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Foot burns: A comparative analysis of diabetic and non-diabetic patients

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ABSTRACT

Introduction: Foot burns represent a small part of the body with many challenges. The impact of diabetes on clinical outcomes adds further issues in management that clinicians must consider in their management. These factors have serious implications on morbidity and long term sequelae. Our aim is to analyse epidemiological trends of foot burns and examine the differences between diabetic and non-diabetics at Concord hospital from 2014 to 2019.
Methods: A retrospective audit from 2014–19 at Concord General Repatriation Hospital Burns Unit summarised patient demographics, burn injury, diabetic status, operations and length of stay. All foot burn injuries from 2014–19 of all ages and gender that attended Concord burns hospital were included in this study.
Results: We treated 797 patients who presented with foot burns, of which 16.2% were diabetic. The average age was higher in diabetics (60.72 years) than non-diabetics (39.72 years) and more males suffered burns compared to females in both groups ($p < 0.001$). There was a larger portion of elderly patients (greater than 65 years old, 15.1% of total) who sustained foot burns in the diabetic group compared to the non-diabetic group ($p < 0.001$). The most affected season was summer (27.0%), but diabetic patients were 1.7 times more likely to sustain injury in winter than non-diabetics. Diabetics were 3.8 times more likely to have contact burns compared to non-diabetic patients ($p < 0.001$). In a multivariable linear regression analysis, factors that contributed to increased length of stay included elderly status, place of event, diabetic status, number of operations, ICU admission, wound infection, amputation, and admission [F (16, 757 = 41.149, $p < 0.001$, $R^2 = 0.465$].
Conclusions: With the increase of diabetes, our multidisciplinary approach to diabetic foot care should include nursing, medical and surgical disciplines to identify patients at risk. The data highlights that a focus on prevention and education for diabetes is central to optimize glycaemic control and burn management, whilst providing a multidisciplinary network on discharge.

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1. Introduction

Foot burns are a unique type of burn, albeit small in area, can have significant morbidity affecting function and mobility. Foot burns in general pose a significant cost of morbidity and disability with 15–25% of diabetics having foot problems related to healing [1]. Diabetic patients have a predisposition to have more complications due to a dysregulated immune system, vasculitic disease and deranged glucose metabolism; these factors superimposed on the burn injury compared to non-diabetic patients can have a lengthened recovery process [2]. Burn patients present differently compared to non-diabetics and complications are often augmented by the underlying pathology associated with the disease. The International Diabetes Federation estimates 1.1 million people aged between 20 and 79 years with diabetes in Australia [3]. The pervasive nature of diabetes affects both the individual on a microscopic and marcoscopic level, such that prevention, education and early detection of type 2 diabetes remains an important part in management. It is well documented that diabetics have increased frequency of urinary tract infections [4], increased hospital length of stay [5], intensive care admissions and high incidence of renal failure [6]. The annual Australian healthcare costs of diabetics range from $ 3468 to $16,698 for patients with both micro- and macrovascular complications; type 2 diabetics primary care represented in the annual health care costs accounts for 32% which is inpatient care [7].

A systematic review of diabetic patients with burns showed that they are more prone to increased morbidity, longer hospital stays, bacteraemia and septicaemia [8]. There have been many studies on lower leg burns, but a focused study on isolated foot burns comparing the outcomes of diabetic and non-diabetic patients in an Australian context is novel. The Concord burns unit is one of two major adult tertiary centres that deals with adult burn victims in New South Wales, Australian Capital Territory, and French Polynesian islands. This study aims to analyse the epidemiological trends of foot burns and examine the impact of diabetes on clinical outcomes in isolated foot burns.

2. Methodology

2.1. *Study setting*

A retrospective audit was conducted at Concord Repatriation General Hospital (CRGH) Burns Unit from January 1st 2014 to January 1st 2019 for patients who presented with foot burns across New South Wales (NSW) and Australian Capital Territory (ACT). The unit treats over 1000 patients annually including inpatient and outpatients. Inclusion criteria were patients older than 16 years of age with an isolated foot burn injury, which was treated as in- or outpatients at the CRGH Burns Unit. Patients were excluded from the study if they sustained a foot burn injury in conjunction with other injuries to other anatomical locations.

