❑ Alive without complication
- ❑ Alive with complication
- ❑ Dead

2- Referral to other health care speciality area

- ❑ Yes ------to ----------
- ❑ No

3- Readmission

- ❑ Yes ------because ----------
- ❑ No

Appendix 2

ROYAL ADELAIDE HOSPITAL
North Terrace
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14 October 2004

Mr Ma'en Zaid Abu-Qamar
DEPT OF CLINICAL NURSING
LEVEL 3, ELEANOR HARRALD BLG
ROYAL ADELAIDE HOSPITAL

Dear Mr Abu-Qamar,

Re : "A comparative study of outcomes for patients with a foot burn injury compared with patients with diabetes and foot burn injury." RAH PROTOCOL NO: 041006.

I am writing to advise that ethical approval has been given to the above project.

Research Ethics Committee deliberations are guided by the Declaration of Helsinki and NH&MRC National Statement on Ethical Conduct in Research Involving Humans. Copies of these can be forwarded at your request.

Adequate record-keeping is important and you should retain at least the completed consent forms which relate to this project and a list of all those participating in the project, to enable contact with them if necessary, in the future. The Committee will seek a progress report on this project at regular intervals and would like a brief report upon its conclusion.

Yours sincerely,

Michael James

Dr M James
Chairman
RESEARCH ETHICS COMMITTEE

STUDY 2

MANAGEMENT OF ADULT INPATIENTS WITH DIABETES: A SURVEY OF BURNS UNITS

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ABSTRACT

The present study investigated the management of diabetes for patients whose hospitalisation was due to a burn injury.

Burns units treating adults in Australia, New Zealand, Hong Kong and the United Kingdom were approached to take part in the study. Selected clinical leaders of these units were asked to complete an ethics approved and valid questionnaire. The questionnaire (in Microsoft Word™ format) was sent as an e-email attachment to liaison persons who then forwarded it to nursing and medical leaders in their identified units. The questionnaire was completed by 29 clinical leaders from 17 out of 30 burns units invited to participate.

Numerical data were analysed using descriptive statistics with the Statistical Package for the Social Sciences (SPSS). Respondents' comments were managed using content analysis. Findings indicated that respondents regularly provided care to patients with diabetes. The regimen used to manage diabetes before admission was most likely to be modified to accommodate the individual needs of each patient in hospital. However, there was no information on how such needs were incorporated in the modified plan. Diabetes multidisciplinary centres were located in all participating sites. Yet, they were not always involved in the process of care. Subcutaneous sliding insulin scales were commonly used to control patients' glycaemic state in burns units. The nursing leaders viewed glycaemic control as an integral part of the management plan of patients with both diabetes and a burn injury. Overall, the findings indicated that both diabetes and burn injuries should receive optimal management because of reciprocal effects.

Diabetes represents a management challenge to burns unit staff because of its multifaceted nature. The constantly fluctuating blood glucose levels, which are characteristics of diabetes, are exacerbated by a burn injury. Therefore, the current study contends that efforts should be directed to provide optimal diabetes management as part of aggressive burns management. Involvement of diabetes multidisciplinary teams may help in managing the multifaceted nature of diabetes. A stronger focus on the primary prevention of burn injuries, might avoid complicated sequalae.

INTRODUCTION

Context of the Study

Diabetes is a complex syndrome, which causes deterioration in general wellbeing and may predispose a person to hospitalisation because of general medical conditions that could conceivably be managed on an outpatient bases. Simultaneously, these medical conditions can exacerbate diabetes, and the person becomes more unwell, making hospitalisation necessary.

Studies have shown that people with diabetes are more likely than those without diabetes to be hospitalised and stay longer in hospital for the treatment of general medical conditions.[1-3] Indeed, such hospitalisation is problematic because diabetes is often unrecognised as a secondary diagnosis.[4-7] Accordingly, diabetes often receives suboptimal management,[5] and poor glycaemic control is often associated with poorer outcomes of the primary condition.[8]

Evidence documents the value of glycaemic control among those with a secondary diagnosis of diabetes.[8] Therefore, proper diabetes management is necessary to improve outcomes for those hospitalised because of a general medical condition, particularly when that condition (for example burns) creates metabolic[9,10] and immune alterations,[11-13] similar to that occurring in diabetes.

The first study in this portfolio and other researchers[14-16] showed that a complex hospital treatment course can be required to treat a burn injury sustained by patients with diabetes compared with those without diabetes. Additionally, it was reported in

the first study and other previous studies[14,16] that persons with diabetes were disproportionably more likely to be hospitalised because of burn injuries than those without diabetes. In fact, both the epidemiological data of diabetes and burn injuries as well as the pathological effects of diabetes suggest that people with diabetes are at higher risk of burn injuries and the treatment can be complex when both conditions coexist.

The first study in the present portfolio claimed that the risk is mainly to the feet because people with diabetes usually have poor eyesight that may hinder their ability to avoid sources of burn injuries. Additionally, they usually have nerve impairment that masks their pain perception, so that they do not feel their skin being burnt. Subsequently, treatment would belatedly be sought after the development of infection resulting in complex clinical decisions. Therefore, it could be appropriate to say that optimal management of diabetes is an integral part of any management plan of burn injuries.

Although clinicians recognise the complexity of diabetes management in burns units,[17,18] several studies of inpatients with diabetes and burn injuries did not demonstrate how diabetes was managed.[14-16] Furthermore, the first study described in this portfolio found that blood glucose levels were managed using the subcutaneous sliding insulin scales, whereas the literature does not recommend these sliding scales because they are retrospective and actually contribute to fluctuating blood glucose levels.[19] Accordingly, further research is required to illuminate the way diabetes is managed in burns units and to develop recommendations for best practice.

Purpose of the Study

The purpose of the study was to describe the management of diabetes when the primary admission diagnosis was a burn injury, and then to determine whether any modifications were needed for management of burn injuries sustained by patients with diabetes. In particular, the study aimed to determine whether diabetes multidisciplinary teams were involved in the management of people with diabetes and a burn injury, and to determine whether diabetes management was included in discharge plans from burn units.

Statement of the Research Questions

The research questions were:

- How is diabetes managed when patients are hospitalised with a burn injury?
- Do burns units staff involve diabetes multidisciplinary teams in management of inpatients with diabetes and a burn injury?
- Do discharge plans from burns units include management of patients' diabetes?

Significance of the Study

Diabetes and burn injuries are associated with similar multi-system involvements, and exacerbate each other. Accordingly, each condition should be managed appropriately to improve the health outcomes for those suffering from diabetes and a burn injury. How diabetes is managed in burns units is not well known. Thus, the findings of the study will address this apparent gap in the knowledge. The findings will also highlight the importance of optimal diabetes management. The information will provide a rational basis to inform changes in practice, and highlight issues for further research.

Definition of Terms

Chief physicians and chief nurses: clinical leaders or senior clinicians in burns units participating in the study.

Appropriate diabetes management: refers to the management that aims to maintain blood glucose levels within the normal range.

Glycaemic state: refers to the state of blood glucose levels.

Secondary diagnosis a term used when hospitalisation is for a condition other than diabetes

Multidisciplinary team refers to group of professionals from different disciplines who manage people with diabetes collaboratively.

Seriousness: a term refers to severity of illness.

Summary

Patients with diabetes put a heavy load on inpatient facilities in the treatment of conditions unrelated to this syndrome such as burn injuries. Specifically, these patients represent a particular group in burns units, because the effects of diabetes are coupled with the effects of burn injuries in terms of metabolic alterations and suboptimal immune functions. As a result, patients with diabetes require prolonged

hospitalisations, recurrent admissions and more hospital resources. Accordingly, where applicable, the management of a burn injury should be accompanied with appropriate diabetes management. They way diabetes is managed in burns units is not fully understood, therefore, further studies are required to specifically investigate the management of diabetes in these units.

LITERATURE REVIEW

Introduction

A literature review is a stepping-stone for any research project because it evaluates the available knowledge concerning the proposed area of research, and then highlights a gap existing in knowledge that should be filled. Hence, an extensive electronic search search was conducted in order to identify contemporary studies of inpatients with diabetes and a burn injury published on MEDLINE, CINAHL databases and found using the search engine, Google. The search was done over four months using different combinations of terms such as diabetes, burns, inpatient, hospitalisation, treatment and management. Studies were considered contemporary if they were published after 1995. However, an exception was given to two studies because they were thorough and comprehensive.[3,20] Relevant references in the identified studies were also reviewed. The present literature review is organised under three main headings: firstly, management of diabetes which introduces contemporary trends and evidence in diabetes care, secondly, management of diabetes in hospitals, which is discussed under two subheadings as follows: hospitalisation patterns and diabetes management. Lastly, information on the management of diabetes in burns units is presented.

Management of Diabetes

Diabetes is of growing concern because of its global nature and because it is often associated with devastating health problems such as stroke, neuropathy, nephropathy, peripheral vascular disease and cardiovascular disease. Because of such a situation,

management plans have been endorsed at international,[21] regional,[22,23] national[24-26] and local levels to ameliorate sequences of diabetes.[27,28] Although these plans have been underpinned by different philosophies of health care, they are directed towards helping the population with diabetes to maintain normal or near normal blood glucose levels.

Indeed, global efforts to address diabetes are not surprising because this disease is a condition where the body can not maintain blood glucose levels within the normal range. Additionally, perhaps these efforts come from the findings of several randomised controlled trials (RCTs)[20,29-31] that demonstrated the role of tight glycaemic control in reducing the incidence and severity of diabetes-related complications. These RCTs varied in terms of size and focus; because of this variation, it was decided to exclude the smaller studies. Accordingly, two mega RCTs[20,31] were examined because they were considered benchmark studies in the field of diabetes.

In the two RCTs mentioned above,[20,31] blood glucose levels were controlled using well-known strategies, namely, diet therapy, exercise and drug therapy that could be insulin and/or oral hypoglycaemic agents (OHAs). In particular, the Diabetes Control and Complications Trial (DCCT)[20] combined diet therapy, exercise plus insulin to normalise blood glucose levels among those with type 1 diabetes. However, one could say: this combination is well accepted as a management of type 1 diabetes.

Over one decade, the DCCT compared prospectively the effectiveness of two forms of the combination (intensive versus conventional therapy) in achieving tight glycaemic

control among 1441 person in 29 centres in the USA. The difference between these therapies is that the intensive glucose management included more frequent blood glucose testing, insulin injections and adjusting of insulin doses according to patients' daily needs. Additionally, the intensive regimen provided a multi-disciplinary follow up on a monthly basis. The DCCT set targets for the treatment strategies used in the study; these targets were absence of signs and symptoms of hypoglycaemia and hyperglycaemia for the conventional therapy group. In the case of intensive management, the target was to keep glycosylated haemoglobin 2 SD above the normal level. Glycosylated haemoglobin is an index of blood glucose levels over a period of two to three months.[32]

Similarly, the UK Prospective Diabetes Study (UKPDS)[31] examined the effectiveness of intensive management in reducing the incidence of diabetes-related complications among 5012 person with type 2 diabetes in 23 centre in the United Kingdom over 17 years. The intensive protocol in the UKPDS included non-pharmacological diabetes management (diet, exercise and follow up) and pharmacological options. The conventional protocol was limited to non-pharmacological measures. Within the context of the pharmacological treatment, the UKPDS considered OHAs as a first pharmacological option, followed by insulin if blood glucose control was not achieved. Thus, if the conventional therapy was not effective, patients were shifted to the intensive management group.

Conventional therapy was considered effective if fasting blood glucose concentrations were $\leq$ 15mmol/L with no signs and symptoms of hyperglycaemia. In the case of intensive management, the results were satisfactory if fasting blood glucose

concentrations were ≤ 6 mmol/L. As such, the UKPDS established targets for each treatment protocol. In review, the UKPDS and DCCT used biological indexes to monitor the effectiveness of intensive glucose management in maintaining the glycaemic state close to the normal range.

The UKPDS and the DCCT followed up the effectiveness of intensive glucose management for ten and seventeen years among those with type 2 diabetes[31] and type 1 diabetes,[20] respectively. The follow-ups established an association between tight glycaemic control and low incidence and severity of diabetes-related complications. Accordingly, maintaining blood glucose at near-normal levels in the long-term has become one goal of diabetes management.

Management of Diabetes: the Multifactorial Nature

Diabetes management is a complex formula that includes many variables affecting the planning and implementation of the management plan. A vital variable is the patient who is currently considered an active participant in this plan perhaps because patients are often required to make radical changes in their life style alongside commitment to lifetime treatment. Consequently, diabetes management needs to become part of the patients' daily life practices in which patient education could play an important role.

Patient education is a well-accepted practice within the area of diabetes care and aims to empower the individual and support them to develop appropriate diabetes self-management behaviours.[33] In this context, it perhaps needs to be acknowledged that currently the focus of diabetes patient education has shifted from the passive delivery of information towards promoting behavioural changes, which requires active patient

involvement in planning and implementing a diabetes self-management education programme.[34] Thus, the education process should be planned and implemented from the patient, rather than the provider perspective. Patient centred approach is necessary because diabetes self-management is a lifelong commitment, and the active involvement of the patient would make diabetes education realistic in terms of the patient needs, abilities and socio-cultural milieu. In addition, the plan should be within providers' abilities, the available resources and their scope of practice.[33] In brief, the management plan should be tailored to match the individual needs of each patient.

Active patient involvement is an evolving approach to achieving optimal glycaemic control. Involving patients in care planning could be challenging for many health professionals, because it is noted that patients with diabetes are less proactive in implementing clinicians' advice or even seeking diabetes care because of their poor understanding of the effects of the disease.[35,36] Importantly, many patients may not be motivated enough to make the dramatic changes in their lifestyle required for diabetes control. Perhaps, as a consequence the scope of multi-professional teams has expanded to include behavioural therapists.

However, diabetes multi-professional teams are often located in hospitals, and it could be very difficult to make these professionals accessible all patients with diabetes because the diabetes population is growing dramatically. Accordingly, it could be sensible to support the current trend to move the management of diabetes from hospital settings to community settings and G.P clinics,[37] and a network of support facilities should be provided. Several authors have advocated this approach.[38-40] However, primary providers show a lack of awareness of the seriousness of diabetes[41]

and report difficulties in managing sufferers of this diseases.[42] Consequently, evidence-based diabetes guidelines have been circulated to G.P clinics.[24,43] In doing so, it is assumed that quality primary care is accessible to the people close to their place of residence.

It is evident that management of diabetes is an ongoing process, where the patient is an active participant in the process. The focus of diabetes patient education is promoting behavioural changes towards maintaining normal or near normal blood glucose levels through the implementation of a multifactorial intervention that requires dramatic change in the activities of daily living. However, one could ask what happens to usual management in the case of hospitalisation, where the daily life needs are disrupted. The next section presents an overview of hospitalisation patterns and management of patients with diabetes when diabetes is a secondary diagnosis.

