Severe burns in Australian and New Zealand adults: Epidemiology and burn centre care

Dr. Jason Toppi[a], Dr. Heather Cleland[a,b,c], Prof Belinda Gabbe[a,d]

[a]Monash University Department of Epidemiology and Preventive Medicine,

Melbourne, Victoria, Australia

[b]The Victorian Adult Burns Unit, The Alfred Hospital, Melbourne, Victoria, Australia

[c]Department of Surgery, Monash University Central Clinical School, Melbourne, Victoria, Australia

[d]Health Data Research UK, Swansea University Medical School, Swansea University, Swansea, United Kingdom

Abstract

Introduction

Studies describing the epidemiology of severe burns (>20% total body surface area) in adults are limited despite the extensive associated morbidity and mortality. This study aimed to describe the epidemiology of severe burn injuries admitted to burn centres in Australia and New Zealand.

Materials and methods

Data from the Burns Registry of Australia and New Zealand (BRANZ) were used in this study. Patients were eligible for inclusion if they were admitted between August 2009 and June 2013, were adults (18-years or older), and had burns of 20% total body surface area (TBSA) or greater. Demographics, burn characteristics and in-hospital mortality risk factors were investigated using multivariable Cox proportional hazards analysis.

Results

There were 496 BRANZ registered patients who met the inclusion criteria. Over half of the patients were aged 18 to 40 years and most were male. The median (IQR) TBSA was 31 (25-47). Most (75%) patients had burns involving <50% TBSA, 58% sustained their burn injury at home, and 86% had sustained flame burns. Leisure activities, working for income and preparing food together accounted for over 48% of the activities undertaken at the time of injury. The in-hospital mortality rate was 17% and the median (IQR) length of stay was 24 (12-44) days. Seventy-two percent were admitted to an intensive care unit (ICU) and 40% of patients had an associated inhalation injury. Alcohol and/or drug involvement was suspected in 25% of cases.

Conclusion

This study describes the demographics, burn injury characteristics and in-hospital outcomes of severe burn injuries in adults whilst also identifying key predictors of inpatient mortality. Key

findings included the over-representation of young males, intentional self-harm injuries and flame as a cause of burns and highlights high risk groups to help aid in the development of targeted prevention strategies.

1. Introduction

Burns serious enough to warrant hospital admission can be difficult to manage and require input from a variety of specialist healthcare professionals [1]. Severe burn injuries (total body surface area (TBSA) of 20% or greater) account for approximately 8% of burn injury admissions to burn centres across Australia and New Zealand [1, 2]. In-hospital mortality rates for severe burn injuries have been shown to range from 27% to 33% [3, 4], and up to 54% for injuries of 40% TBSA or greater [5].

Despite the high levels of morbidity and mortality associated with severe burn injury, there is still a lack of published data describing the epidemiology of this patient group. Epidemiological studies are important as they help facilitate targeted burn prevention, management and organise burn care. Australian literature investigating the epidemiology of severe burns has been limited to specific regions, with some of these studies using data that is over two decades old [1, 6-8]. Whilst studies investigating the epidemiology of burns based in specific geographical areas are helpful, broader nationally based perspectives using contemporary data are required to best inform prevention and treatment strategies. This also provides the opportunity to analyse a relatively larger cohort of patients when compared to previously published literature. Thus, the aim of this study was to describe the epidemiology of severe burn injuries admitted to burn centres in Australia and New Zealand.

2. Materials and methods

2.1 Setting

The Burns Registry of Australia and New Zealand (BRANZ) is a clinical quality registry of burns that incorporates burn-related epidemiological, quality of care, and outcome data from patients in Australia and New Zealand [9]. The BRANZ was formed as a collaboration between Monash University and the Australia and New Zealand Burn Association (ANZBA) which aims to implement evidence-based recommendations to improve patient care, outcomes, cost-effectiveness and burn

centre capacity. To be included on the registry, burns patients must be admitted to hospital for at least 24 hours, be admitted for less than 24 hours but require surgical management, or die prior to discharge. Furthermore, patients must have also been admitted within 28 days of the burn or transferred from another hospital (irrespective of the time from injury) [9].