2.2. *Data collection and study design*

Burn patients referred to the CRGH Burns Centre (in-and outpatient services) are assessed by a surgical trainee and/or a surgeon at the time of presentation. A comprehensive history is taken, the burn wound is clinically assessed, and a management plan formulated.

For the present study, data was retrospectively collected via the Agency of Clinical Innovation Database (ACI SBIS) and by reviewing CRGH medical records. Ethics approval was granted from the Human Research and Ethics Committee [CH62/6/2019-184]. Patients provided their consent to have the information recorded for the registry.

The following recorded parameters were analyzed for this project:

1 Demographic information: gender, age, elderly status*, diabetes status, and peripheral neuropathy**.
 * Elderly status, elderly is defined as 65 years and older. ** Peripheral neuropathy in the lower limbs is clinically determined by decreased sensation in the distal extremities and decreased ankle reflexes [9].
2 Socioeconomic parameters & place of injury: place of injury, socioeconomic index for areas (SEIFA)**, and insurance status.
 **The Socioeconomic Indexes for Areas (SEIFA) is a measure of disadvantage created by the Australian Bureau of Statistics (ABS) who defines the index of relative socioeconomic advantage and disadvantage (ISRAD) in terms of people's access to material and social resources, and the ability to participate in society [10]. The ISRAD score was assessed from the patient's postcode and analysed in conjunction with the ABS framework.
3 Information about the burn injury, treatment, complications & hospitalisation: mechanism of injury (scald, friction, flame, contact, chemical, electrical, radiation), first aid*, time of injury (year and season), burn depth, percentage of total surface area burnt (%TBSA), intensive care admission and length of stay in the intensive care unit, number of operations, amputations, wound infection**, admission, hospital length of stay, discharge destination, and mortality.
 *An assessment of adequate first aid is defined as cool running water for more than 20 minutes. **Infection that was treated with antibiotics.

2.3. *Statistical analysis*

A statistical analysis using SPSS (Version 26.0) was computed for continuous variables assessing the relationship between linear data and correlation based on a level of significance set at p value of 0.05. Continuous variables were expressed as mean and standard deviation (SD) or as median and interquartile range (IQR). Differences between proportions between diabetic and non-diabetics derived from categorical data were analyzed using Pearson's chi-squared test and an independent-samples t-test for continuous variables. Logistic regression analyses were conducted to study the association between diabetic and non-diabetic groups for variables and expressed as odds ratios (ORs) and 95% CIs. A multivariable

Table 1 – Differences in the diabetic and non-diabetic foot burn group.

	Non diabetics (n = 797)	Diabetics (n = 129)	p-Value
Demographics			
Gender			
Male	424 (63.5%)	109 (84.5%)	*p* < 0.001
Female	244 (36.5%)	20 (15.5%)	
Age (years)			
Average ± SD	39.7 ± 17.5	60.5 ± 12.8	*p* < 0.001
Range	16–93	21–87	
Elderly			
<65 years	598 (89.5%)	70 (61.2%)	*p* < 0.001
>65 years	70 (10.5%)	50 (38.8%)	
Sensory disability			
Yes	14 (2.1%)	56 (43.4%)	*p* < 0.001
No	654 (97.9%)	73 (56.6%)	
Socioeconomic parameters and place of injury			
Place of event			
Domestic	409 (63.1%)	102 (79.7%)	*p* < 0.001
Workplace	148 (22.8%)	7 (5.5%)	
Other	91 (14.0%)	19 (14.8%)	
ISRAD Quintiles			
Quintiel 5 (Least disadvantaged)	234 (35.1%)	29 (22.5%)	*p* < 0.001
Quintile 4	145 (21.8%)	27 (20.9%)	
Quintile 3	82 (12.3%)	13 (10.1%)	
Quintile 2	115 (17.3%)	29 (22.5%)	
Quintile 1 (Most disadvantaged)	90 (13.5%)	31 (24.0%)	
Insurance			
Medicare	489 (73.2%)	119 (92.2%)	*p* < 0.001
Workers comp	129 (19.3%)	7 (5.4%)	
Private	19 (2.8%)	1 (0.8%)	
Other	31 (4.6%)	2 (1.6%)	
Burn injury			
Mechanism of injury (MOI)			
Scald	408 (61.1%)	44 (34.1%)	*p* = 0.021
Flame	69 (10.3%)	6 (4.7%)	
Contact	100 (15.0%)	52 (40.3%)	
Chemical	54 (8.1%)	5 (3.9%)	
Electrical	2 (0.3%)	0	
Radiant	17 (2.5%)	22 (17.1%)	
Friction	13 (1.9%)	0	
Cold burn	5 (0.7%)	0	
First aid adequacy			
Inadequate	291 (43.6%)	101 (78.3%)	*p* < 0.001
Adequate	377 (56.4%)	28 (21.7%)	
Year	**[n = 668]**	**[n = 129]**	p = 0.733
2014	120 (18.0%)	22 (17.1%)	
2015	114 (17.1%)	26 (20.2%)	
2016	148 (22.2%)	19 (14.7%)	
2017	140 (21.0%)	33 (25.6%)	
2018	146 (21.9%)	29 (22.5%)	
Season			
Summer	182 (27.2%)	33 (25.6%)	p = 0.528
Autumn	172 (25.7%)	25 (19.4%)	
Winter	150 (22.5%)	43 (33.3%)	
Spring	164 (24.6%)	28 (21.7%)	
Burn depth			
Superficial	92 (13.8%)	6 (4.7%)	*p* < 0.001
Mid dermal	374 (56.0%)	45 (34.9%)	
Deep full thickness	202 (30.2%)	48 (60.5%)	
%TBSA			
Average	1.196	1.048	p = 0.189
Treatment			
Number of operations			