Management of Diabetes in Hospitals

Hospitalisation Patterns

Diabetes is a complex disease whereby the general health status of a person deteriorates and extended hospitalisations may be required. Accordingly, understanding hospitalisation patterns of people with diabetes is necessary in order to highlight the problem, and then identify the various reasons for hospitalisation. This knowledge could help inform practice and help with the prevention of unnecessary hospitalisations for the diabetes population. If such a goal could be met, the load on hospitals could be reduced, and a major saving in health care costs could be achieved, particularly as a significant proportion of the diabetes budget is spent on inpatient care.[44]

Reports have shown that people with diabetes have occupied substantial percentages of hospital beds.[45,46] Interestingly, diabetes is often a secondary diagnosis in inpatient settings.[47,48] Importantly, non-diabetes-related conditions are common reasons for hospitalisation.[1,3,5]

A report by Aro *et al*[3] documented a comparison between patients with and without diabetes in terms of use of inpatient services. Patients discharged from all Finnish hospitals for the years 1987-1989 were identified from the National Hospital Discharge Register. Those with diabetes were linked to the National Drug Register using a personal identification number in order to identify those on diabetes medications. Thus, the population with diabetes was those eligible for diabetes medication reimbursement by the Finnish government (n=89683).

Analysis of the data demonstrated that patients with diabetes were more likely to be admitted, readmitted and stay longer in hospital in comparison with those without diabetes. Such was the case, even if reasons for hospitalisation happened to be non-diabetes-related conditions such as infectious diseases and neoplasms. This is not surprising because the disease is often associated with a poor tissue healing process and a reduced immune system.[49]

Accordingly, Aro *et al*[3] claimed that admission of patients with diabetes because of general medical conditions utilised a significant proportion of hospital resources in comparison with patients without diabetes. This conclusion was considered a real reflection of diabetes in Finnish hospitals because the sources of data accessed had a

high degree of accuracy, despite being secondary sources.[3] However, these findings do represent a relatively outdated profile of inpatients with diabetes in a single country. Therefore, further reports are required to confirm this information.

Ray *et al*[1] documented a comparison of the patterns of hospitalisation amongst people with and without diabetes (n=1084039) in order to estimate the financial burden associated with diabetes when the reason for hospitalisation was a general medical illness. Ray *et al*[1] used data from two national American surveys; namely the National Medical Expenditure Survey (NMES) and the National Hospital Discharge Survey (NHDS). The NMES is a survey done every decade (since 1977) to provide information on the varying costs of health care.[50] The NHDS is a yearly survey carried out to provide information on patients discharged from hospitals.[51] Ray *et al* approached the NMES (1987) to estimate the costs of inpatient management, and they approached the NHDS (1991) to obtain data on hospitalisations for general medical conditions.[1] Specifically, acute and chronic diabetes-related complications were excluded from the study.

Supporting data reported from Finland,[3] Ray *et al*'s report[1] showed that patients with diabetes were more likely to be hospitalised and stay longer in hospital than those without diabetes in the middle-aged and the older age groups. They also noted that septicaemia and liver disease were reasons for hospitalisation in both diabetes age groups, whilst depression was more common among the older people suffering from the disease. Ray *et al*[1] estimated the financial burden associated with the illness in non-diabetes-related admissions to be as much as double that of diabetes-related conditions.

It is possible to say that Ray *et al*'s report[1] underestimated costs associated with treating general medical conditions in people with diabetes because the prevalence of unrecognised diabetes in hospitals is high.[4,6] Additionally, in Ray *et al*'s report,[1] sources of data did not represent all American hospitals. In particular, the NHDS is limited to civilian non-federal hospitals, and does not include psychiatric conditions,[51] while the NMES is limited to American civilians.[50] Similarly, data reported from Finland excluded psychiatric and childbearing women.[3] Additionally, it was limited to people treated with specific diabetes medications,[3] whereas a considerable proportion of the population with diabetes do not use medicines. Also, half of persons with diabetes may remain undiagnosed.[52] In brief, in the American[1] and Finnish studies,[3] the findings are limited by sources of data. These data were obtained from secondary sources that also prohibited the stratification by diabetes type.[1]

However, the reports[1,3] highlighted the significance of diabetes in hospitals secondary to general medical conditions. This significance comes from two perspectives: firstly general medical conditions may aggravate the glycaemic state, and secondly poor glycaemic control may complicate these conditions. In short, hyperglycaemia complicates the course of hospitalisation and treatment. This assertion supports the findings of the next report.

A report by Umpierrez *et al*[5] documented the estimated prevalence of diabetes and hyperglycaemia in hospitals, and the effect of hyperglycaemia on patient outcomes. Hyperglycaemia was documented in 38% of the study (n= 1886). Additionally, one third of those with hyperglycaemia had no history of diabetes, which could be

explained by the fact that firstly many cases with diabetes are discovered incidentally.[52] Secondly hyperglycaemia may be a physiological response to stress associated with acute illness.[53] In Umpierrez *et al's study*, patients with hyperglycaemia were also more likely to stay longer in hospital, be admitted to the Intensive Care Unit (ICU) and die in hospital. Surprisingly, these outcomes were even worse in patients with hyperglycaemia and no previous history of diabetes (new cases of hyperglycaemia) in comparison with those with a history of diabetes. The authors suggested that improper glucose management could be one reason for these findings.

However, Umpierrez *et al*[5] did not find statistically significant differences in blood glucose levels between the two groups in their study. Moreover, the blood glucose levels amongst new cases of hyperglycaemia who died in hospital were more likely to be lower than those with diabetes. A possible explanation for these findings is that new cases of people suffering with hyperglycaemia might have a low tolerance for hyperglycaemia than people with known diabetes. The low tolerance was coupled with a lack of glucose control and so poorer outcomes were more likely to be among these new cases of hyperglycaemia.

However, the association between hyperglycaemia and poor outcomes is not a direct cause and effect relationship, and therefore Umpierrez *et al's*[5] findings could be attributed to the effects of extraneous variables. Yet, evidence documents the importance of normalising blood glucose levels to improving outcomes for those with a secondary diagnosis of diabetes.[8,54] Concisely, under-management of hyperglycaemia is a contributing factor in poor outcomes for inpatient.

Information given in this section showed that patients with diabetes occupy large percentages of hospital beds for the treatment of non-diabetes-related conditions. However, the actual prevalence of diabetes in hospitals is often underestimated, which could be attributed to the fact that hospital staff may consider the state of hyperglycaemia to be a transient physiological response to the acute condition. As a consequence, hospital staff may ignore the management of hyperglycaemia. The following section contains a discussion of the management of inpatients with a secondary diagnosis of diabetes.

Diabetes Management

As discussed earlier in this chapter, diabetes management is a life long process aiming to keep blood glucose levels close to normal. Such a goal can be accomplished by tailoring a multifactorial intervention to individual patient's daily needs. In the case of hospitalisation, these needs change secondary to acute illness and disruption to daily activities. Accordingly, it should be necessary to modify the management plan. A number of studies[1,3,5] show that the population with diabetes is at risk of hospitalisation for non-diabetes-related conditions. The following reports are reviewed in an effort to understand the way diabetes is managed when the primary reason for hospitalisation is a non-diabetes related condition.

Deepak *et al*[55] and Bhattacharyya *et al*[56] investigated the adequacy of glycaemic control among patients treated in an 800 bed Indian hospital and Salford Royal hospital in the UK, respectively. Deepak *et al*[55] and Bhattacharyya *et al*[56] reviewed case notes of patients with diabetes who were discharged from the medical and surgical wards. In particular, the Indian[55] study included the first 150 patients

hospitalised in the year 2002, while the UK[56] study included the first 100 consecutive patients hospitalised in the first three months of the year 2001. Both studies excluded hospitalisations for emergency diabetes conditions, myocardial infarction or gestational diabetes. The Indian report[55] also excluded cases hospitalised for less than three days, and those admitted to the ICU.

Deepak *et al*[55] and Bhattacharyya *et al*[56] noted similar glycaemic control among medical and surgical patients. In particular, poor glycaemic control among patients hospitalised for non-diabetes related conditions was common. More specifically, hyperglycaemia and hypoglycaemia were often observed in medical and surgical wards. Hypoglycaemia was experienced by 20% (n=30)[55] and 25% (n=25)[56] of the study populations. Surprisingly, although some people experienced more than one episode of hypoglycaemia, both studies reported no documentation of action taken to prevent recurrent attacks. Sadly, Bhattacharyya *et al*[56] reported hypoglycaemia as a reason for one patient's death.

Hyperglycaemia was common in both populations: an estimated 50% (n=150) in the Indian hospital,[55] and <50% (n=100) in the UK hospital.[56] Both reports[55,56] indicated that there insulin doses were not adjusted in a considerable proportion of patients, although their blood glucose levels were constantly above 10 mmol/L. The explanation given for not adjusting insulin doses is that insulin was prescribed on a weekly basis, rather than daily according to blood glucose levels.[55,56] The UK report[56] blamed junior physicians who often prescribed insulin doses for one week, rather than on a daily basis. This explanation seems reasonable given that ignorance of hyperglycaemia management was more common in surgical wards, where physicians

may have a lack of knowledge of how hyperglycaemia should be managed compared with medical ward staff. In brief, hospitals' routines and a lack of staff awareness could be reasons for poor glycaemic control in medical and surgical wards.

Deepak *et al*[55] suggested involving specialists in the management of inpatients with diabetes hospitalised for conditions not-related to this disease because they[55] noted better control among patients treated by specialists compared with those treated by physicians. Importantly, the involvement of the specialists was not associated with more episodes of hypoglycaemia. Bhattacharyya *et al*[56] recommended educating hospital staff on the importance of their judgment in achieving proper glycaemic control rather than mere application of hospital guidelines. Bhattacharyya *et al's*[56] recommendation is sensible because most problems were because of inadequate care rather than patients' issues. However, one could say that this inadequate diabetes care could be specific to hospitals included in the Bhattacharyya *et al*[56] and Deepak *et al*[55] reports. Accordingly, reviewing reports from other settings is necessary to verify how diabetes is managed in different inpatient settings.

Smith *et al*[57] examined episodes of hyperglycaemia and hypoglycaemia in order to identify the underlying causes of these episodes among patients hospitalised in a large American tertiary hospital from February to July 2003. Adults (n=50) hospitalised in medical and surgical floors were included giving a similar population to the UK[56] and Indian studies.[55] Like those, admissions in maternity floors and people hospitalised for diabetes emergencies were excluded from Smith *et al*'s report.[57] They also excluded hospitalisations in other wards such as ICU "similar to the Indian study",[55] dialysis

and preoperative suites. Briefly, Smith *et al* clearly indicated that their population was solely adults hospitalised in general medical and surgical wards.

In Smith *et al*'s report,[57] there were two additional main differences from the Indian and UK studies featured earlier.[55,56] These differences were the strategy of identifying episodes of hypoglycaemia and hyperglycaemia plus the definitions of these episodes. In Smith *et al*'s report, hypoglycaemia and hyperglycaemia were defined as blood glucose level below 2.22 mmol/L or above 22.2 mmol/L, respectively. In the previous two studies,[55,56] these definitions were below 4.5 mmol/L for hypoglycaemia, and above 10 mmol/L for hyperglycaemia.

In Bhattacharyya *et al's*[56] and Deepak *et al's* studies,[55] the eligible cases were identified retrospectively from patients' case notes; whereas Smith *et al* identified cases prospectively from hospital laboratory records. In particular, episodes of hypoglycaemia and hyperglycaemia were identified from the hospital laboratory daily printout of abnormal blood glucose levels. These episodes were followed up to identify cases eligible for inclusion in the study.[57] Smith *et al*[57] considered fifty cases eligible for inclusion in the study, out of 327 patients who experienced 509 episodes of hypoglycaemia and hyperglycaemia. Of the fifty, there were twenty-four and twenty-six patients with hypoglycaemic and hyperglycaemic episodes, respectively.

In order to identify the causes of the episodes mentioned in the previous paragraph, data were obtained from firstly the case notes and secondly through interviews with staff and sometimes with patients to elaborate reasons for these episodes. The interviews were held with the provider responsible for each episode, as indicated in

the data obtained from the case notes. The interviews were extensive and written narratively.

The narrative forms of the interviews were analysed by a panel of experts. The panel analysed each case individually in order to identify the causes of the episode and determine whether that episode could be prevented if changes were made in hospital policy. The panel uniformly decided that prevention was possible in 69% (n=18) of hypoglycaemic and 100% (n=26) hyperglycaemic episodes. Although some of the episodes resulted from more than one cause, causes were arranged into five groups. One of these groups was related to the patients such as, refusal of medication and a lack of adherence to the prescribed diet. The remaining four groups were related to the staff that ranged from a lack of adequate knowledge of and skills in the management of diabetes, a lack of implementing the correct plan, discrepancies and a lack of interest in the management of diabetes.

It was noted that hypoglycaemia was mainly due to discrepancy in the course of care followed by poor management. In particular, reduced oral intake during hospitalisation was the main contributing factor to the development of hypoglycaemia. Smith *et al*[57] reported a wide range of reasons for reduced oral intake such as changing dietary habits during hospitalisation associated with no adjusting of antidiabetic medications and inadequate monitoring of blood glucose levels, similar data were reported from the UK.[56] In many cases, Smith *et al* noted that antidiabetic medications were administered, followed by requesting procedures that required fasting the patients and sending them to different departments. These factors cause an imbalance between food intake, dosage of diabetes medications and inadequate

monitoring were common reasons for hypoglycaemia among inpatients with diabetes as a secondary diagnosis.

However, Smith *et al*[57] reported that some patients experienced hypoglycaemia with no documentation of a diagnosis of diabetes. Considering reports[4,6] that documented missed cases of diabetes in hospitals, it is quite possible to say that diabetes was unrecognised among some patients of Smith *et al*'s study.[57] Accordingly, poor glycaemic control was documented among those patients.

Within the context of poor glycaemic control, Smith *et al* found the main cause of hyperglycaemia to be medical officers believing that the management of diabetes was outside their scope of practice. In particular, their main duty was managing the primary reason of admission, rather than diabetes. Furthermore, they were not interested in modifying the preadmission diabetes management plan despite their awareness that the diabetes was poorly managed.

Given these findings, it seems clear that the glycaemic state is poorly managed in general medical and surgical wards. Although there is a wide range of reasons for the poor management, most were related to issues of staff knowledge of, skills in and attitudes towards diabetes management when the primary diagnosis was unrelated to this illness. Hospital staff may ignore the management of diabetes because the primary diagnosis, which they see as their main duty, is more serious. Additionally, the state of hyperglycaemia may be considered a physiological response to the sickness which is a stressful situation stimulating the autonomic nervous system and endocrine system. The effects of the stress response vary from person to person due to

the individual stress response and the situation that evoked the response. In review, a lack of attention is given to diabetes in general wards when the reason for hospitalisation is not related to diabetes. Within this, one could ask what occurs in specialised units like burns units, where a high level of care is supposed to exist.

Management of Diabetes in Burns Units

Patients with diabetes in burns units are a unique group because they often experience traumatic hospitalisation resulting from the combined effects of diabetes and a burn injury. A few contemporary reports have investigated the association between these conditions.