2.2 Participants

Patients eligible for inclusion in this study were: adults (age of 18-years or greater) with a TBSA burned of 20% or greater who were admitted to a BRANZ participating hospital between August 2009 and June 2013. For this study 10 of 12 BRANZ sites contributed data.

2.3 Procedures

Factors used to describe the demographic profile of the population included age, gender, and comorbidities. Comorbidities were based on the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). The ICD-10-AM is a coding scheme for diseases and external causes of injury. Comorbidities reported in this study based on ICD-10-AM codes were the presence of type 1 or type 2 diabetes mellitus, obesity, chronic obstructive pulmonary disease (COPD) or asthma and ischaemic heart disease (IHD). Chronic kidney disease was not included because of low numbers (less than five). Codes were also used to calculate a Charlson Comorbidity Index (CCI) for each patient. The CCI predicts the 10-year mortality for patients based on the presence of certain conditions. Patients were assigned a score of 0, 1, 2, 3, or 6 based on the conditions present, with a higher score representing the risk of less favourable outcomes. Nineteen Charlson conditions were mapped from ICD-10-AM codes to assign CCI scores to each patient [10]. Fund sources for admission were also reported. These were categorised as Australian public healthcare (i.e. Commonwealth state funding agreement), private health insurance (Australia), self-funding (Australia), workers compensation (Australia), motor vehicle third party personal claims (Australia), Department of Veterans Affairs (Australia), reciprocal health care

agreements (with other countries), other sources (e.g. travel insurance), motor vehicle compensation (Australia), Accident Compensation Corporation (no-fault personal injury cover in New Zealand), surgical services contract and other private insurance (New Zealand).

Burn injury event characteristics included the activity being performed when the burn occurred, the place of injury, the primary cause, intent of burn injury (I.e. unintentional, intentional self-harm or assault), and if alcohol or drugs were confirmed or suspected to be a factor in the occurrence of the burn. The burn injury was further characterised by the %TBSA, body area involved, whether an inhalation injury was sustained and the burn depth. A patient was recorded as having an inhalation injury if this was documented during the admission. Alcohol and/or drug involvement was recorded if clinical documentation indicated there was confirmed, or a suspicion of, alcohol and/or drug use contributing to the patient sustaining a burn.

The 'rule of nines' was used to assess %TBSA [11] by the most senior burns clinician within 72-hours of admission. Categorisation based on quartiles (20-25%, 26-30%, 31-49% and ≥50%) was used to describe the %TBSA given the skewed distribution of this variable. Burn depth was assessed clinically and classified as superficial dermal, mid-dermal, deep dermal and full thickness at the time of assessment [12]. For this study these terms were then simplified to three groups: superficial partial thickness burns (superficial or mid dermal), deep partial thickness/full thickness burns (deep dermal or full thickness) and combination burns (where a patient had been assessed as having areas of superficial partial thickness burns *and* deep partial/full thickness burns). The following in-hospital measures were also reported; mortality, length of stay and admission to an intensive care unit (ICU).

2.4 Data Analysis

Descriptive statistics were used to summarise the characteristics of the included patients. Frequencies and percentages were used for categorical variables and an assessment of normality was undertaken for all continuous variables. The mean and standard deviation (SD) were reported

for normally distributed variables, otherwise median and interquartile range (IQR) were used. Chi-square tests were used to compare categorical variables. Mann-Whitney U tests or Kruskal Wallis tests were used to compare groups using continuous variables.

A Cox Proportional Hazards regression model was used to model time to in-hospital death [13]. For this survival analysis the time of admission was designated the time of origin (t0) and survivors were censored at the time of discharge. Potential risk factors for mortality were analysed and included age, gender, comorbidities, cause, injury intent (I.e. self-harm), %TBSA, the presence of an inhalation injury, body region involved and whether the patient had a surgical procedure performed. Factors showing a significant association on univariate testing were included in the multivariable model. The hazard ratio, and corresponding 95% confidence intervals, were then reported and represent a measure of how often an event (I.e. death) occurred in one group compared to the other over time. A p-value of less than 0.05 was considered significant and statistical analyses were performed using STATA (version 13).

3. Results

3.1 Patient demographics

There were 496 patients eligible for inclusion in this study (Table 1). Three Australian burn centres provided care for 56% of the patients, 57% of patients were 18 to 40 years of age and most were male (Table 1).