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Table 1 (continued)

	Non diabetics (n = 797)	Diabetics (n = 129)	p-Value
None	575 (86.1%)	89 (69.0%)	***p* < 0.001**
1	83 (12.4%)	30 (23.3%)	
2 or more	10 (1.5%)	10 (7.8%)	
ICU admission			
Yes	3 (0.4%)	1 (0.8%)	p = 0.578
No	665 (99.6%)	128 (99.2%)	
ICU length of stay (days)			
Average ± SD	0.0 ± 0.2	0.1 ± 0.4	p = 0.632
Range	0–2	0–3	
Complications			
Amputations	1 (0.1%)	7 (5.4%)	***p* < 0.001**
Wound infection			
None	663 (99.3%)	123 (95.3%)	***p* < 0.001**
Yes	5 (0.7%)	6 (4.7%)	
Hospitalisation			
Admissions			
Yes	70 (10.5%)	45 (34.9%)	***p* < 0.001**
No	598 (89.5%)	84 (65.1%)	
Length of stay (days)			
Average ± SD	0.8 ± 4.3	7.0 ± 19.2	***p* < 0.001**
Median	0.0	0.0	
Range	0–68	0–141	
None	598 (89.5%)	84 (65.1%)	
>24 h	26 (3.9%)	5 (3.9%)	
>3 days	17 (2.0%)	10 (7.8%)	
>1 week	15 (2.1%)	12 (9.3%)	
>2 weeks	9 (1.3%)	12 (9.3%)	
>1 month	3 (0.4%)	6 (4.7%)	
Discharge destination			
Home	658 (98.5%)	118 (91.5%)	***p* < 0.001**
Home with services	1 (0.1%)	4 (3.1%)	
Hospital facility	4 (0.6%)	5 (3.9%)	
Nursing home	2 (0.3%)	0	
Rehab	2 (0.3%)	0	
Death	1 (0.1%)	1 (0.8%)	
Mortality	1 (0.1%)	1 (0.8%)	p = 0.194

IRSAD, Index of Relative Socio-Economic Advantage and Disadvantage; TBSA, total burn surface area; ICU, intensive care unit; *p < 0.05; #, no value.

logistic and linear regression analysis was performed to determine potential risk factors for length of stay.

3. Results

3.1. Demographics

797 presentations of isolated foot burns were treated at the unit of which 129 (16.2%) were diabetic. Of these diabetic patients, 109 were male (84.5%) and 20 (15.5%) were female patients with a mean age of 60.20 years (SD ± 12.19) and 61.95 years (SD ± 16.04) respectively. More males suffered burns compared to females in both the diabetic and non-diabetic groups ($p < 0.001$). Male diabetics were 2.9 times significantly more likely to suffer burns compared to non-diabetics, and females were 34.5% less likely respectively. The mean age was higher in diabetics (60.5 years) than in non-diabetics (39.7 years). There was a larger portion of elderly patients (greater than 65 years old, 15.1% of total) who sustained foot burns in the diabetic group compared to the non-diabetic group ($p < 0.001$). Elderly diabetics were 5.7 times significantly more likely to have a foot burn than non-diabetics. Table 1 illustrates the differences between diabetic and non-diabetic patients with a foot burn injury for all the assessed independent variables.