Three reports from different burns units in the USA[14-16] plus the first study in this portfolio documented complex hospitalisation experiences amongst those with diabetes. Specifically, more surgical procedures and a longer duration of hospitalisation were required to treat burn injuries among those with diabetes compared with patients without diabetes who had similar burn sizes,[15] and also were in the same age range.[14,16] Reports gave a wide range of explanations for these findings.

One report proposed that the high prevalence of foot burn injuries amongst patients with diabetes were reasons for their traumatic hospitalisation experiences.[15] In fact, the anatomical and the functional properties of the foot complicate a burn injury in this area,[58] as does the effects of diabetes that slow the healing process and predispose patients to infection. From this perspective, the first study reported in this portfolio

claimed that foot burn injuries amongst patients with diabetes were more likely to be complex than similar injuries among those without diabetes.

Another possible explanation is that patients with diabetes are more likely to delay seeking health care than those without diabetes, probably because of poor protective nerve sensation.[14,16] As a result, it is not surprising that the first study and previous studies[14,16] documented that patients with diabetes were more likely to develop wound infections and cellulitis. In particular, they had higher rates of community-acquired wound infections.[14] In other words, those with diabetes sought treatment after the development of infections, making the situation and therefore the management more complex.

It should be noted that these reports[14,16] had used small numbers of case notes to generate the association between the delay in presentation and the development of post-burn infections. However, these studies[14,16] were done in different places at different times by different researchers using varying approaches to compare outcomes for patients with and without diabetes. For example, those with diabetes were compared with the those without diabetes when data were stratified by age, as is the case of the first study of this portfolio and other studies,[14,16] or matched by gender and date of admission,[16] or when comparisons were made between all patients with and without diabetes, as reported in the first study in this portfolio and previous studies.[14-16]

In fact, clinicians noted the association between the delay in presenting for the treatment of a foot burn injury and the development of post burn infections among

those with diabetes.[59,60] Additionally, the principles of secondary prevention suggest early detection and treatment of a disease can improve outcomes and prevent complications. In short, a delay-seeking health care may predispose those with diabetes to post-burn complications, particularly since many are mainly older and have debilitating health problems.

The first study in this portfolio and other reports[14-16] demonstrated that those with diabetes were significantly older than those without diabetes. In particular, the first study in the portfolio identified that 58% (n=7) of patients with diabetes were aged 56 or over while 19% (n=10) of those without diabetes were in that age group. In one report, the number of the older persons with diabetes hospitalised for burn injuries was five fold their peers who had no diabetes.[16] These findings support the epidemiological profile of type 2 diabetes as a disease of the older people.[52,61,62] Similarly, ageing is a risk factor for burn injuries in developed countries.[63-65] However, McCampbell *et al*'s[16] report and the first report in this portfolio considered these numbers inconsistent with the prevalence of diabetes in the general population. The explanation given for these disproportionably high numbers of patients with diabetes hospitalised because of a burn injury is that those patients were at risk for injuries from burns. This explanation seems reasonable, because the pathological effects of diabetes reduce a person's ability to keep away from sources of injuries, which are often discovered belatedly. In short, diabetes complications can predispose the older people to burn injuries.

Within the context of diabetes complications, the first study in this portfolio considered cardiovascular conditions a factor that may predispose those with diabetes

to poor outcomes. Memmel[14] report documented a higher rate of cardiovascular conditions among those with diabetes, but did not clarify whether these conditions had a role in poor outcomes. Indeed, cardiovascular conditions may reduce blood supply to the burned area, and then poor healing may result. Additionally, the state of blood hyperviscosity secondary to hyperglycaemia may reduce blood supply to the burned area, and also may hinder the immune system.[66] In other words, hyperglycaemia complicates the hospital treatment course of patients with diabetes and a burn injury.

In McCampbell *et al*'s report,[16] it was noted that patients with uncontrolled diabetes were more likely to sustain large burn injuries, develop infections, stay longer in hospital and experience more surgical procedures than those with controlled diabetes. This contrasts with the findings of the first study of this portfolio that demonstrated no differences between those with controlled and uncontrolled diabetes. The first study related this difference to the fact that both groups (controlled vs. uncontrolled diabetes) had diabetes complications, and also that the relationship between hyperglycaemia and infections is not a cause and effect relationship.

Given this information, it seems clear that people with diabetes are a challenging group in burns units because they may require prolonged hospitalisation and complex management in comparison with those without diabetes. This challenge stems from the fact that each condition may aggravate the other, particularly since they may create somewhat similar effects in terms of weakness of the immune system and metabolic alterations. Indeed, patients with diabetes require management of the burn injury alongside the diabetes. In this context, clinicians have stressed the importance of appropriate diabetes management in these patients.[17]

However, previous reports did not demonstrate how the state of diabetes was managed during hospitalisation in burns units.[14-16] Moreover, the first study in this portfolio indicated that subcutaneous sliding insulin scales were used to control the glycaemic state, although diabetes literature considers this approach to be ineffective.[19] Memmel[14] report indicated that insulin drips were used to control hyperglycaemia among those with post burn nosocomial infections. Accordingly, studies are required to feature the way diabetes is managed when the primary diagnosis of admission was a burn injury, given the importance of controlling blood glucose levels in people with diabetes hospitalised because of non-diabetes-related conditions.[8]

Summary

In this review of the literature, it was noted that patients with diabetes put a heavy financial burden on inpatient facilities for treatment of conditions unrelated to diabetes. Importantly, an integral part of this treatment is achieving optimal diabetes control. Evidence showed that diabetes was poorly controlled in general medical and surgical wards. Precisely, poor control was more prominent in surgical wards than in medical wards. The reason for this is that surgical staff lack knowledge and interest in the management of diabetes since their primary duty is managing the surgical problem. Within the context of surgical wards, one could ask what occurs in surgical speciality areas, like burns units, where patients with diabetes represent a challenging group because the effects of diabetes may be coupled with the effects of burn injuries in terms of metabolic alterations and suboptimal immune functions. Consequently, the management of a burn injury should be associated with appropriate diabetes management. How diabetes is managed in burns units is not fully understood,

therefore further studies are required to investigate the management of diabetes in burns units.

METHODS

Introduction

This chapter reports on the methods used to acquire information on the management of diabetes in burns units. Information is presented on the research design in terms of its advantages to the present study and in terms of the techniques used in obtaining data, followed by a justification of their adoption in the current inquiry. Details are given about development of the data collection tool, ethical issues and subjects, as well as how the survey was disseminated and returned. Finally, the chapter outlines the data analyses undertaken.

The Design of the Study

A descriptive-exploratory design was applied to obtain information on the way diabetes was managed in burns units. In this design, data from the actual environment is used to feature a situation or a phenomenon where little is known about that situation or phenomenon.[67]

The descriptive-exploratory design is recommended when variables of interest are often values, beliefs, feelings or opinions. Thus, in such research, data are obtained cross-sectionally from people who are familiar with the phenomenon of interest. Although this design inhibits in-depth elaboration of the phenomenon under study, information covers a wide range of aspects, and therefore, background information about the proposed area of research is established.[67,68] Accordingly, bases for subsequent studies are formulated, and also bases for informing practice are provided because the data provide a detailed description of the study variables. As such, the

descriptive-exploratory design is a non-experimental approach that aims to relate study variables, rather than establishing a cause and effect relationships between these variables.[67,68]

Techniques for Collecting Data in Descriptive-Exploratory Studies

A questionnaire or an interview is typically administered to collect data in the descriptive-exploratory design.[67,69,70] The decision to collect data through either a questionnaire or an interview requires considerable contemplation because several factors should be taken into account, such as available resources, time constraints, sample size and geographical dispersal.[70] Questionnaires allow the inclusion of large samples from different geographical areas, and the data is collected quickly with minimal costs.[68] The interview is a flexible technique that has a high response rate in comparison with the questionnaire.[70] However, researcher interference may be reflected in the subject response.[69,70] Additionally, it may be problematic to interview a large sample, even within the same geographical area, because the interview tends to be time-consuming and costly.[68,70] Accordingly, authors recommend using the questionnaire to eliminate interviewer bias,[69,70] and to enhance subjects' anonymity, especially when the survey asks sensitive questions.[71] Hence, the decision to conduct either a survey questionnaire or an interview is based on the situation in which the research is being conducted.

As the present study used a self-completed questionnaire it is useful to examine techniques commonly used to disseminate questionnaires. The traditional technique of distribution is post because it is relatively inexpensive.[70] However, it could be costly when the sample size is large, and where funds are needed for printing and postage.[72]

Costs increase when overseas subjects are included. Additionally, posting overseas is time consuming and the questionnaire could be lost through the post.

Consequently, the use of electronic surveys is popular as an economic alternative to postal surveys. This popularity is facilitated by the widespread availability of electronic communication systems.[73] There are two main techniques for distributing electronic surveys, namely web-based and e-mail.

E-mail is a flexible and common form of communication that gives subjects a chance to complete the questionnaire at a time of their choosing. Whereas, web-based surveys require subjects to be online for the time needed to complete the questionnaire,[74] which might interrupt their professional duties. In e-mail surveys, subjects have the choice to return the questionnaires either via e-mail, post or facsimile. However, and similar to postal surveys, e-mail surveys may not reach subjects for technical reasons; therefore, low response rates are noted in e-mail as well as in postal surveys.[75] In fact, the response rate in e-mail surveys is based to some extent on the person's attitudes towards, and familiarity with this mode of communication.[73] In order to address this issue, researchers used a combination of methods: e-mail, post and facsimile.[73,76] This is known as multiple-mode surveys.

Multiple-mode surveys are a growing technique for addressing the weakness of single mode surveys.[77] In such surveys, the process is tailored to the requirements of each situation. Dillman[77] featured different circumstances for using mixed-mode surveys; in each circumstance, the process is implemented to achieve certain advantages such as improving the response rate, reducing the cost, broadening the scope of the study

sample and fitting personal preferences. However, multiple-mode surveys are often associated with some potential risks like incongruity between responses obtained.[77] Taking these issues into consideration, Dillman[77] advocates that survey studies should be designed in a manner that suits the individual aspects of each study.

Justification of the Design of the Current Study

Since there was a dearth of literature about the management of diabetes in burns units, and the descriptive-exploratory design is an appropriate starting point for new areas of research, the decision was made to survey burns units using this design. The chosen design allowed the researcher to collect information on a wide range of variables affecting management of diabetes in burns units.

The descriptive-exploratory design enabled the researcher to obtain information from people in the field, thereby reflecting the actual day-to-day practice. Additionally, patient information was not required and clinicians' daily work was not disrupted.

Justification of the Data Collection Technique

After considerable thought taking into account advantages and disadvantages of techniques possible for collecting data in descriptive-exploratory studies, a self-completed questionnaire, rather than a face-to-face interview, was chosen for the present research. Telephone or Internet interviews were also not chosen because it would be difficult to schedule online interviews with subjects. Reasons included the busy nature of the burns units and possible restrictions on telephone and Internet usage. In addition, there was the time difference between the participating countries and the researcher's country of residence to consider.

Due to these reasons, the current study used an e-mail rather than web-based approach to distribute the questionnaire. A web-based survey requires certain skills in programming techniques and data processing in which the researcher was not skilful. At the same time, seeking professional help in this regard was beyond the financial capacity of the study, which was the reason for avoiding the postal technique.

It could be argued that people often hesitate to open e-mails or attachments of unknown origin. However, threats associated with e-mail communications were not considered to be an issue in the current study because, from one perspective, subjects received the questionnaire from identified liaison persons in their respective units. From another perspective, it was hoped that the previously sent invitation to participate reassured the liaison persons of the safe origin of the e-mail.

Given there was no finance available to support the present research, an e-mailed self-completed questionnaire, rather than a postal/web-based questionnaire or an interview, was considered an appropriate technique to collect data. Additionally, subjects can participate at a time convenient to them and their time zone without disruption to patient care. Furthermore, there was less probability for misunderstanding items of the questionnaire, because subjects were professionals in the field of study.

Subjects

Thirty burns units in Australia, New Zealand, Hong Kong and the United Kingdom were invited to participate in the study. Data were obtained from clinical leaders/managers of the participating units. As there was no common title usage

across countries for those with responsibility for nursing and medical management of patients, the working term "chief" was used to address those leaders in the present study. The participating countries were chosen because of similarities in their health care and socio-economic systems; thereby heterogeneity between subjects would be reduced. Consequently, data for comparisons between different countries were obtained.

Inclusion Criteria

Chief leaders were included in the study if they were:

- working in burns units that treat adult patients
- chief physicians or chief nurses in Australia, New Zealand, Hong Kong or the United Kingdom

Exclusion Criteria

Chief leaders were excluded from the study if they were:

- working in specialised paediatric burns units.

Recruitment

The researcher strived to include all eligible burns units in the targeted countries. Firstly, national burns associations were approached to obtain lists of burns units, namely, the Australian and New Zealand Burns Association, the British Burns Association and the Hong Kong Burns Association.

Direct communication with the Secretariat Service Coordinator of the Australian and New Zealand Burns Association indicated that there were twelve burns units in Australia and four units in New Zealand. Of the twelve Australian units, four were

specialised paediatric burns units and were therefore excluded, resulting in eight burns units from Australia eligible for the present study.

Communication with the Hong Kong Burns Association was unsuccessful. Consequently, help was sought from a professor of plastic surgery in one of the major burns centres in Hong Kong. The professor forwarded a recently published article on advances in burns care in Hong Kong.[78] The article indicated that there were two burns units and four facilities providing burns care. The term "burns facility" refers to surgical units equipped to treat patients with simple burn injuries aiming at reducing load on burns units which treat complex burn injuries.[79]

Burns facilities were excluded from the study because patients with diabetes are more likely to be managed in burns units, due to possible complications. Additionally, other countries included in the study, namely Australia and New Zealand, had no burns facilities. For this reason, a decision was made to restrict the present study to burns units in order to decrease heterogeneity among the study population. Accordingly, two burns units in Hong Kong were considered eligible for the study.

Obtaining a list of British burns units was associated with many more difficulties than the rest of the countries included in the study. Several e-mails and facsimiles were sent to the British Burns Association, but they did not respond. Thus, alternative ways were used to obtain a list of British burns units. For example, personal communication was established with people who were identified after extensive internet searches. The results of these communications ranged from no answer, responses offering moral support, giving the contact details of burns units, to suggesting the British Burns

Association as a best resource for a list. Help was also sought from a researcher who published a survey[80] of British burns units. However, the list used had limited applicability in the current study because of recent dramatic changes in burns care services at the UK level since Edward-Jones *et al* undertook their study.[80] Therefore, a suggestion from Edward-Jones to obtain a list from the International Journal of Burns Injuries or the British Association of Plastic Surgeons (BAPS) was followed.

A list of all hospitals that had plastic surgery and burns departments was sourced from BAPS.[81] The list included 282 plastic surgery and burns departments; of these 60 were documented as major units. Individual e-mails and facsimiles were forwarded to each major unit in order to identify whether the unit was a plastic surgery or burns unit. After four months of communication, a list of sixteen major units was developed.

At this point, it is necessary to indicate that the developed list included both burns units and plastic surgery departments treating burns. Plastic surgery departments were included because burns units in the other countries in the study were both plastic surgery and burns units. The researcher decided that the British plastic surgery units treating burns were not burns facilities, which were excluded from the study, as indicated earlier.