3.2 Burn injury event

Most patients sustained their injuries at home. The most common activities that resulted in a severe burn were leisure activities, working for income, and preparing food or drink. Intentional self-harm injuries contributed 18% of recorded cases (Table 2). Flame burns accounted for 86% of cases and 40% of patients with a flame burn also sustained an inhalation injury (Table 2).

3.3 Severity of burn injury

The median (IQR) %TBSA was 31 (25-47) and ranged from 21 to 100 with 75% of patients sustaining burns involving <50% TBSA. Lower %TBSA burns were more commonly superficial; 31% of 20-25% TBSA burns were superficial partial thickness (Figure 1).

3.4 In-hospital outcomes

Fifty-two percent of patients were discharged to a place of residence and there were 84 (17%) in-hospital deaths. Of the deaths, 49 (58%) had treatment withdrawn (active treatment commenced but ceased), 13 (15%) did not have active treatment instituted on admission, and 8 (10%) died without withdrawal of treatment. For 14 deaths, this information was not provided. Of the survivors, 79% were male and were younger than those who died (Table 3). The median (IQR) length of stay was 24 (12-44) days and 72% of patients were admitted to an intensive care unit (ICU). The median (IQR) length of stay in ICU was 173 (48-374) hours. Multivariable analysis revealed the presence of an inhalation injury, older age and greater TBSA were associated with increased risk of in-hospital mortality (Table 4). The presence of comorbid conditions including obesity, diabetes, COPD/asthma and ischaemaic heart disease were not shown to increase the risk of in-hospital mortality. An analysis of CCI and mortality was also undertaken. A *higher* CCI (I.e. more comorbidities) was shown to be significantly associated with *survival* (P-value <0.01).

4. Discussion

This study provides the first epidemiological analysis of Australian and New Zealand adults with severe burn injuries. The findings highlight the large number of severe burns occurring in the home which were mostly flame type injuries. The important predictors of mortality were increased age, intentional self-harm, higher %TBSA and the presence of an inhalation injury.

In our study, 4.9% of admissions to Australian and New Zealand burn centres involved burns >=20% TBSA while previous studies have reported values ranging from 8 to 31% [3, 4, 14, 15]. Data from

the National Burn Repository (NBR) in the United States of America (USA) and a study involving 1,063 cases from Hong Kong each quoted severe burn injury proportions of 8% [4, 15]. It is possible that in the USA, a higher proportion of smaller burn injuries were managed outside burn centres, as compared to Australia and New Zealand [16]. It was also possible that in Australia and New Zealand a greater proportion of patients were admitted with less severe injuries that could have been managed elsewhere, which may have accounted for the lower proportion of severe burns observed in BRANZ patients when compared with those from Hong Kong and the USA [15, 16]. The highest proportions were seen in Brazilian (31%) and North-East China (20%) cohorts of patients [3, 14]. Reasons for variability in reported proportions were multifactorial with differences between healthcare systems, models of care, referral patterns and patient populations likely contributors [3, 14].

Severe burn injuries in BRANZ patients predominantly occurred in males aged 18-40 years. Our findings were consistent with data from previous Australian studies and studies undertaken in other high-income countries [16-20]. In contrast, studies undertaken in low and middle-income countries (LMIC) reported a higher proportion of severe burn injuries in women, with the most common mechanisms largely attributed to burn injuries related to cooking [21, 22].

The mortality rate of adults with severe burn injuries in this study was 17%. Similar mortality rates have been described in comparable patient populations from other high-income countries throughout Europe [17]. A previous study from the USA reported a mortality rate of 27% between 2005 and 2014 [4]. Mortality rates in LMIC have not been well reported [21]. However higher rates have been observed, with one study from Brazil demonstrating a mortality rate of 33% amongst adults with severe burn injuries [3].

The important predictors of in-hospital mortality in this study were older age, intentional self-harm, higher %TBSA and an associated inhalation injury, which were consistent with previously published literature [17-19, 23-27]. Comorbidities have been identified as a possible predictor of mortality in

burn injuries previously [28-31]. In this study there were no significant associations found between the presence of obesity, diabetes, COPD/asthma or IHD and an increased risk of in-hospital death. A significant association between survival and *higher* CCI was found (P-value<0.01) on multivariate analysis, despite adjusting for age, gender, injury intent, %TBSA and inhalation injury (not shown in tables). Upon further investigation it was found that close to 88% of deaths within 24-hours of admission had no reported CCI conditions. Thus, it may have been that in cases of such early deaths there was no recording or collection of information about patient comorbidities, and this association may have been the result of bias in the collection of comorbidity information. While multiple studies have found women to be at increased risk of mortality [17, 20, 22, 32-34], we found no association between gender and mortality after adjusting for age, %TBSA, CCI, intentional self-harm and inhalation injury.