3.2. Socioeconomics of foot burn injuries and place of injury

Looking at the socioeconomic status by using the SEIFA scoring scale, there were statistically significant differences in the number of foot burn injuries between diabetic and non-diabetics. The most disadvantaged people were 1.9 times significantly more likely to have foot burn injuries in the diabetic compared to the non-diabetic group ($p < 0.001$). The least disadvantaged diabetics were 53.5% less likely to have a foot burn compared to non-diabetics.

There was statistical difference between diabetics and non-diabetics regarding place of injury ($p = 0.027$), where non-diabetics had a higher rate of workplace injuries and diabetics were 2.3 times significantly more likely to have an injury at home. 65.9% of foot burn injuries commonly occurred at domestic residences, 19.4% were workplace injuries, and the remaining accidents occurred at sports grounds and public places. Approximately three quarter of all cases (75.50%) were referred from a hospital facility, followed by a local medical centre (12.40%) and the remaining from other sources. The majority of the cases were accident related either at home or the workplace, however 6 cases were suicide related with an average of 33 years (4 males, 2 females; range: 20–44 years) involving flame or chemical burns in both groups. Whilst the majority of patients are covered under Medicare (77.11%), there were significantly lower odds between the two groups insurance coverage with more non-diabetics held work related cover or private health insurance ($p < 0.001$).

3.3. *Information about the burn injury, treatment & complications*

3.3.1. *Mechanism of injury*

Overall for both groups, the most common mechanism of injury was scald (56.70%), followed by contact (19.10%) and flame burns (9.40%). Most scalds occurred in autumn (64.00%), whereas most contact burns occurred in summer (29.80%). Summer was the most prevalent season (27.00%) for foot burns, followed by autumn (24.70%). There was a statistically significant association between mechanism of injury and seasons ($p < 0.01$). All mechanisms of injury showed a statistically significant difference between diabetic and non-diabetic patients. Diabetics were 3.8 times significantly more likely to have a contact burn and 7.1 times more likely from a radiant burn than non-diabetics, but less likely to have a scald or flame burn [Table 2].

There were higher rates of contact burns in diabetic patients compared to non-diabetic patients. Diabetic patients had a higher rate of injury in winter from contact burns, compared to non-diabetic patients who had a higher rate of injury in summer from scald burns. Diabetics were 1.7 times significantly more likely to have a foot burn in winter than non-diabetics.

3.3.2. *Burn wound assessment*

The mean %TBSA for both groups was not statistically different ($p = 0.189$). For both groups, the mean %TBSA was 1.91 % (Males: 1.91 ± 1.265, females: 1.91 ± 1.161), a statistically non-significant difference of 0.005 %TBSA [95% CI, −0.177 to 0.187), $p = 0.960$].

The most common type of burn depth was mid dermal injuries overall, but there were more full thickness injuries in diabetic patients than non-diabetic patients with a statistically significant difference in the type of burn depths ($p < 0.001$). Diabetics were 3.1 times significantly more likely to have a full thickness injury than non-diabetics, but less likely for superficial and mid dermal burn injuries [Fig. 1]. Furthermore, diabetics had a significantly larger proportion of sensory disability compared to non-diabetic patients and poorer rates of first aid adequate administration of running cool water for 20 minutes ($p < 0.001$). Diabetics were 17 times significantly more likely to have sensory disability than non-diabetics.

Table 2 – Univariable analysis of variables in the diabetic and non-diabetic foot burn group.