The justification for the decision mentioned in the previous paragraph was that the list[81] identifying the British burns units did not include referral criteria, unlike the Hong Kong list that included different referral criteria to burns units from those to burns facilities.[78] In particular, it was not known whether or not the acuteness of cases with burn injuries treated in British plastic surgery units differed from those treated in

British burns units, as was the case in Hong Kong. Therefore, it was assumed that the inclusion of British plastic surgery units treating cases with burn injuries matched burns units in Australia, New Zealand and Hong Kong. In conclusion, the study included chief physicians and chief nurses of eight burns units in Australia, four in New Zealand, two in Hong Kong and sixteen in the United Kingdom.

Materials

Development of the Questionnaire

A self-reported questionnaire was developed from the available literature in order to collect data on the management of diabetes in burns units (Appendix 1). The questionnaire was designed to collect basic data concerning burns units and clinical leaders; in particular, data were collected on the leaders' qualifications and experiences, plus unit size and focus of care. These data were necessary to determine whether there were differences between the units and leaders included in the study. Such differences might be reflected in the quality of the care provided.

Data concerning management of inpatients with diabetes were collected in order to understand how diabetes was treated and monitored in burns units. These data were concerned with the main focus of the study that aimed to explore the way diabetes was managed when the admission diagnosis was a burn injury. The questionnaire also sought information on whether diabetes care was included in burns discharge plans. Such information was necessary because discharge planning is considered an integral part of inpatient management.

Testing of the Questionnaire

The questionnaire was examined for its validity and reliability. Content and face validity were established firstly through reviews by clinical nurse experts in the areas of diabetes and burns. Face validity was also ensured as the proposal was reviewed by the Research and Higher Degree Sub-committee (RAHDS) of the Discipline of Nursing, the University of Adelaide, and as a result, amendments were made. The questionnaire was also peer reviewed by colleagues in the Discipline of Nursing whose suggestions were considered in improving the survey.

Reliability refers to the stability of results obtained from administering an instrument at different points in time to same subjects. Accordingly, accuracy of the instrument is a primary requirement of its reliability. The reliability of the questionnaire administered in the study was established in two stages; firstly, expert reviewers established the accuracy of the survey. Secondly, the peer review process ensured, as far as possible, the stability of the questionnaire. This assurance stemmed from the fact that the peer reviewers were research students and clinical lecturers with a wide range of sound nursing experiences. Such multi-perspective reviews helped in establishing consistency in the questionnaire.

A traditional approach of establishing reliability in survey studies is pilot testing.[70] This approach was considered inappropriate in the present inquiry because the target population was small, and piloting the tool may dilute the sample. Therefore, pre-testing with peers was conducted.

Procedure

Data Collection

Adult burns units in Australia, New Zealand, Hong Kong and the United Kingdom were contacted in order to identify a key person in each unit for liaison between the researcher and eligible subjects. Key persons were to receive the questionnaire and then forward it to chief nurses and chief physicians. Thus, there was no direct communication between the researcher and subjects. A database containing the contact details of the key persons was created to track the delivery of the questionnaire.

Key liaison persons were given the choice of receiving the questionnaire either by post or e-mail which was indicated as the researcher preferred choice. Invitation letters clarified that postage costs would be accepted by the researcher.

All key persons who agreed to take part in the study chose to receive the questionnaire electronically. Thus, the questionnaire (in Microsoft Word™ format) was sent as an e-mail attachment to each individual liaison person.

To improve the participation rate in the study, several reminders were sent to key persons who did not reply to the invitation to participate, or where completed questionnaires were not received from their units. Further copies of the questionnaire were enclosed with reminders directed towards those who had agreed to be involved. Three reminders were sent four weeks apart after either sending the invitations or forwarding the questionnaire. The reminders were sent by e-mail, facsimile to all units including telephone to Australian units. Reminders continued for five months, after

which time data analysis was started because it was assumed that non-respondents were unable to participate.

Ethical Considerations

The Research Ethics Committee of a large tertiary hospital in South Australia approved the study (Appendix 2). As per the policy of the University of Adelaide, the Human Research Ethics Committee was informed of the ethics clearance obtained for the study. Ethics approval from other countries or sites was not necessary because no patient information was collected or an intervention administered. Importantly, subjects were anonymous to the researcher.

In accordance with the advice of the Research Ethics Committee, communication with subjects was indirect through key liaison persons. This advice was underpinned by the fact that persons' contact details outside their organisation may be sensitive information. Therefore, the questionnaire was distributed by a key liaison person in each burns unit, and subjects' names and their contact details were not known to the researcher.

One New Zealand site requested further ethics approval from the New Zealand Multi Region Ethics Committee plus another further approval from its own committee. After consultation with two scholars from the Discipline of Nursing, the University of Adelaide, and in the light of the fact that there was no such request from other sites, a letter was forwarded to the New Zealand site in order to encourage them to participate. However, the site indicated that participation would not be possible without further approvals from New Zealand; and, one of the clinical leaders who had

indicated willingness to participate was instructed not to participate. Fortunately, this leader consulted the New Zealand ethics committee resulting in support for the researcher perspective that no further ethics approvals were required. Consequently, subjects from the New Zealand site completed the questionnaire.

Throughout the study, ethical aspects were respected by providing subject information and maintaining confidentiality.

Informed Consent

Each subject received a copy of the questionnaire with a covering letter **(**Appendix 3**)** explaining the purpose and outlining the possible outcomes of the study. This letter clarified that participation would be on a voluntary basis without payment, and ensured them that their identity would be protected. Completion and return of the posted or e-mailed questionnaire implied consent.

Confidentiality

To maintain confidentiality, access to computer files was restricted to the researcher only, via password. Data collection sheets and contact details of key persons are secured in the Discipline of Nursing, the University of Adelaide in a locked cabinet and will be kept for five years, after which time they will be shredded. All data collected were de-identified.

Data Analysis

Completed questionnaires were coded, and numerical data entered into a dataset in order to be analysed using Statistical Package for Social Sciences (SPSS) version 13.[82] Descriptive statistics, such as frequencies and measures of central tendency, were used to describe the study variables. Non-parametric statistical tests were used to identify differences between the study variables and groups.

Additional comments and responses to open ended questions were analysed using relational analysis, a category of content analysis.[83] In this category, the analysis moves beyond identifying concepts in the qualitative data to grasping meaningful relationships between these concepts.[83] Such relationships were used to develop an understanding of the management of diabetes in burns units.

Summary

An ethics approved, electronic self-completed survey was used to feature how diabetes was managed in burns units treating adults. The questionnaire was developed from the available literature, and its validity and reliability were established. The questionnaire was forwarded as an e-mail attachment to key persons who were liaisons between the researcher and chief leaders (clinical leaders/managers) of units participated in the study. The participating units were from four countries: Australia, New Zealand, Hong Kong and the United Kingdom. Data analysis was performed using SPSS for numerical data and relational analysis for qualitative data.

RESULTS

Introduction

This chapter presents the findings obtained from analysis of the survey on management of diabetes when admission to hospital was due to a burn injury. The findings obtained from both statistical analysis and content analysis are jointly presented under three main headings: response rate and population profile; management of diabetes; and discharge planning.

Response Rate and Population Profile

As mentioned in the previous chapter, the sampling population for the present study was burns units in Australia, New Zealand, Hong Kong and the United Kingdom. The information that informed the study was obtained from clinical leaders of these units. Accordingly, the response rate was calculated for participating units but not for clinical leaders. A unit was considered participating if at least one of its clinical leaders responded. The response rate was calculated as the number of units participated divided by the total number of eligible burns units. Out of 30 units approached, 17 expressions of interest were received, resulting in a response rate of 56% (Table 1). As there were only two eligible units in Hong Kong, it was pleasing that both accepted the invitation to participate.

Table 1 Response Rate

Country	Invited Units	Participating Units	F
Australia	8	7	87%
New Zealand	4	2	50%
Hong Kong	2	2	100%
The UK	16	6	37%
Total	30	17	56%

Participating units are described in terms of speciality and size (Table 2). These parameters were identified from responses that indicated the number of beds available for burns care in each unit. An addition parameter was the focus of care provided by the unit, whether on burn injuries only, or both burn injuries and plastic surgery, or whether it only managed adult patients or managed both adults and children. Respondents considered their units as specialised adult burns units (45%), mixed adult and paediatric burns units (31%), and mixed burns and surgical units (17%) (Table 2). One Australian unit was mixed burns/surgical adult unit (3.5%), and another British was mixed adult/paediatric and mixed burns/surgical unit (Table 2).

Table 2 Focus of Care in the Participating Units

Country	Adults	Adults and children	Burn and surgical cases	Other
Australia	10	1	2	1
New Zealand	1	3	1	0
Hong Kong	0	1	2	0
The UK	2	4	0	1
Total	13	9	5	2

Other = Mixed burns/surgical adult unit, or mixed adult/paediatric and mixed burns/surgical unit

In the participating units, the available beds for burns care ranged from 4 to 30 beds with a standard deviation of 5.673 beds. Three respondents did not report an exact number of beds available for burns care. In one response, this number ranged from 6 to 12, in another the number was flexible. One respondent mentioned that his/her unit had 25 beds, but the unit was considered a plastic surgery unit, as such there were no beds specified only for burns care.

Respondents' Demography

The responses received were completed by 29 clinical leaders of which approximately 55% were medical leaders, and 45% were nursing leaders (Table 3). It was noted that all British and most Hong Kong (66%) respondents were from a medical background. Whereas, most Australian (64%) and New Zealand (60%) respondents were from a nursing background (Table 3). However, one should note that the total number of respondents from Hong Kong and New Zealand was relatively small compared with Australia and the United Kingdom (Table 3).

Table 3 Leaders Participating in the Study

Country	Nursing Leaders	Medical Leaders	Total
Australia	9	5	14
New Zealand	3	2	5
Hong Kong	1	2	3
The UK	0	7	7
Total	13	16	29

The profile of the respondents is described from two perspectives: qualifications and experience.

Qualifications

For the purpose of analysis, qualifications were sorted into four groups: non-university basic degrees, undergraduate degrees (nursing or medicine), postgraduate degrees and other qualifications. Postgraduate degrees represented qualifications in the health field, in particular postgraduate qualifications of medical leaders were solely clinically based qualifications (Table 4). Academic qualifications in the health care field held by medical leaders were considered within the group "other". In so doing, a clear description of the study population was obtained because some medical leaders held both clinical and academic postgraduate degrees.

Analysis revealed that all non-university basic degrees were held by nursing leaders, and there was a wide range of names for these degrees (Table 4). It was noted that two nursing leaders reported their qualifications as RN which is a professional licence awarded after studying a basic nursing degree either as a university degree or non-university course.

All respondents except four nursing leaders (14%) held undergraduate degrees; specifically nine respondents had a bachelor degree in nursing, and sixteen had undergraduate degrees in medicine. In particular, fourteen medical leaders had a bachelor degree of medicine/ bachelor of surgery (MBBS). One medical leader had a honours degree in medicine, and another one from the United Kingdom had three primary medical degrees, namely bachelor of medicine (MB), bachelor of surgery (BCH) and bachelor in the art of obstetric and gynaecology (BAO).

It was noted that all medical leaders, except one had fellowship degrees; ten of them (63%) completed fellowships in plastic surgery (Table 4). One medical leader (6%)

held a bachelor degree in medical science, which is a one-year degree programme in advanced medical research. There were six nursing leaders (46%) who held postgraduate qualifications. Three of them held qualifications in burns care; one had a Master degree and two had diplomas. Twelve respondents (41%) had other qualifications such as bachelor, master of human biology, bachelor of business administration, bachelor of arts, medical doctorate, master of medical sciences, New Zealand Certificate in Sciences-Biology, medical diplomas and post graduate diploma in teaching.

Table 4 Respondents' Qualifications

	Field	Degree	F
Non-university	Nursing	General Certificate	1
		Diploma	2
		Certificate IV work place training and assessment	1
		Reg. General and obstetric Nurse	1
		RN	2
Postgraduate	Nursing	Master	1
		Diploma	2
	Medical	Fellowship	2
		Fellowship in plastic surgery	2
		Fellowship in plastic surgery and others	8
		Multiple fellowships	3

Experience

Respondents' experiences were grouped into three main classes, namely total experience in burns care, experience in the current burns units and years in the current position. The experience in burns care ranged from 2 years to 25 years; experience in the current unit and position ranged from 0.2 years to 18 and 16 years, respectively (Table 5).

Table 5 Respondents' Experiences

Leader group	Type of experience	$\bar{\chi}$	Range	SD
Nursing	**Burns care**	11.2	3-24	5.77
	Current unit	7.6	0.66-18	4.826
	Current position	4.78	0.66-16	4.15
Medical	**Burns care**	13.1	2-25	0.20
	Current unit	7.7	0.20-18	4.97
	Current position	6.48	0.20-15	4.86

Management of Diabetes

Caring for Patients with Diabetes

All except one respondent (4%) reported that they provided care to patients with diabetes. Among those who provided care to patients with diabetes, 21 (72%) respondents mentioned when they provided the care. The examination of this data revealed that the respondents regularly provided care to patients with diabetes. The regularly category included responses such as "several times a year, various times, weekly, often, very often, routinely, frequently, always and ongoing." Other respondents focused on how recently they provided this care. This category included responses such as "currently, last month and a couple of months ago." Four responses were excluded because they were not relevant to the context.

A large proportion of respondents (n=16; 55%) had a belief that burns management of patients with diabetes should be different from that of those without diabetes. Interestingly, this belief was more prevalent among leaders from a nursing background than from medicine (Table 6). However, this does not reach statistical significance (P= 0.264). This viewpoint was noted mainly among respondents from Australia which is not surprising as most were nurses.

Table 6 Burns Care: Should it be Different for Patients with and without Diabetes?

		N	Yes		No	
			F	%	F	%
Country	**Australia**	14	10	71	4	29
	New Zealand	5	3	60	2	40
	Hong Kong	3	0	0	3	100
	The UK	6*	3	43	3	43
Leader	**Nursing**	13	9	69	4	31
	Medical	15*	7	43.8	8	50
	Total	28	16	55	12	41

*=there was one missed response from this group

Fifteen respondents (52%) wrote comments on the belief mentioned in the previous paragraph, and illustrated in Table 6. Analysis of these comments reflected the notion that proper glycaemic control is an integral part of the management plan of people with diabetes hospitalised because of a burn injury. In particular, the challenging step is the reciprocal effect of diabetes and burn injuries. Diabetes poses the risk of poor wound healing, and a burn injury often leads to deterioration in glycaemic control.

In accordance with the analysis given above, the majority of respondents (n=27; 93%) considered management of both diabetes and burns to be the most important aspects of care. This agreement is also confirmed by the respondents' comments on why this is the most important aspect of care. Analysis of these comments reflected agreement between respondents that management of each condition should not be compromised.