Despite adjusting for %TBSA and inhalation injury, intentional self-harm injuries were still found to significantly increase the risk of in-hospital mortality when compared with accidental injuries. It is possible other confounding factors not adjusted for in this analysis, such as burn depth, may be an explanation for this association. Self-immolation burns are known to be associated with greater burn depth when compared with accidental burns [35-37]. Dousing and setting alight an accelerant is the most common method of self-inflicted burns and it is likely this is the main contributor to the increased severity, and thus higher rates of mortality, observed in these patients [37].

4.2 Conclusion

This study identified key predictors of mortality in adults with severe burn injuries and provides a comprehensive descriptive analysis of demographics, burn injury characteristics and in-hospital outcomes related to adults with severe burn injuries in Australia and New Zealand. This study has highlighted the over-representation of young males, intentional self-harm injuries and flame as a

cause of burns. Together, these findings can be used to inform prevention strategies aimed at reducing mortality and morbidity related to severe burn injuries in adults.

Table 1 Demographics of the patient population

Characteristics	All patients N= 496
Age group	
18-25 years	113 (22.8%)
26-40 years	168 (33.9%)
41-55 years	107 (21.6%)
≥56 years	108 (21.8%)
Sex	
Male	374 (75.4%)
Female	122 (24.6%)
Comorbidities	
Diabetes	32 (6.5%)
Obesity	9 (1.8%)
COPD or asthma	7 (1.4%)
IHD	6 (1.2%)
Hospital Campus	
Hospital A	109 (22.0%)
Hospital B	105 (21.2%)
Hospital C	63 (12.7%)
Hospital D	62 (12.5%)
Hospital E	57 (11.5%)
Hospital F	53 (10.7%)
Hospital G	15 (3.0%)
Hospital H	13 (2.6%)
Hospital I	12 (2.4%)
Hospital J	7 (1.4%)
Insurance fund source[a]	
Australian health care agreements (Australia)	331 (66.9%)
Accident Compensation Corporation (NZ)	72 (14.6%)
Workers' compensation body (Australia)	51 (10.3%)
Private health insurance (Australia)	15 (3.0%)
Other[b]	26 (5.3%)
Admission source	
Inter-hospital transfer	279 (56.3%)
Via ambulance from scene of injury	189 (38.1%)
Other referral source[c]	28 (5.6%)

[a]Insurance fund source data missing for n=1;[b]Funded by self, motor vehicle compensation, reciprocal health care or department of veterans affairs; [c]From general practitioner, self-presentation or other burn centre

Table 2 Burn injury event characteristics of entire population

Place, action and primary cause that resulted in severe burn injury	All patients N= 496
Place of burn injury[a]	
Home	272 (57.5%)
Place of recreation	35 (7.4%)
Other residence	31 (6.6%)
Trade or service area	30 (6.3%)
Street or highway	29 (6.1%)
Industrial or construction area	29 (6.1%)
Farm	17 (3.6%)
Other specified place[b]	30 (6.3%)
Activity at the time of burn injury[c]	
Leisure activity (excludes sport)	69 (17.7%)
Working for income	68 (17.4%)
Preparing food/drink	53 (13.6%)
Sleeping/resting	35 (9.0%)
Suspected illegal activity	30 (7.7%)
Household maintenance	24 (6.2%)
Vehicle maintenance	23 (5.9%)
Gardening	21 (5.4%)
Other specified activities[d]	67 (17.2%)
Intent of injury[e]	
Unintentional	373 (77.7%)
Intentional self-harm	85 (17.7%)
Assault or maltreatment	22 (4.6%)
Primary cause of burn injury[f]	
Flame	427 (86.3%)
Scald	44 (8.9%)
Other specified cause[g]	24 (4.9%)
Associated inhalation injury	
No	296 (59.7%)
Yes	200 (40.3%)
Alcohol or drugs involved[h]	
No	305 (74.9%)
Yes	102 (25.1%)