	Odds ratio (95% CI)
<u>**Demographics**</u>	
Gender	
Male	**2.900 (1.794–4.688)***
Female	**0.345 (0.213–0.558)***
Elderly	
<65 years	**0.176 (0.116–0.267)***
>65 years	**5.671 (3.742–8.595)***
Sensory disability	
Yes	**17.032 (8.816–32.904)***
No	**0.059 (0.030–0.113)***
<u>**Socioeconomic parameters and place of injury**</u>	
Place of event	
Domestic	**2.298(1.478–3.473)***
Workplace	**0.217 (0.099–0.475)***
Other	#
ISRAD Quintiles	
Quintile 5 (Least disadvantaged)	**1.929 (1.239–3.003)***
Quintile 4	**1.364 (0.872–2.135)**
Quintile 3	**0.738 (0.400–1.360)**
Quintile 2	**1.020(0.656–1.586)**
Quintile 1 (Most disadvantaged)	**0.535 (0.345–0.829)***
Insurance	
Medicare	**3.845 (2.031–7.728)***
Workers comp	**0.259(0.118–0.567)***
Private	**0.299 (0.092–0.972)***
Other	#
<u>**Burn injury**</u>	
Mechanism of injury (MOI)	
Scald	**0.367 (0.250–0.539)***
Flame	**0.471 (0.240–0.926)***
Contact	**3.812 (2.548–5.704)***
Chemical	**0.468 (0.184–1.191)**
Electrical	#
Radiant	**7.116 (3.736–13.457)***
Friction	#
Cold burn	#
First aid adequacy	
Inadequate	**3.894 (2.572–5.894)***
Adequate	**0.257 (0.170–0.389)***
Season	
Summer	0.796 (0.522–1.215)
Autumn	0.767 (0.491–1.200)
Winter	**1.744 (1.170–2.601)***
Spring	0.856(0.552–1.326)
Burn depth	
Superficial	**0.299 (0.129–0.697)***
Mid dermal	**0.474 (0.324–0.692)***
Deep full thickness	**3.097 (2.126–4.511)***
<u>**Treatment**</u>	
Number of operations	
None	**0.426 (0.285–0.639)***
1	**2.345 (1.565–3.513)***
2 or more	#
ICU admission	0.566 (0.170–1.884)
<u>**Complications**</u>	
Amputations	**15.706 (4.112–59.992)***
Wound infection	**3.585 (1.342–10.956)***
<u>**Hospitalisation**</u>	
Admissions	**3.093 (2.073–4.615)***

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Table 2 (continued)

	Odds ratio (95% CI)
Discharge destination	
Home	**0.442 (0.200–0.978)***
Home with services	#
Hospital facility	#
Nursing home	#
Rehab	#
Death	#
Mortality	1.394 (0.155–12.565)

IRSAD, Index of Relative Socio-Economic Advantage and Disadvantage; TBSA, total burn surface area; ICU, intensive care unit; *p < 0.05; # no value.

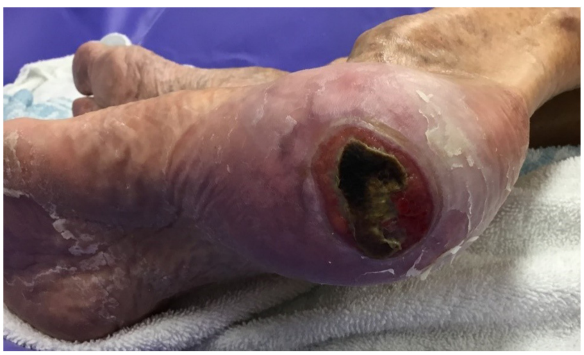

Fig. 1 – Foot burn in an elderly diabetic.
Below, a 12 day old contact burn to the left heel of an 83 year old diabetic male with multiple significant comorbidities. The heel shows black eschar with surrounding granulation tissue. The patient was initially managed as an outpatient with regular dressings and debridement, however, after 3 weeks of conservative management he eventually underwent multidisciplinary care from endocrinologists and cardiologists, followed by a skin graft and return home within a month.

Diabetics 3.9 times significantly more likely to have inadequate first aid compared to non-diabetics.

3.3.3. *Clinical treatment*

40 patients (31.00%) with diabetic foot burn underwent split thickness skin grafting, whereas 93 (13.92%) with non-diabetic foot burns underwent split thickness skin grafting ($p < 0.001$). Diabetic patients received a significantly higher number of non-excisional wound debridements and operative intervention with 2.3 times greater compared to non-diabetic patients ($p < 0.001$). Diabetics had significantly higher rates of wound infections with 3.6 times greater compared to non-diabetics ($p < 0.001$).