Respondents argued that the implications of one condition resulted from the other, leading to poor outcomes for patients. In their comments, respondents again emphasised glycaemic control and slow wound healing as the main issues faced in the management of patients with diabetes and burn injuries. The relationship between diabetes and burns was described as being situation like a "chicken and the egg", in that hyperglycaemia increases the likelihood of infection and results in slow burns healing and *vice versa*. Additionally, diabetes-associated morbidities, for instance peripheral vascular disease, also worsen the situation by reducing blood supply to the local burned area. Accordingly, it was not surprising to find in the current study that optimal management of diabetes is an integral part of burn injuries management plans.

Inpatient Management of Diabetes

Most respondents (n=15; 58%) reported that new plans need to be initiated to manage diabetes when hospitalisation is for a burn injury. This was a common response in all countries except Hong Kong, where there was more frequent pre-admission management (Table 7). Medical leaders recommended the initiation of new management plans more frequently than nursing leaders (Table 7), but the difference was not statistically significant. One-fifth of respondents indicated that management of diabetes should continue as before admission, and one-quarter chose the item "other" to describe diabetes management during hospitalisation (Table 7).

Table 7 Inpatient Management of Diabetes

		N	Pre-admission		New Plan		Other	
			F	%	F	%	F	%
Country	Australia	14	1	7	8	57	5	36
	New Zealand	5	1	20	4	80	0	0
	Hong Kong	3	2	67	0	0	1	33
	The UK	6*	2	29	3	43	1	14
Leader	Nursing	13	2	15	6	46	5	39
	Medical	15*	4	25	9	56	2	13
	Total	28	6	21	15	58	7	24

*=there was one missed response from this group

For further explanation of the item "other" mentioned above and illustrated in (Table 7), respondents provided narrative descriptions of inpatient management of diabetes. These descriptions focused on the fact that management of diabetes is most likely to be modified, and this modification is individual according to the scenario in each case. Respondents mentioned many variables affecting such a scenario, for instance the individual profile, the state of glycaemic control, size of a burn injury and treatment requirements.

Respondents did not indicate how these variables affected the management. Specifically, there was no information clarifying the process of developing management plans for inpatients with diabetes and burn injuries. In this regard, medical leaders from two sites (one from Hong Kong and one from the United Kingdom), reported that if a patient with diabetes hospitalised because of a burn injury, management of this disease is directly shifted to diabetes multi-disciplinary teams. In this regard, this research tried to explore the role of such teams in management of diabetes. Information obtained is presented here.

All respondents indicated the availability of specialised diabetes centres in their hospitals, and all of these centres were multi-disciplinary clinics. All respondents except one (4%) reported that these centres were involved in the management of patients with diabetes and burn injuries.

Respondents were asked to rate the necessity of involving diabetes centres in the management of inpatients with diabetes and a burn injury on a scale ranging from "always" to "never". This involvement was rated as "always" by most respondents from the United Kingdom, and as "often" by most Australians (Table 8). It was also noted that equal numbers (5) of medical leaders rated this involvement as "always, often and occasionally" (Table 8). It was also noted that the choice "always" was more frequent among nursing leaders (Table 8). Around quarter of nursing leaders reported that they "often" consider diabetes centre involvement to be necessary; while another quarter rated this as "occasionally" (Table 8). One medical leader from Hong Kong and one Australian nursing leader reported rare involvement of diabetes centres in the process of care. An Australian nursing leader indicated that the diabetes centre was never involved in the process of care.

Table 8 Involvement of Diabetes Centres in the Process of Care

		N	Always		Often		Occasionally		Rarely		Never	
			F	%	F	%	F	%	F	%	F	%
Country	**Australia**	14	3	21	5	36	4	29	1	7	1	7
	New Zealand	5	2	40	1	20	2	40	0	0	0	0
	Hong Kong	3	1	33	0	0	1	33	1	33	0	0
	The UK	7	4	57	2	29	1	14	0	0	0	0
Leader	**Nursing**	13	5	39	3	23	3	23	1	8	1	8
	Medical	16	5	31	5	31	5	31	1	6	0	0
	Total	29	10	34	8	28	8	28	2	7	1	3

Respondents provided reasons for when and why diabetes centres were occasionally, rarely or never involved in management. These reasons were structured around two main themes. Firstly, help is sourced from diabetes centres when there is a problem in glycaemic control, and secondly when diabetes patient education is required before discharge. One respondent (4%) stated that the diabetes centre was more an outpatient clinic, therefore the endocrine team and the diabetes educator were involved, if necessary, in the management of inpatients with diabetes and a burn injury.

Subcutaneous sliding insulin scales were the most frequently used strategy to control blood glucose levels (Table 9). This was noted in responses from medical and nursing leaders in addition to responses from each country except the United Kingdom, where insulin algorithm was more frequently to be used (Table 9). The dominance of the subcutaneous sliding scales use was clearly reflected in the comments of the

respondents who chose the item "other" to describe their strategies for controlling blood glucose levels (Table 9).

Table 9 Strategies of Blood Glucose Control

		N	Sliding Scale		Algorithm		Sliding & Algorithm		Other	
			F	%	F	%	F	%	F	%
Country	**Australia**	14	7	50	1	7	2	14	4	29
	New Zealand	5	3	60	2	40	0	0	0	0
	Hong Kong	3	2	67	1	33	0	0	0	0
	The UK	6*	1	14	3	43	0	0	2	29
Leader	**Nursing**	13	6	46	3	23	1	8	3	23
	Medical	15*	7	44	4	25	1	6	3	19
	Total	28	13	41	7	24	2	6	6	29

*=there was one missed response from this group

Examination of respondents' comments in relation to the aforementioned strategies suggests that leaders from Australia were more likely to support the premise that the subcutaneous sliding insulin scales are an appropriate strategy to manage uncontrolled diabetes. In other words, they encouraged continuing with the pre-admission plan if the blood glucose levels were stable. The Australian comments also considered the selection of a strategy depending on the individual profile of each case. This contrasts with comments of a British respondent who recommended the subcutaneous sliding insulin scales in the initial period, followed by a review of the pre-admission plan.

As fasting could be necessary for inpatients with a burn injury, the present study sought information on how diabetes was managed if fasting is scheduled for a patient suffering from this illness. Respondents were asked to select, from a list of options, the strategy that they recommend for managing this disease in the case of fasting. These options were: insulin infusions, administering diabetes medications as usual,

holding anti-diabetic tablets along with administering insulin, or holding all diabetes medications. If non-of these strategies were recommended, respondents had the option of "other" to describe their strategies and they were advised to specify how diabetes should be managed in the case of fasting.

In all countries, insulin infusions were used as a strategy to manage diabetes in the case of fasting (Table 10). One British respondent indicated that insulin infusion should be used in addition to giving the same insulin dose as before admission. Surprisingly, two respondents indicated that no diabetic medication is necessary in the case of fasting.

Table 10 Diabetes Management: The Scenario of Fasting Cases

		N	Infusion		Insulin		Nil		Infusion & insulin		Other	
			F	%	F	%	F	%	F	%	F	%
Country	**Australia**	14	3	21	2	14	0	0	0	0	9	64
	New Zealand	5	4	80	0	0	0	0	0	0	1	20
	Hong Kong	3	1	33	0	0	1	33	0	0	1	33
	The UK	7	2	29	1	14	1	14	1	14	2	28
Leader	**Nursing**	13	4	31	1	8	1	8	0	0	7	54
	Medical	16	6	38	2	13	1	6	1	6	6	38
	Total	29	10	35	3	10	2	7	1	7	13	45

Nil= no diabetic medications was given

It was noted that 45% of respondents (Table 10) selected the item "other" to describe diabetes management in the case of fasting, and they provided narrative descriptions of this management. In these descriptions, respondents indicated that, in the case of fasting, management of diabetes should be individualised according to requirements of each patient, similar to the suggestions for controlling blood glucose levels, reported in page 52. The variables affecting individualisation of management included

size of a burn injury, type and length of procedure and what time of day it is being done. Two main strategies used for managing blood glucose levels in the case of fasting were using of subcutaneous sliding insulin scales and insulin infusions combined with close monitoring of blood glucose levels.

Within the context of the strategies used to manage blood glucose levels during fasting, it is necessary to report that some respondents outlined components of insulin infusions. One respondent said "insulin infusion, simply dextrose." Others reported that the infusion contained normal saline and glucose. One respondent indicated that the treatment protocol composed of 5% glucose solution at a rate of 100 ML per hour with half of the usual insulin dose. Two respondents suggested holding antidiabetic medications for type 2 diabetes, while using insulin infusions or subcutaneous sliding insulin scales for type 1 diabetes. In one Australian site the management was according to a standard protocol addressing various aspects of different types of diabetes, but the protocol was not available to the researcher.

Monitoring

All respondents recommended capillary blood glucose testing as the main method of glucose monitoring. Eight respondents (28%) reported that hospital laboratories could also be used.

Respondents were asked if targets for blood glucose levels should be established as part of management plans for patients with diabetes hospitalised because of a burn injury. The responses to this question, either "yes" or "no", indicated that in all countries except Hong Kong, the option "no" was more frequently selected (Table

11). The option "no" was also frequently selected by nursing leaders; but not by medical leaders (Table 11). In particular, half of medical leaders suggested setting specific targets for patients with diabetes receiving burns care. There were no statistically significant differences between nursing and medical leaders.

Table 11 Setting Target Blood Glucose Levels: Is It Necessary?

		N	Yes		NO	
			F	%	F	%
Country	Australia	14	6	43	8	57
	New	5	2	40	3	60
	Hong Kong	3	3	10	0	0
	The UK	5*	2	29	3	43
Leaders	Nursing	13	5	39	8	62
	Medical	14*	8	50	6	38
	Total	27	13	45	14	49

*=there was two missed responses from this group

In answering the question about the values of the targets mentioned in the above paragraph, 12 respondents (41%) commented on this question. Specifically, ten of the 12 ranged these targets from 4-10 mmol/L. One nursing leader mentioned that these targets should be based on the individual needs of each patient. Such was the case of one medical leader who specifically mentioned diabetes and infection status as factors determining target blood glucose levels.

Most respondents from all countries indicated that blood glucose levels should be tested for every admission (Table 12). Respondents only from Australia and the United Kingdom believed that admission blood glucose levels should be requested when necessary (Table 12), and they provided examples of when blood glucose testing was necessary. These examples were known cases of diabetes, large burns,

suspected diabetes, obese patients, failure to heal, changes in the level of consciousness and delayed presentation with infected burn injuries.

Table 12 Testing Blood Glucose Levels on Admission: When Is It Requested?

		N	Every Patient		When Necessary	
			F	%	F	%
Country	Australia	14	10	71	3	21
	New Zealand	5	5	100	0	0
	Hong Kong	3	3	100	0	0
	The UK	7	5	71	2	28
Leaders	Nursing	13	10	77	2	15
	Medical	16	13	81	3	19
	Total	29	23	79	5	17

In relation to glucose monitoring during hospitalisation, most respondents indicated that the frequency of testing glucose concentration in blood and urine should be according to the individual needs of each patient (Table 13). This individualisation of monitoring was recommended by medical leaders more frequently than nursing leaders, and it was more frequent in the United Kingdom than other countries in the study (Table 13). However, there were no statistically significant differences in this regard between nursing and medical leaders. Standard protocols for monitoring blood glucose concentration were also used in all study participating countries except Hong Kong (Table 13). These protocols were more frequently used in New Zealand and recommended more frequently by nursing than medical leaders (Table 13). Two respondents indicated that they modify the protocol according to the individual needs.

Table 13 The Frequency of Glucose Monitoring

			Blood testing						Urine Testing			
		N	MsABT		Protocol		Individualised		Individualised		Never	
			F	%	F	%	F	%	F	%	F	%
Country	Australia	14	1	7	5	36	8	57	10	71	3	21
	New	5	1	20	3	60	1	20	3	60	2	40
	Hong	3	1	33	0	0	2	67	2	67	1	33
	The UK	7	1	14	1	14	5	71	6	86	1	14
Leaders	Nursing	13	2	15	5	39	6	46	9	69	4	31
	Medical	16	2	13	4	25	10	63	12	75	3	19
	Total	29	4	14	9	31	16	55	21	72	7	31

MsABT= Glucose level should be tested before every meal and at bedtime

To complete the profile on diabetes monitoring, the study sought information on ketone testing. The information aimed to identify when it is necessary to request ketone testing for patients with diabetes hospitalised because of a burn injury. All respondents except one commented on this issue. Comments indicated that ketone testing is infrequent or even rarely required because regular monitoring and treatment of blood glucose should result in tight glycaemic control, making ketone testing unnecessary.

There were two main groups of indications for ketone testing; namely non-diabetes-related and diabetes-related indications. The non-diabetes-related indications were major burn injuries, pregnancy and shock. The diabetes-related indications were centred on the fact that ketone testing is necessary for patients with uncontrolled diabetes. In particular, respondents considered this test necessary if hyperglycaemia persists and when ketoacidosis is suspected; in addition to this it was recommended in the case of prolonged fasting especially when it was not associated with intravenous therapy.

Discharge Planning

In all countries, diabetes was included in discharge planning from burns units (Table 14). Interestingly, in New Zealand and Hong Kong, all respondents indicated that diabetes is always included in discharge planning. Such was the case among most respondents from Australia and the United Kingdom, and among most medical and nursing leaders (Table 14). All Respondents except two nursing leaders (7%) believed that this discharge planning should be done in conjunction with the diabetes centres. Three nursing leaders (10%) from Australia reported that diabetes is occasionally included in discharge planning (Table 14). In particular, they reported that diabetes is included when changes are made to the pre-admission management plan, and so the patient needs to be informed of these changes.

Table 14 Diabetes in Burns Discharge Planning

		N	Diabetes included						Centre involved			
			Always		Often		Occasionally		Yes		NO	
			F	%	F	%	F	%	F	%	F	%
Country	Australia	14	7	50	4	29	3	21	13	93	1	7
	New Zealand	5	5	100	0	0	0	0	4	80	0	0
	Hong Kong	3	3	100	0	0	0	0	2	67	1	33
	The UK	7	5	71	2	29	0	0	7	100	0	0
Leaders	Nursing	13	9	69	1	8	3	23	11	85	2	15
	Medical	16	11	69	5	31	0	0	15	94	0	0
	Total	29	20	69	6	21	3	10	26	90	2	7

Summary

The twenty-nine responses from 17 out of 30 burns units which participated in the survey were analysed using the data management software: SPSS. Relational analysis

was also used to analyse respondents' comments. Statistical tests were not performed on many variables and subgroups because of the small sample size. The small sample size could be one reason for the lack of statistical significant differences between medical and nursing leaders regarding items in the current study.

The findings can be summarised as follows: participating units ranged in size from 4 to 30 beds, and from units specialising in adult burns to mixed burns/surgical units treating both adults and children. Despite the availability of diabetes multidisciplinary centres in all sites participating in the study, more than 25% of the respondents believed that these centres should only occasionally be involved in the process of care. On the other hand, more than half of the respondents recommended the initiation of new diabetes management plans for patients hospitalised because of burn injuries. Respondents reported that the individual profile of each patient plays a major role in determining the strategy of diabetes management. Additionally, it was found that the subcutaneous sliding insulin scales were commonly used in the management of diabetes in burns units.