Diabetics were significantly longer hospitalized compared to non-diabetics with a mean length of stay 7.03 days compared to 0.82 days, respectively ($p < 0.001$). Four patients (one diabetic, three non-diabetics) received intensive care admissions for a period of 1–3 days. There was no statistical difference between the two groups receiving intensive care unit admissions or difference for the length of stay respectively.

3.3.4. *Complications*

15 post operative complications occurred in both groups: 11 patients had wound infection, 1 patient had sepsis, 8 underwent amputations [3 below knee amputations, 1 above knee amputation, 1 mid foot, 2 toes, 1 ray]. 7 of the 8 patients were diabetic; the one patient with the below knee amputation had transverse myelitis with peripheral neuropathy. The amputee group's mean age of 66.4 years and 1.23% TBSA full thickness injuries were equally from radiant or scald burns in the home setting. There was statistical difference for amputations ($p < 0.001$) between the diabetic and non-diabetic group with an average length of stay of 1.83 ± 8.93 days [range: 0–141 days]. Diabetics were 15.7 times significantly more likely to have amputations than non-diabetics with foot burns.

There was one death in the diabetic and one death in the non-diabetic group, which was not statistically different ($p = 0.194$).

3.3.5. *Length of stay and discharge status*

The most common initial presentation was to the outpatient clinic [n = 780, 97.9%]. The majority of patients in both groups were discharged home with no community services with diabetics 44.2% less likely to be sent home than non-diabetics ($p < 0.05$). The remaining patients were sent home with community services, transferred to a rehab facility, or transferred to another smaller hospital. None of the diabetic patients were sent to rehab or nursing home compared to 4 of the non-diabetic patients ($p < 0.001$) [Table 1].

Table 3 outlines a multiple regression analysis including factors that may contribute to length of stay. Elderly status, place of event (home), diabetic status, number of operations, ICU admission, wound infection, amputation, and admission were independently associated with increased length of stay [F (16, 757 = 41.149, $p < 0.001$, $R^2 = 0.465$].

4. Discussion

There are few studies that focus on the impact of diabetes on isolated foot burns, where seasonal variations and mechanisms of injury vary considerably in their presentation. Thus, we believe the present analysis adds valuable information as it appears that these aspects have an impact on the outcome of diabetic patients. Furthermore, the microvascular and macrovascular complications of diabetes play a role in patient outcomes, particularly neuropathy, vasculopathy and hyperglycaemia, which negatively influences burn injuries to feet in this patient cohort.

4.1. *Microvascular complications and peripheral neuropathy*

In European studies, the most common mechanism of foot burns is scalds [11,12]. In diabetic patients, peripheral neuropathy leads to loss of protective sensation from axonal damage due to microvascular impedance. There is the

Table 3 – Factors contributing to longer length of stay.

	Estimate	Lower 95% CIa	Upper 95% CIa	p-Value
Season = winter	−0.072	−0.499	0.356	0.742
Burn depth = full thickness	0.111	−0.709	0.932	0.790
Gender = male	0.173	−0.863	1.209	0.743
Elderly >65 years	1.696	0.293	3.099	**0.018***
IRSAD Quintiles = most disadvantaged	−0.224	−0.548	0.100	0.175
Work Related	0.226	−1.298	1.749	0.771
First aid adequacy	0.305	−0.714	1.325	0.557
Mechanism of injury = scald	−0.049	−0.430	0.332	0.801
Place of event = home	−0.661	−1.190	−0.131	**0.015***
Diabetic status	1.663	0.208	3.119	**0.025***
TBSA	0.270	−0.152	0.692	0.209
Total number of operating sessions	3.937	2.767	5.108	<**0.001***
ICU Admission	22.683	15.705	29.661	<**0.001***
Wound infection	14.426	10.171	18.681	<**0.001***
Amputation	19.077	13.894	24.260	<**0.001***
Admission	5.183	3.465	6.902	<**0.001***

95%CI, 95% confidence interval; IRSAD, Index of Relative Socio-Economic Advantage and Disadvantage; TBSA, total burn surface area; ICU, intensive care unit; *$p < 0.05$.

potential for prolonged exposure to a stimulus without appropriate feedback responses resulting in deep dermal to full thickness burn injuries. In a case series of 33 patients focused on diabetic lower leg burn injuries, scalds represented the most common type of injury in this group, but season was not accounted for in these findings. Our study notes the association between season and mechanism of injury, which statistically differed between the two groups ($p < 0.01$). Diabetic patients were 1.7 times more likely to sustain a thermal injury during winter ($p < 0.001$) compared to non-diabetics, and most frequently from contact burns (40.3%, $p = 0.021$) with 3.8 odds risk respectively. A very common history of diabetic foot burns is a contact burn from a heater in winter, which reflects the problem of peripheral neuropathy and the need for education tailored to each season to prevent these types of injuries. The role of peripheral neuropathy is implicated in the diabetic group compared to the non-diabetic group, where diabetics have greater depth of burn injury (3.1 times more likely) and inadequate first aid (3.9 times more likely) compared to non-diabetics ($p < 0.001$).

Katcher et al. retrospective analysis of 37 diabetic patients noted 10 patients suffered scalds during foot baths or heat compressors likely implicated from peripheral neuropathy, all which can be considered as preventable injuries [13]. Katcher further noted that younger males, presence of Type 1 diabetics and peripheral neuropathy, and application of thermal self-care treatments were all risk factors associated with preventable lower extremity burns in diabetics. Their findings show that 70.00% had peripheral neuropathy, whereas our findings reflected a lower rate of 43.40%. However, all our diabetic cases were Type 2 diabetics with increased odds, mainly men (84.5%, 2.9 odds risk), of older age (mean 60.5 years), and socioecomically more disadvantaged (1.9 odds risk) compared to non-diabetics ($p < 0.001$).

Our findings reflect similar results to Memmel's retrospective study of 1063 burn patients keeping in line with a statistically significant older age group and male predominance in the diabetic group [14]. Memmel further noted that there was a lower likelihood of presentation within the first 48 hours after injury ($p < 0.001$) likely due to the role of peripheral neuropathy, prolonged hospitalization, increased morbidity and delayed presentation due to an insensate wound. The differences in the mechanism of injury may be attributed to the microvascular complications associated with diabetes. Peripheral neuropathy is implicated in the presentation and clinical outcome of diabetic foot burns. The difference in burn depth and timing of presentation is supported by other studies adding clinical value to the way we understand and treat this high-risk group. Burn units can focus education programs before the two peaks that address both groups: before the summer season, and the winter season respectively.

4.2. *The elderly and socioeconomically more disadvantaged*

The ageing population represents another a high-risk group for burn injuries, which is associated with a delayed hypermetabolic response, increased hyperglycaemic and hyperlipidemic responses, inversed inflammatory response, immune-compromisation and delay in wound healing predominantly due to alteration in characteristics of progenitor cells [15]. 38.8% of our diabetic cohort were older than 65 years and significantly different compared to the non-diabetic group with 5.7 the odds risk of diabetics having foot burns than non-diabetics ($p < 0.001$). The score of the residential statistical local area of each person was used as the area-based composite measure of socioeconomic status [16]. The non-diabetic group represented the least disadvantaged group (35.1%) according to the quintile scale scoring, compared to the diabetic cohort who was the most disadvantaged (24.0%, $p < 0.001$). Diabetics from the most disadvantaged group are already more vulnerable before the event of a burn injury with 1.9 odds risk of foot burns compared to non-diabetics. When a burn injury is added to their comorbidities, they have additional risks for poor outcomes. Interestingly, diabetics from the most advantaged socioeconomic group were 50% less likely to have foot burns than non-diabetics perhaps owing to

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higher education, income and access to health services. A previous study of 33 foot burns at our unit found that diabetics were less likely to be working, underwent more regrafts and amputations; they were also less likely to be prescribed pressure garments suggesting that pressure garments were not suitable for many patients with diabetes from friction or pressure points [17]. The present study expands on these previous findings encompassing greater detail about the epidemiology, clinical outcomes and future care of foot burns. Most of the patients were seen in an outpatient setting, where the focus for burn care for these injuries indicates a holistic approach to foot burns.