DISCUSSION

Introduction

This chapter situates the findings of the study within the context of the available literature, taking into account the methods used. The chapter also highlights implications for clinical practice, presents limitations of the study and the researcher's suggestions for further investigations.

Overview of the Study

The study was conducted to describe the way diabetes was managed when the patient's admission diagnosis was a burn injury. A self-report questionnaire was forwarded as an e-mail attachment to liaison persons in burns units treating adults in Australia, New Zealand, Hong Kong and the United Kingdom. The liaison persons passed the questionnaires to nursing and medical clinical leaders in order to be completed, and then forwarded to the researcher either via post, fax or e-mail.

Summary of Key Results

The researcher received 29 completed questionnaires from 17 burns units out of 30 invited to participate in the study. It was found that all participating units were treating adults with burn injuries. However, around 50% of the respondents indicated that their units were not pure adult burns units, but were a mixture of adult and children and/or burns and surgical units. All respondents indicated the availability of diabetes multidisciplinary centres in their hospitals. The involvement of these centres in the management of inpatients with diabetes and a burn injury was reported as "always" by 34% of the respondents, "often" by 28% and "occasionally" by another

28% of the respondents. A few respondents indicated that they rarely (n=2; 7%) or never (n=1; 3%) involved the diabetes centres. In particular, they reported that the centres were most likely to be involved in the process of care when there was a problem in glycaemic control and/or a need for patient education. It was found that subcutaneous sliding insulin scales were a common strategy used to manage diabetes in burns units. Overall, respondents valued the importance of considering patients' individual profile in management of diabetes.

Context of the Results

Response Rate

The present study achieved a response rate of about 56% (17 out of 30 the units invited to participate). The achieved response rate was more than the researcher's expectation of 50% which was estimated from literature data on survey studies. The response rate varies and depends on many factors, such as subjects' demographic profile, technique of conducting the survey and clarity of the questionnaire items.[68] In other words, there is no standard response rate to survey studies, and therefore the response rate should be evaluated within the context of each study individually, and compared with similar studies.

As there were no published surveys investigating management of diabetes in burns units, it was difficult to compare the response rate with other studies. Additionally, the sample of the current study was purposive. Furthermore, the target population of the current study was relatively small, and therefore, relying solely on the retaining percentage to evaluate the success in recruiting subjects might be misleading.

Management of Diabetes

The findings indicated that clinical leaders in burns units often provide care to patients with diabetes. A possible explanation for this phenomenon is that patients with diabetes are regularly admitted to burns units, which is not surprising because, as it is argued in the first study of this portfolio and the literature,[16,84] diabetes increases the risk for burn injuries, and hospitalisation could be necessary in many cases.

Hospitalisation of a patient with diabetes and a burn injury is a challenging issue because of implications on the healing process that results from hyperglycaemia, the diabetes associated morbidities and a burn injury itself. Additionally, deterioration of each condition would worsen the other, making the management more complex. Accordingly, it is not surprising that respondents of the current study indicated the reciprocal effects of hyperglycaemia and wound healing as common management problem. Perhaps because of this, respondents (n=27; 93%) reported that the most important aspects of caring for patients with diabetes is optimal diabetes management and optimal management of burns.

The importance of optimal management of patients with diabetes and a burn injury was highlighted by Munster *et al*[17] in early 1970s. Specifically, they reported their difficulties in managing such a sub-population, which are similar to those reported by respondents of the present inquiry, where respondents reported that wound infection and poor glycaemic control as issues complicating patient management. Munster *et al*[17] featured the pathological profile of this difficulty in terms of hydration needs, rapid changes in insulin requirements and high susceptibility towards infection caused by multiple organisms. This pathological profile is supported by clinicians'

experiences[18] and findings of recent case note reviews of inpatients with diabetes and burn injuries.[14,16]

Accordingly, special attention should be paid to burn wounds sustained by patients with diabetes in terms of frequent observations and monitoring for signs and symptoms of infection.[17,84] Specifically, Napoli *et al*[84] argued that the special attention should also be given to other areas of skin invasion (e.g. intravenous cannulation and indwelling catheters) because of suppression of local inflammatory reactions secondary to hyperglycaemia. As such, management of a burn injury sustained by a patient with diabetes should be meticulous or even more aggressive than that of those without diabetes.

McCampbell *et al*[16] claimed that a different approach is required to manage burn injuries sustained by sufferers of diabetes from those without diabetes. As part of such an approach, McCampbell *et al*[16] suggested substituting visual inspection with another technique to assess depth of burn injuries. In so doing, the assessment would be more accurate, and therefore appropriate management would be applied in the early stages of a burn injury.[16]

Within the context of McCampbell *et al*'s suggested approach, perhaps it is sensible to ask on which basis the approach will define patients with diabetes requiring different management of burn injuries. Such a question stems from the following standpoints: firstly, burn injuries may associate with hyperglycaemia with no previous history of diabetes; this is known as disease-induced diabetes.[85,86] Secondly, many patients with diabetes remain undiagnosed and may be discovered accidentally.[52]

Importantly, it is very difficult to differentiate whether the hyperglycaemia is produced by diabetes or by the burn injury during the acute stage of the burn.[18] Burns literature documents that hyperglycaemia is often associated with poor outcomes for patients with undiagnosed diabetes,[18] diagnosed diabetes[16] or no history of pre-existing diabetes.[86,87] In short, hyperglycaemia, regardless of the underlying mechanism, slows the healing process.[66]

Accordingly, management of hyperglycaemia should be part of the management plan of inpatients regardless of the admission diagnosis. A reasonable body of research documented the effectiveness of tight glycaemic control in improving outcomes for patients hospitalised in surgical intensive care units,[54,88-90] and in medical intensive care units.[88,89,91] In accordance with this body of research, it is reasonable to accept that more than half of the respondents of the current study considered management of hyperglycaemia as part of the management plan for burn injuries sustained by patients with diabetes, which was reported as the difference between patients with and without diabetes in terms of burns management. To clarify, the current study did not indicate whether patients with diabetes need different wound management, from those without diabetes, which contrasts with the trend mentioned in previous studies-[15,16] namely burns management should be meticulous and aggressive in the case of diabetes.

In particular, respondents from a medical background considered that burns care to patients with diabetes should not be different from those without diabetes, whereas respondents who were from a nursing background viewed glycaemic control part of the management plan of patients with diabetes and burn injuries. A possible explanation for this difference is that nurses believe that patient care should be

holistic, while medical officers focus on the treatment of a specific illness. In support of this explanation, Smith *et al*[57] reported that medical officers in surgical wards consider their primary duty is managing the surgical problem, and diabetes is beyond their scope of practice. However, and as mentioned in page 67, for better patient outcomes diabetes should be managed as part of total patient management plan.

Inpatient Management of Diabetes

The findings from the current study indicated that the patient's diabetes management regimen prior to hospitalisation is most likely to be modified after admission to a burns unit. These findings are in accordance with current opinions on inpatient diabetes therapy which suggest modifying the pre-admission diabetes management regimen regardless of admission diagnosis.[92] Adjustment is needed because of changes in life-style due to the hospital environment, as indicated in the present study and literature regarding the inpatient management of diabetes.[92-94] These changes could be due to hospital routine in terms of meal times, medications, procedures, treatment requirements and disease-induced stress.[92-94] In burns units, modification is particularly important because of metabolic alterations produced by a burn injury which are similar to those associated with diabetes.[85,86]

The current study does not detail how these variables are considered in modifying pre-admission regimens in order to be examined against literature data. However, the common notion in the current study is that diabetes management should be individualised according to each patient's specific needs, which is a philosophy of diabetes care.[33,95] Yet, authors argue that individualisation of care may lead to variations in quality of care provided to patients.[96]

Studies have shown that mere implementation of hospital guidelines without considering patients' daily changing needs results in poor glycaemic control.[56] Accordingly, care should be delivered within a flexible standardised approach, rather than according to rigid procedural guidelines. Perhaps, it could be difficult for burns unit staff to consider all aspects of inpatient diabetes management because these aspects are not homogenous, and some of them are beyond the interest of such staff. Similar barriers were reported in literature debating diabetes management when the admission diagnosis was unrelated to diabetes.[57,93]

In order to overcome these difficulties, respondents in the current study and other authors suggested involving multidisciplinary diabetes teams when people with diabetes are hospitalised.[55,93,97] However, the frequency with which multidisciplinary teams were involved varied among countries and professional disciplines in the current study. Multidisciplinary diabetes team involvement was policy in one British unit and in another Hong Kong. Overall, it was noted that British respondents recommended multidisciplinary team involvement more frequently than other countries participating in the study.

The British recommendation for involving multidisciplinary teams could be explained from many perspectives. Firstly, all British respondents were from a medical background, and these clinicians traditionally determine if it is necessary to consult colleagues from other fields. On the other hand, most respondents from the other participating countries, were from a nursing background, and might not have the

authority to consult clinicians outside burns units. However, diabetes consultation is infrequently requested by surgeons.[92]

Another explanation is that the focus of multidisciplinary diabetes teams is mainly on outpatients and this focus may still not be fully developed to include inpatients, especially when the admission diagnosis is unrelated to diabetes. In the literature, there is little attention to the way of delivering inpatient diabetes management when diabetes is a secondary diagnosis.[98] In particular, the available literature reports on the benefits of tight glycaemic control in improving outcomes for patients hospitalised with diabetes as secondary diagnosis. Specifically, the literature examines the effectiveness of selected approaches (e.g. Subcutaneous sliding insulin scales[97,99] and insulin infusions[91,100]) to achieve optimal glycaemic control for inpatients.

Information obtained in the current study showed the commonality of using subcutaneous sliding insulin scales to control blood glucose concentrations, whereas the effectiveness of this approach is questionable.[19,92,101-105] The objection against using these scales stems from the retrospective nature of estimating the required insulin doses using a single value of blood glucose levels.[92,96,105] In other words, subcutaneous sliding scales recommend insulin doses according to blood glucose concentrations, whereas insulin doses should be decided considering many other variables affecting glycaemic state.[105] Examples of these variables as reported in the current research and other publications[92,106] include: time of day, food intake, level of activity and "lag time" (the period between administering insulin and starting eating).

Therefore, a flexible approach calling on the whole context of the patient, rather than solely the glycaemic state should be used for deciding insulin doses and doses interval. An increasing volume of literature suggests insulin algorithm as a substitution for subcutaneous sliding scales.[92,106] In such an approach, insulin supplementation takes into account all relevant variables affecting glycaemic state[92,106] including patient's response to the previous doses of insulin, and possible schedule changes in food intake and treatment plan.[106] In so doing, insulin doses would be determined from expected changes in glycaemic state, rather than after the occurrence of these changes. Boldly speaking, insulin algorithm aims to manage glycaemaic state at the prevention level. As a result, burden and outcomes of hospitalisation would improve.

Inpatient Management of Fasting Patients

The study showed that diabetes management in the case of fasting should be individualised according to the patient's profile, which is in accordance with the contemporary trend towards tailoring the management plan to address the individual needs of each case. However, the question is: which strategies are best to implement when fasting is necessary. Respondents indicated that blood glucose monitoring should be part of management of diabetes in the case of fasting. Additionally, subcutaneous sliding insulin scales and insulin infusions were reported as strategies for management during fasting. The flaws in using subcutaneous sliding scales were discussed in the previous section, and therefore reiterating this information is not necessary.

Literature recommends using an insulin infusion to manage diabetes during fasting, regardless of diabetes type.[92,106] Such was the case in the present research, but the frequency of recommendations suggesting insulin infusions to manage diabetes during fasting was low. Specifically, some respondents in the current study recommended an insulin infusion to manage type 1 diabetes, while with holding all anti-diabetes medications for type 2 diabetes. It is sad to find such a recommendation for managing type 2 diabetes still being applied in clinical settings because management of diabetes is a lifelong strategy that should be modified by the patient's changing needs, as mentioned in page 52. In the case of fasting, such needs might indeed be affected, resulting in deterioration of the glycaemic state.

Intravenous insulin infusions address underlying physiological changes associated with illness and fasting and enables blood glucose levels to be maintained within an acceptable range. Intravenous insulin infusions have shown their effectiveness in controlling blood glucose levels among patients with stroke[107] or heart attacks, where hospitalisation outcomes have been improved.[108] However, one should note that insulin has anti-inflammatory activities[97] and authors question whether the improvements in outcomes for inpatients have resulted from glycaemic control or from the anti-inflammatory actions of insulin.[97] Perhaps because of these anti-inflammatory actions, authors recommend insulin as the best agent to manage inpatients with diabetes.[97]

In the current study, a few respondents reported components of insulin infusions, and the reported information was varying and brief, making it difficult to examine this information. A range of insulin infusion protocols have been published in the

literature,[93] which might reflect varying needs of inpatients with diabetes that should be addressed through a flexible approach acknowledging all variables affecting glycaemic control. The current debate in the literature is that hospitals should develop their own strategies for diabetes management considering the nature of the glycaemic state. Specifically, the multifaceted nature of diabetes should be addressed through flexible guidelines allowing the involvement of professionals from a variety of fields in the management, regardless of the admission diagnoses.

Monitoring

All respondents in the current study recommended capillary blood glucose testing to monitor the glycaemic state. This findings was not surprising because such testing is a widely recommended strategy for bedside blood glucose monitoring.[109] This strategy is popular because results of blood glucose levels can be obtained quickly, and therefore deterioration in glycaemic control can be discovered immediately, allowing for instant modifications in the treatment protocol.

In the present study, most respondents (21; 72%) suggested that urine glucose testing could be requested on an individual basis. However, an earlier editorial (1972) argued the inappropriateness of urine glucose monitoring for patients with diabetes and a burn injury.[17] Diabetes literature also argues the limited value of urine testing in diabetes care in general.[109] Specifically, urine glucose testing gives a rough estimation of the glycaemic state because it could be affected by many factors such as fluid and medicines intake and renal impairment.[109]

The current study found that optimal glycaemic control makes ketone testing unnecessary, but respondents reported indications of ketone testing, which are similar

to what is documented in the literature.[109] Examples of these indications include: persistent hyperglycaemia, pregnancy, shock, symptoms of ketoacidosis and others.

It was noted that less than half of the respondents recommended establishing targeted blood glucose levels for inpatients with diabetes and burn injuries. Indeed, setting such targets is an evolving movement in inpatients diabetes care. The impetus behind this initiative could be attributed to the findings of DCCT[20] and UKPDS-[31] namely the incidence and/or the severity of diabetes associated complications can be reduced if blood glucose levels maintained close to normal.

The principle of establishing targeted blood glucose levels was applied to improve short term outcomes of other illnesses among inpatients with diabetes.[110] Growing evidence suggests that outcomes of hospitalisation in critical care units could be improved if blood glucose levels are maintained within suggested ranges.[54,88-91,100] Accordingly, the American College of Endocrinology recommended maintaining blood glucose levels below 6.1 mmolL (110 mg/dl) in intensive care units. This is also the recommended pre-prandial target for non-critical patients whose blood glucose levels should not reach 10.0 mmolL (180 mg/dl) in any circumstance.[93]

Information obtained from the current research suggests that blood glucose levels should be kept within the range 4-10 mmol/L. This information contrasts with the view that, in the case of a burn injury, "little" hyperglycaemia is preferable to tight glycaemia control because of possible sudden changes in insulin requirements.[17] As such, the point that should be emphasised is that tight glycaemic control should be implemented safely. Safe implementation requires constant monitoring of blood

glucose levels combined with insulin adjustment, considering all possible factors affecting blood glucose concentrations.

Discharge Planning

One aim of the present research study was identifying whether discharge plans included diabetes status, and if so whether diabetes specialised professionals were consulted. The findings of the current study indicated that diabetes management was often included in burns discharge plans and diabetes centres were consulted when changes were done to the preadmission diabetes management regimen. This contrasts with findings of a previous study investigating management of diabetes when the admission diagnosis was unrelated to diabetes.[98] One explanation for the different findings is that data in the present study was obtained from providers of care, while, in the study cited above, data were obtained from patients.[98]

In fact, it is necessary to include diabetes in discharge planning because, after hospitalisation, the pre-admission diabetes management plan is most likely to be modified, and therefore patients need information to enable them to go home safely.[96] Additionally, diabetes education should be ongoing to enhance patient understanding of self management, and to meet patients' emerging needs.

Hospitalisation is a good opportunity to educate people with diabetes of the importance of lifelong management of this chronic illness.[94,98] However, hospitalisation for acute illnesses might not be the appropriate time to provide diabetes education for many reasons, including that the patient's attention is focused mainly on the acute illness and the environment might not be appropriate to conduct

effective education. Furthermore, diabetes education should be a lifelong process and one session of education might not be enough. Therefore, hospitalisation could be used to assess patients' understanding of diabetes self-management, and then direct the patient to the appropriate resources that might help in improving diabetes self-care.

Implications for Practice and Future Research

As the description of management of diabetes was developed from written responses to closed and open-ended questions, one might question its accuracy. As such, further work is needed in this regard to verify this description. Such verification would be done by reviewing the patient case notes and/or prospective follow up of patients with diabetes from admission until discharge. This is in addition to involving diabetes centre staff and utilising their clinical expertise and knowledge. Such sources of information would make the description of diabetes management closer to the real practice, formulating clear principles informing changes in practice.

One of the main findings of the present study, reported in quantitative data and emerging from respondents' comments, was using subcutaneous sliding insulin scales to manage diabetes, which is not strongly recommended by a volume of literature.[19,92,101-105] Perhaps special attention should be given towards educating burns unit staff of a lack of effectiveness of this approach and its drawbacks in controlling blood glucose concentrations. Importantly, efforts should be directed towards managing the metabolic state at the prevention level. To do so, management should address the varying nature of the glycaemic state, which is the end product of a wide range of factors affecting the metabolic process.

Diabetes multidisciplinary teams could play an important role in achieving glycaemic control because all aspects of the disease would be managed by specialised clinicians. As such, burn injuries sustained by patients with diabetes could be managed effectively with shorter hospital stays and use fewer resources. As a result, major hospital cost savings could be achieved, particularly as a significant proportion of the diabetes budget is spent on inpatient care.[44]

Limitations

The findings of the current study described the way diabetes was managed in burns units treating adults. However, the description should be taken in consideration of limitations in the study. These limitations were in general related to the study design and the technique of data collection adopted in the current inquiry. This is in addition to limitations resulting from factors specific to the present study, such as the small sample size, the respondents' demographic and professional profiles. However, these sources of limitations are often inter-related, making it imperative to be discussed from different perspectives.

With regard to the general sources of limitations, the methods chapter in this report demonstrates the fact that information obtained from descriptive-exploratory studies is often superficial. In addition, the fact that the information obtained might solely represent the views of the people participating in the study, rather than what actually occurs in practice. In the case of the current study, the respondents were a few professionals from each eligible burns unit, and therefore one is always concerned that

the information obtained reflected professionals' personal views rather than the actual practice in the participating units.

However, it is arguable that these professionals were clinical leaders of the involved sites, and therefore such senior professionals should be familiar with the practice in their sites. However, there was always a possibility for unfamiliarity with details of practice among senior people, and the personal view of the professional might be reflected in responses. For further explanation of this point, traditionally each hospitalised patient is assigned to an individual senior medical officer, and such an officer might not discuss care of his/her patients with other colleagues. This is most likely to occur if the care is not directly related to their scope of practice, as reported in a previous study.[57] In short, responses obtained in the current study might not represent the practices of other nurses and physicians in the participating units.

Indeed, the lack of representation mentioned in the previous paragraph is a common limitation in questionnaire survey studies, where personal interest in the topic of research might affect the decision to participate. In the study under report, the risk of personal interest in the topic was serious, because burns units were approached through liaison persons, and therefore the interest of the liaison person might deicide whether or not participation from the site was possible. This interest could be one reason for the lack of participation from the United Kingdom, where the identified liaison persons of nine units did not reply to the invitations. Similarly, participation from two Australian sites was not possible because the liaison persons replied that everyone was busy and had no time to complete the questionnaire.

On the other side of the equation, one should note that personal interest in the topic might also be the reason why some leaders participated. This was clearly noted among subjects from New Zealand and Hong Kong and was described in the methods chapter. Accordingly, results of the study might represent responses with mainly positive views towards the topic and subjects' attitudes towards the topic may be a source of bias in the present inquiry.

Another reason for the lack of representation was the mode of communication with liaison persons. E-mail was chosen to collect data quickly. However, data collection took a long time, and many sites did not participate. Although the low response rate could be explained as a lack of interest as already mentioned, one should bear in mind that the e-mail might not have reached the liaison persons for technical reasons. Furthermore, the identified liaison persons might have moved from the site, making an assumption that the questionnaire did not reach the site. Additionally, it was difficult to visit the sites in order to verify whether or not the questionnaire was received, which might result in the small sample size that did not allow robust statistical analysis. A final point is that, in the current inquiry, information was obtained from burns units, and was not checked with the diabetes centres of the participating sites and they may have different views.

Summary

The current study indicated that subcutaneous sliding insulin scales are commonly used in management of inpatients with burn injuries, perhaps because of a lack of awareness of the drawbacks associated with subcutaneous sliding scales. The study showed that clinical leaders of burns units believe in individualisation of diabetes

care, and many variables should be taken into account in designing and implementing a diabetes management plan. Examples of these variables include: food intake, burn size, medications, scheduled procedures, glycaemic state and other variables. However, no information was provided on how these variables were incorporated in the management plan. Specifically, it was noted that few diabetes centres were always involved in care-giving to inpatients with diabetes and a burn injury. Diabetes centres were most likely to be involved in discharge planning due to changes in the pre-admission diabetes management regimen. Such discharge planning would be a good opportunity for patient education and to direct patients to the appropriate diabetes care resources.

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Appendix 1

Code

The purpose of this study is to describe the management of diabetes for adult inpatients with burns.

I. –Demographic data

1) Would you please list all of your qualifications?
   i. [ ]
   ii. [ ]
   iii. [ ]
   iv. [ ]
   v. [ ]

2) How long have you been working in burns care?
   [ ] years
3) How long have you been working in the current burns unit?
   [ ] years
4) What position do you currently hold in burns care?
   [ ]
5) How long have you held this position?
   [ ] years

II. -The burns unit

1) Where is your burns unit located?

Please give the country and the State, [ ]

2) How many available beds (burns only) are in your burns unit?

   [ ]

3) Please, indicate which most closely corresponds to your burns unit.
   ☐ an adult burns unit
   ☐ a mixed adult/paediatric burns unit
   ☐ a mixed burns/ surgical unit
   ☐ other please specify [ ]

Note: If your burns unit is a mixed adult/paediatric burns unit, please note that this questionnaire is concerned with adult patients only

III. –Caring for patients with diabetes

1) Have you provided care for patients with diabetes hospitalised because of a burn injury?
   ☐ yes when [ ]
   ☐ no (Please go question 4)

2) If you answered yes to question 1, do you think burns management of patients with diabetes should be different from those without diabetes?
   ☐ yes
   ☐ no (Please go question 4)

3) If you answered yes to question 2, how should it be different?
   [ ]

4)
   a. What do you consider is the most important aspect of the management of patients with diabetes who are hospitalised with a primary diagnosis of a burn injury?
      ☐ management of diabetes
      ☐ management of burns
      ☐ management of both diabetes and burns

   b. Why do you think this is the most important aspect?
      [ ]

5) What do you consider in your experience to be the main issues faced in the management of patients with burns and diabetes?

   [ ]

IV. -Inpatient management of diabetes

A- Treatment

1) Which of the following options corresponds most closely to the management of diabetes status in your burns unit?
   ☐ management continues as it was before the admission
   ☐ a new plan is initiated
   ☐ other please specify [ ]

2) Is there a specialised diabetes clinic/centre in your hospital?
   ☐ yes
   ☐ no (please go to question 6)

3) If you answered yes to question 2, is it a multidisciplinary diabetes clinic/centre?
   ☐yes
   ☐no

4) How often do you think it is necessary to involve the diabetes clinic/centre in the management of inpatients with diabetes who are hospitalised in the burns unit?
   ☐always
   ☐often
   ☐occasionally
   ☐rarely
   ☐never

5) If you chose occasionally, rarely or never for the question number 4, please give examples of when or why this would occur.

When: [ ]

Why: [ ]

6) During hospitalisation of patients with diabetes in your burns unit, what strategy(s) do you think should be used to control blood glucose levels?
   ☐sliding scale insulin coverage
   ☐insulin algorithm
   ☐other ----------please specify how such cases should be managed. [ ]

7) If fasting is scheduled for patients with diabetes, which strategy(s) should be used for the management of diabetes in this scenario?
   ☐insulin infusion is initiated
   ☐diabetes medications (either insulin or oral hypoglycaemic agents)are given as before the admission
   ☐ oral hypoglycaemic agents are not given while insulin is given as before the admission
   ☐no diabetic medication is given
   ☐other ----------please specify how such cases should be managed. [ ]

B-Glucose Monitoring

1) For whom do you think admission blood glucose levels should be requested for patients admitted to the burns unit?
   ☐for every patient
   ☐when necessary ----------please specify when in your opinion admission blood glucose levels should be requested. [ ]

2) As part of management plans of patients with diabetes hospitalised in burns units, do you think it is necessary to set targeted blood glucose levels?
   ☐yes
   ☐no (Please go to question 4)

3) If you answered yes to question 2, what are these targets?

[ ]

4) For patients with diabetes hospitalised in your burns unit, how often do you think it is necessary to check their blood glucose levels?
   ☐before every meal and at bedtime

☐according to a standard protocol
☐according to the individual needs of each patient (no standard protocol)
☐other -------- please specify [ ]

5) For patients with diabetes hospitalised in your burns unit, what method do you recommend to test blood glucose levels?
☐portable capillary blood testing devices (capillary blood glucose)
☐hospital laboratory
☐other-------- please specify [ ]

6) When do you think it is necessary to request urine glucose testing for patients with diabetes hospitalised with a burn injury?
☐with every blood glucose testing
☐according to the individual needs of each patient
☐never
☐other -------- please specify [ ]

7) When do you think it is necessary to request ketone testing for patients with diabetes hospitalised because of a burn injury?
[ ]

V. Discharge planning

1) In discharge planning of patients with diabetes from your burns unit, how often do you think diabetes management should be included?
☐always
☐often
☐occasionally
☐rarely
☐never

2) If diabetes is included in the discharge planning, do you think this should be done in conjunction with health professionals who provide diabetes care in your hospital?
☐yes (Please go question 4)
☐no

3) If you answered no to question 2, please specify who conducts diabetes discharge planning for those who are discharged from your burns unit.
[ ]

4) If you chose occasionally, rarely or never for the question number 1, would you please give examples of when or why this occurs.
When:[ ]

Why: [ ]

Thank you for your time and effort in completing this questionnaire, and if you like to add any information or comments, please do so on the next page.

Further information or comments:

[ ]

Appendix 2

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22 March 2006

Mr Ma'en Zaid Abu-Qamar
Discipline of Nursing
Level 3, Eleanor Harrald Building
ROYAL ADELAIDE HOSPITAL

Dear Mr Abu-Qamar,

Re: "Management of adult inpatients with diabetes: A survey of burns unit staff."
Subject Questionnaire.
RAH PROTOCOL NO: 060306.

I am writing to advise that Research Ethics Committee approval has been given to the above project.

Research Ethics Committee deliberations are guided by the NHMRC National Statement on Ethical Conduct in Research Involving Humans.

The general conditions of approval follow:

- Adequate record-keeping is important. If the project involves signed consent, you should retain the completed consent forms which relate to this project and a list of all those participating in the project, to enable contact with them in the future if necessary. The duration of record retention for all research data is 15 years.
- You must notify the Research Ethics Committee of any events which might warrant review of the approval or which warrant new information being presented to research participants, including:
  (a) serious or unexpected adverse events which warrant protocol change or notification to research participants,
  (b) changes to the protocol,
  (c) premature termination of the study.
- The Committee must be notified within 72 hours of any serious adverse event occurring at this site.
- Approval is ongoing, subject to satisfactory annual review. An annual review form will be forwarded to you at the appropriate time.

If University of Adelaide personnel are involved in this project, you, as chief investigator, must submit a Human Research Approval Notification form (available at: http:www.adelaide.edu.au/research/ethics/human/guidelines/) within 14 days of receiving this ethical clearance to ensure compliance with University requirements and appropriate indemnification.

Yours sincerely,

pp **Dr M James**
CHAIRMAN
RESEARCH ETHICS COMMITTEE

Appendix 3

DISCIPLINE OF NURSING
FACULTY OF HEALTH SCIENCES

MA'EN ZAID ABU-QAMAR
Research student
LEVEL 3, EEANOR HARRALD BUILDING
ROYAL ADELAIDE HOSPITAL
THE UNIVERSITY OF ADELAIDE
SA 5005

Dear Sir/ Madam,

I am a research student in the Discipline of Nursing at the University of Adelaide, Australia. I am doing a study titled " Management of adult inpatients with diabetes: A survey of burns unit staff ". The purpose of this study is to describe how diabetes is managed when a person is hospitalised because of a burn injury, and to determine if any modifications are required in the management.

The findings of this study will increase the awareness of the appropriate inpatient management of diabetes in burns units, add to evidence based practice and assist care providers to deliver quality diabetes care. As a result, outcomes for patients with diabetes and a burn injury should improve.

I send this letter to invite you to participate in this study. You are invited because of your involvement in burns care. Be assured that your privacy will be protected in this research. Your identity will stay anonymous during and after the course of the study and access to all data will remain restricted to the researcher only. However, you can request a copy of your data. The data will be stored in locked facilities in the Discipline of Nursing, the University of Adelaide, for five years, and then they will be shredded.

Your involvement in this study on a voluntary basis is appreciated. Please fill out the attached questionnaire. The questionnaire can then be returned as a hard copy or as an email to the address given below. If you are not able to participate, please return the questionnaire uncompleted.