4.3. *Place of injury and admissions*

Most injuries occurred at home with 3.5 times more likely diabetics have foot burn injuries compared to non-diabetics. However, injuries at the workplace occurred more frequent in non-diabetics (21.7% less likely in diabetics), potentially reflecting that the population of diabetics is older and thus less likely to still actively work. In contrast to the national study where electrical burn injuries are the most prevalent work-related mechanism of injury [18], most work-related incidents in our study were scald burns or chemical burns in both groups.

Most cases (85.57%) did not undergo an overnight admission to the hospital, however there was a statistically significant difference amongst the two groups with approximately 3 times the rate of hospital admissions for diabetic foot burns ($p < 0.001$). A previous study of 233 patients with isolated foot burns reported a rate of 52% for admission with similar distribution of mechanism of injury, however children were involved in the overall cohort [19]. They further highlight the importance of how delayed referral and presentation can impact wound healing and clinical outcomes. Unfortunately, for the present study, the timing of delayed referrals with injury was not documented accurately and therefore could not be included in the analysis.

4.4. *Long term outcomes*

A systematic review noted that diabetic patients were 2.55 times more likely to sustain local or wound infections compared to non-diabetic patients, but did not have longer hospital length of stay or increased mortality rates [8]. Our findings note similarities with the wound infection rate 3.6 times more likely in diabetics compared to non-diabetics ($p < 0.001$) and 15.7 times more likely for amputations. There were no significant differences with mortality, but length of stay was significantly longer in the diabetic group attributed to their admission and complications. In contrast to other units [21], our unit does not routinely use antibiotics for burn injuries. Antibiotic treatment is only initiated if the clinical assessment suggests a wound infection. Overall, there was a trend towards conservative management with wound debridements and dressings for foot burns in both groups. The operative intervention was accounted for the impact diabetes, old age and cardiovascular comorbidities have on wound healing [22] and showed that diabetic patients had 2.3 times the rate of operative interventions like xenograft dressings, grafting or amputations ($p < 0.001$).

Our findings along with other studies have shown a statistically increased length of stays for diabetic patients compared to non-diabetics (mean 0.8 days vs mean 7.0 days, $p < 0.001$). Kimball et al. reported a mean length of stay of 14.1 days in diabetic patients compared to 9.8 days in non-diabetic patients [6]. Our multivariable analysis of factors contributing to longer hospital length of stay, determined diabetic status, place of event at home, and elderly age as significant independent contributors. Obviously, age cannot be changed, but reducing the complications of diabetes in turn effects the number of operations and admission. Diabetics are 40% less likely to return home than non-diabetics, which is attributed by the modifiable and non-modifiable variables. Duke et al. population longitudinal based study reports that the burn population are 2.21 times more likely to be admitted and almost three times the number of days in hospital with a diabetes mellitus diagnosis comparted to a non-injured cohort [24].

In our study, most presentations were to the outpatient clinic, which benefits from a multidisciplinary approach to improve care for these patients including managing glycaemic control and optimising wound care, in order to decrease the length of stay and amputation rates [25]. A limitation of the present study is the retrospective nature. Additionally, the control group was randomly selected, not formally matched, and does not have an equal number of subjects compared to the diabetes group.

5. Conclusion

A lot of studies focus on lower leg burns, but there are almost no reports on isolated foot burns with direct comparisons of diabetic and non-diabetic patients. With the rise of non-communicable disease, the number of diabetic patients presenting to burn units is expected to increase with a shift towards holistic care to prevent burn diabetic disease related admissions [26,27]. The aim is to restore functional capacity in the feet by limiting infection, reducing oedema and pain so mobility ensues. Diabetics should be regarded as a high-risk vulnerable group that benefit from considerable attention, monitoring and holistic medical therapy that encompasses surgical and medical expertise in foot burn management. The contrasting characteristics between the two groups highlights the role for patient focused education to minimise complications and future injury, particularly surrounding the micro and macrovascular complications of diabetes and the dangers of a burn injury in different seasons.

Competing interests

No authors have any competing interests.

This project has been approved by the Human Research Ethics Committee with no restrictions. There is no source of financial or other support and no financial or professional relationships which may pose a competing interest. Patient consent has been obtained. The data is deemed confidential

and under ethics cannot be disseminated openly due to confidentiality and privacy. Photo consent has been obtained for patients.

Authors contribution

The authors contributed to the conception and design of the manuscript, revised it critically for important intellectual content, approved the final version to be published and agreed to be accountable for all aspects of the work.

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