This is an exciting area of new research and I look forward to hearing from you. Please feel free to contact me for any question or to ring the Chairman of Research Ethics Committee, Royal Adelaide Hospital on +61-8-82224139 who is not directly involved in the study. If you wish, you can also ring my supervisor, Dr. Anne Wilson on +61-8-8303593, or email her on (anne.wilson@adelaide.edu.au).

Best regards,

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CONCLUDING CHAPTER

Table of Contents

Introduction

This chapter summarises the research portfolio and provides ideas for further investigation. The chapter also links knowledge gained from the current research with clinical practice.

Summary of the Portfolio

This research portfolio is composed of two studies that investigated burn injuries sustained by patients with diabetes. As outlined in the introductory section of the portfolio (pp. 15-17), the topic was investigated because of the seriousness and the high incidence of burn injuries in people with diabetes in addition to poorer outcomes for patients and the complex management of coexisting diabetes and burns. Very few studies investigating the topic were identified, thus an empirical non-experimental approach was applied to examine two different aspects of the association between diabetes and a burn injury, namely, outcomes for patients and diabetes management strategies when people with diabetes sustain a burn injury. Two different techniques to obtain data on these aspects from two different populations were used.

Data on outcomes were obtained from patient case records using an ethics approved data collection sheet. Records were reviewed to collect data on outcomes for patients hospitalised with a principal diagnosis of a foot burn injury in a large tertiary hospital in South Australia between 1999 and 2004. Data on diabetes management were obtained from clinical leaders of burns units treating adults in Australia, New Zealand, Hong Kong and the United Kingdom. The clinical leaders were approached

through a key liaison person in each unit and were asked to complete an ethics approved questionnaire.

The data obtained from both sources (case notes and questionnaires) were analysed using SPSS (Statistical Package for Social Sciences). Open ended questions on the questionnaire were analysed using relational analysis, which is a form of content analysis.[1]

Overall, the case note review showed an association between diabetes and poor outcomes for patients hospitalised with foot burn injuries. Importantly, these injuries were discovered late and most resulted from domestic appliances. Analysis of the questionnaire indicated that clinical leaders felt it was important to manage diabetes holistically according to the individual needs of each patient considering his/her personal needs including: diet intake, treatment requirements and medications among others. Additionally, the management plans in hospital were likely to be different from the preadmission plans. Subcutaneous sliding insulin scales were frequently used to manage diabetes in burns units.

Implications for Practice

As the findings of research should be reflected in clinical practice to improve the quality of patient care, it is necessary to link findings of the current research to clinical settings. Specifically, the findings are linked firstly to primary diabetes care, and secondly to inpatient management of diabetes.

Primary Prevention

As the findings of this portfolio of research were generated from data obtained from real settings, they could provide new perspectives to diabetes care. Specifically, the current portfolio of research highlights the complexity of managing patients with diabetes and a burn injury. The complexity arises from the increasing risk of a burn injury in people with diabetes due to ageing and social factors; as well as the combined effects of diabetes and a burn injury in terms of metabolic alterations and suboptimal immune functions. A further complex situation would arise, if we accept the fact that longstanding diabetes and large burn injuries are often associated with cardiovascular problems, which reduce blood flow to the wounded area.[2]

In the light of the situation outlined in the above paragraph, it is important to address burn injuries among the population with diabetes at the primary prevention level, which could reduce the incidence of burn injuries, and then help to avoid admitting patients with diabetes to burns units, where they require longer and costly treatment. Adding primary prevention of burn injuries to the tasks of diabetes care providers requires considerable thought on how burn injuries should be incorporated into preventive diabetes care.

There is an evolving trend that preventive care should be delivered by multidisciplinary teams because different aspects of diabetes would be managed by qualified professionals. As such, the question is: which profession should take primary responsibility for address the prevention of burn injuries? Before answering this question, it is necessary to take into account that the first study of the present portfolio argued that burn injuries could initiate the development of diabetic foot.

Hence, one answer to the question is that podiatrists could play a key role because primarily they deal with lower limb conditions. However, one should note that it is very difficult to assign such responsibility only to podiatrists because of the alarming number of patients with diabetes[3-5] and limited number of podiatrists.[6,7] Additionally, multidisciplinary diabetes teams are often located in hospitals, where many patients with diabetes can not access these teams because of financial and/or physical limitations.[8] As such, the responsibility of preventing foot burn injuries among the population with diabetes should be shared with community nurses and GPs whom the patients can reach easily.

If we accept that sharing of the responsibility for preventive foot care education is necessary, the next question should be how such preventive action can be implemented and shared between podiatrists and other diabetes care providers? The preventive action should be part of the ongoing diabetes care in which achieving tight glycaemic control would prevent the incidence and severity of diabetic peripheral neuropathy and retinopathy. Such prevention would, firstly, improve the person's ability to see and then avoid contact with possible sources of trauma. Secondly, it would maintain the integrity of protective peripheral sensation leading to early detection and treatment of a burn injury. In brief, the first line of prevention is maintaining the patient's visual and peripheral sensation abilities.

Additionally, efforts should be made to help patients identify and avoid possible sources of burn injuries. In the first study of the present portfolio and other published research,[9-11] household appliances were common sources of burn injuries. Therefore, prevention efforts should be directed towards the home environment. This could be

done by community nurses or district nurses who could visit patients' homes, and work collaboratively with them to eliminate local sources of burn injuries. These nurses could also work collaboratively with diabetes care providers who could identify people at risk of foot burn injuries, through annual foot screening, and refer these people to district nurses to eliminate risk at the home environment. Successful involvement of district nurses in the prevention efforts requires increasing not only their attention but also the attention of diabetes care providers to the importance of addressing burn injuries at the prevention level. However, one should note that it could be difficult to visit all people with diabetes by district nurses; as such prevention strategies should be expanded to include population based strategies.

However, one should note that such strategies might not prevent burn injuries among all patients with diabetes because, first, half of persons with diabetes remain undiagnosed and may be discovered accidentally after the development of complications.[12] Second, it is documented that many people with diabetes do not adhere to treatment protocols.[13-15] Poor adherence might reduce the effectiveness of preventive strategies, partly because of the inability to achieve tight glycaemic control among a vast proportion of the population with diabetes, and partly because they do not have their feet examined regularly.

Foot examination is mostly neglected during annual diabetes screening[16-20] for various reasons relating to professional, political, economic and social factors. According to a recently published review,[21] it is important to emphasise that, despite possible efforts that could be made to improve adherence to diabetic foot screening, peripheral neuropathy largely remains undiagnosed. Accordingly, the risk of foot burn injuries

continues to be high in people with diabetes. Thus, it is necessary to consider the second line of prevention.

Secondary Prevention

The current portfolio of research claims that delay in seeking health care is a significant contributing factor to and increases the complexity of burn injuries among patients with diabetes. Because of this, detection and treatment of such injuries should be made early, before the development of infection that might further complicate the management and then hinder the healing process. Accordingly, patients should not only be advised of the importance of, but also how to perform self-assessment of their feet, including soles. District nurses can also help by inspecting the feet of risk cases at regular intervals. In doing so, burn injuries would be discovered in the early stages, and therefore treatment could be commenced early and as a result health outcomes would improve.

For reasons mentioned in previous sections of the portfolio, some burn injuries might indeed not be discovered in the early stages, making hospitalisation necessary for many people with diabetes. Accordingly, preventive efforts should move towards hospital management aiming to improve outcomes for patients with diabetes admitted for a burn injury. To achieve such improvement, findings of the current research suggest optimal management of both diabetes and a burn injury is essential. The justification for this, as obtained from the current portfolio of research, is that the cyclical deterioration in these two conditions is reflected in outcomes for patients.

As part of the portfolio investigated management of diabetes in burns units, the argument here focuses on management of diabetes, rather than management of burn

injuries. Such focus does not undervalue optimal management of burn injuries, which should be more aggressive in the presence of diabetes.[10,22]

The current research recommends modifying the diabetes management plan which patients use prior to admission. If such modification is required, it would be preferable to be done in consultation with diabetes multidisciplinary teams. The second study in the portfolio found that modification to the preadmission plan does not occur very often. In fact, involvement of these teams in the process of care could help manage all aspects of diabetes, resulting in optimal glycaemic control which contributes to improved outcomes for patients, has been found in critical care units.[23-27] However, an important issue is how can the multidisciplinary team involved in an effective way?

Diabetes multidisciplinary teams should work collaboratively with burns unit staff to manage the patient holistically, rather than managing diabetes in isolation. This could be the challenge because burns unit staff may have different perspectives and priorities from diabetes multidisciplinary teams. Such different views are documented as a barrier for effective management of diabetes in surgical wards.[28] Other barriers documented in the literature include practice cultures in hospital settings, a lack of staff and other administrational issues.[29,30]

Strategies should be implemented to deliver effective diabetes care to all inpatients with diabetes through providing administrational support to efforts of multidisciplinary teams in terms of time and resources.[29] In the few publications on this issue, diabetes multidisciplinary teams work to manage this illness at hospital level, rather than in selected wards, perhaps by identifying inpatients with diabetes

from admission records.[31,32] Consequently, all inpatients with diabetes, regardless of their admission diagnosis, would they receive multidisciplinary care. However, one should note that diabetes as not a primary diagnosis of admission is often omitted from hospital records.[33,34] In addition, some non-diabetes specialists are known to have doubts about the value of optimal glycaemic control in improving outcomes of hospitalisation for conditions unrelated to the disease,[29] which might be related to their fear of hypoglycaemia.[29] Because of these reasons, burns unit staff, as reported in the second study described in this portfolio, might not seek help from diabetes multidisciplinary teams.

For diabetes multidisciplinary teams to participate in the process of care efficiently and effectively, all relevant professionals should be involved in developing a protocol for the management of diabetes among patients with a burn injury. Such a protocol could detail the principles of diabetes management and outline the collaborative involvement of diabetes centres and burns units in the process of care. The protocol should be flexible enough to meet the changing, demanding needs of each individual patient. Such needs could include: food intake, severity of burn injury, fluid resuscitation, length of procedure and time of day that is scheduled to perform procedures. In review, developing a flexible protocol would enable making consistent decisions to be made about patient care which is vital for the success of management.

Importantly, education programmes are necessary to increase staff awareness of the importance of flexible approach in managing people with diabetes and a burn injury. Subsequently, staff would recognise that the protocol should be used as a guide considering emerging changes in the patient's condition. The need for a flexible

protocol is recommended in recent studies of inpatients with diabetes hospitalised in general medical surgical wards, where mere prescription of insulin doses, as suggested in hospital protocols without considering daily changing patients' needs, results in poor glycaemic control.[35,36]

Accordingly, another study suggested involving diabetes specialists in managing inpatients with diabetes hospitalised for general medical conditions, rather than mere application of the protocol by junior physicians.[35] In burns units the situation could be more dramatic than general wards, where rapid changes in insulin requirements are common due to fluctuation in blood glucose levels.[22] Because of such fluctuation, the tradition in clinical practice is that blood glucose levels should be maintained slightly above the normal range to avoid the risk of hypoglycaemia.[37] This tradition contradicts the current evolving philosophy of inpatient therapy of diabetes that the glycaemic state should be maintained within the normal range in order to improve outcomes of hospitalisation.[38]

Indeed, developing a protocol to manage diabetes in burns units would address such different views about targeted blood glucose levels. In such a protocol, insulin doses could be modified frequently according to the concentration of glucose in blood, calling on the whole context of the patient. In short, management of diabetes among inpatients with burn injuries should be under constant monitoring and review to ensure that blood glucose levels are maintained within the normal range.

One should note that such an approach suggested in the previous paragraph would add extra loads on inpatient settings. An example of these loads could be employing extra

diabetes specialists, mainly nurses who are the core of diabetes care either for outpatients[39] or inpatients.[29] This stems from nurses' role as a coordinator of diabetes multidisciplinary care teams, and providers of patient education in terms of disease process and self monitoring of blood glucose levels and self-administration of anti-diabetic medications.[40] In addition to these roles, in the case of inpatient management, nurses are required to work closely with burns unit staff to improve outcomes of inpatients with diabetes. Furthermore, extra tasks would be added to nurses who work in burns units, such as using intensive insulin therapy and hourly checking of blood glucose levels. Similar loads are reported from intensive care units, where a protocol of intensive insulin therapy was implemented.[41]

In fact, adding extra loads to nurses is considered to be a barrier towards improving management of inpatients with diabetes,[29] which could be coupled with the shortage of nursing staff in most countries. As such, reasonable justification is necessary to make the idea of a flexible approach (suggested in page 10) acceptable in inpatient facilities. Specifically, the cost-containment value of developing such an approach should be explained to administrators of these facilities. Value could be achieved from the fact that such an approach would help in eliminating outdated strategies that are still used to manage diabetes despite a lack of effectiveness. One such strategy is subcutaneous sliding insulin scales, as was found in the second study of this portfolio. Accordingly, optimal glycaemic control would be achieved among patients with diabetes and a burn injury. As a result, wounds are more likely to heal quickly with much less intervention. Importantly, hospitalisation stay could be reduced, resulting in financial savings to hospitals.

Suggestions for Further Investigation

The portfolio of the present research used a descriptive exploratory approach, in which information on a wide range of aspects of the phenomenon under investigation was collected. Thus, many possibilities for future research on the association between diabetes and burn injuries emerged. Some are presented here.

It would be interesting if the first study described in this portfolio was replicated in other burns units. Consequently, evidence from different independent settings would be obtained that could help in enhancing credibility of the findings obtained. It would also be interesting to investigate the topic of the first study, namely, outcomes for patients with diabetes and a foot burn injury, using the phenomenological approach. In such an approach, an understanding would be developed from the perspective of patients who experience the coexistence of both diabetes and a foot burn injury. Such an understanding would be merged with evidence obtained from case notes enabling the development of a comprehensive picture of the association between diabetes and foot burn injuries.

Another interesting topic for investigation would be using mixed method designs to feature management of diabetes in burns units. Examples of these methods include: reviewing case notes of patients and interviews with providers of both diabetes and burns care. Another possible method is prospective follow-up of patients with diabetes and burn injuries from admission to discharge. Such different methods could lead to results according to which changes can be made in the clinical practice.

Summary

In this section, the portfolio of the current research was summarised and its implications for both practice and research are presented. In particular, this portfolio of research recommended prevention as an approach of choice to managing burn injuries among the population with diabetes. Preventive measures should start with tight glycaemic control, identification and avoidance of sources of trauma, early detection and treatment, and continue to aggressive inpatient management of patients with both diabetes and a burn injury. Patients and primary providers of diabetes care should join with district nurses to work collaboratively to firstly prevent the occurrence of a burn, and if such an injury occurs, identify and treat it early. As a result, hospitalisation for a burn injury would be avoided for many cases with diabetes. If hospitalisation is required, burns unit staff and the inpatient multidisciplinary diabetes team should work jointly to improve outcomes for patients.

The researcher recommended reviewing case notes of patients with diabetes hospitalised in other burns units, and investigating the experience of patients who sustained foot burn injuries some areas for further research. The researcher suggested adopting mixed method designs to explore in more detail the way diabetes is managed when hospitalisation is due to a burn injury.

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