[a]Place of burn injury data missing for n=23; [b]Residential institution, school or public administrative area, sports or athletics area, farm; [c]Action when burn injury occurred data missing for n=21. Leisure activities included anything with an entertainment element such as being at a cinema, a party or participating in activities of a voluntary organisation; [d]Sports activity, cleaning, near person preparing food/drink, driving, bathing, vehicle/household; [e]Intent when burn injury occurred data missing for n=16 [f]Primary cause of burn injury data missing for n=1; [g]Contact, chemical, friction, electrical, pressurised gas/air (non-flame), radiant heat; [h]Document confirmation or suspicion of alcohol and/or drugs involved data missing for n=89

Table 3 Comparison of survivors to discharge and in-hospital deaths

Characteristics	Survivors to discharge N= 411	In-hospital deaths N= 84	P-value
Age			
Median (IQR)- years	36 (25-50)	53 (39-66)	<0.01
Range- years	18-84	19-97	
Gender			
Male	323 (86.6%)	50 (13.4%)	<0.01
Female	88 (72.1%)	34 (27.9%)	
Comorbidities[a]			
Diabetes	26 (81.3%)	6 (18.8%)	0.81
Obesity	7 (77.8%)	2 (22.2%)	0.69
COPD or asthma	6 (85.7%)	1 (14.3%)	0.84
IHD	5 (83.3%)	1 (16.7%)	0.97
Charlson Comorbidity Index[a]			
0	281 (83.9%)	54 (16.1%)	<0.01
1	76 (91.6%)	7 (8.4%)	
≥2	47 (67.1%)	23 (32.9%)	
Primary cause of burn injury[b]			
Flame	350 (82.2%)	76 (17.8%)	0.22
Other specified cause[c]	60 (88.2%)	8 (11.8)	
Intent of injury[d]			
Unintentional	334 (89.8%)	38 (10.2%)	<0.01
Intentional self-harm	50 (58.8%)	35 (41.2%)	
Assault or maltreatment	18 (81.8%)	4 (18.2%)	
%TBSA group			
20-25%	136 (96.5%)	5 (3.6%)	<0.01
26-30%	101 (95.3%)	5 (4.7%)	
31-49%	115 (89.8%)	13 (10.2%)	
>50%	59 (49.2%)	61 (50.8%)	
Associated inhalation injury			
Yes	135 (67.5%)	65 (32.5%)	<0.01
No	276 (93.6%)	19 (6.46%)	
Face involved[e]			
Yes	256 (83.9%)	49 (16.1%)	0.66
No	96 (85.7%)	16 (14.3%)	

[a]CCI and Comorbidity data missing for n=7; [b]Primary cause missing for n=1; [c]Scald, contact, chemical, friction, electrical, pressurised gas/air (non-flame), radiant heat; [d]Intent when burn injury occurred data missing for n=16; [e]Face involved missing for n= 18

Table 4 Predictors of time to in-hospital mortality (multivariate analysis)

Factor	Hazard Ratio (95% CI) N=472	P-value
Age	1.06 (1.04, 1.07)	<0.01
Gender		
Male (reference)	1.00	
Female	1.22 (0.75, 1.99)	0.43
Diabetes		
No (reference)	1.00	
Yes	0.44 (0.18, 1.09)	0.08
Obesity		
No (reference)	1.00	
Yes	0.69 (0.19, 4.09)	0.88
COPD/asthma		
No (reference)	1.00	
Yes	0.84 (0.09, 7.97)	0.88
IHD		
No (reference)	1.00	
Yes	0.65 (0.07, 5.90)	0.70
Intent of injury		
Unintentional (reference)	1.00	
Intentional self-harm	2.90 (1.76, 4.77)	<0.01
Assault or maltreatment	1.37 (0.47, 3.99)	0.56
%TBSA group		
20-25% (reference)	1.00	
26-30%	1.50 (0.40, 5.66)	0.55
31-49%	2.79 (0.89, 8.75)	0.08
>50%	17.20 (5.93, 49.85)	<0.01
Inhalation injury		
No (reference)	1.00	
Yes	2.14 (1.21, 3.78)	0.01

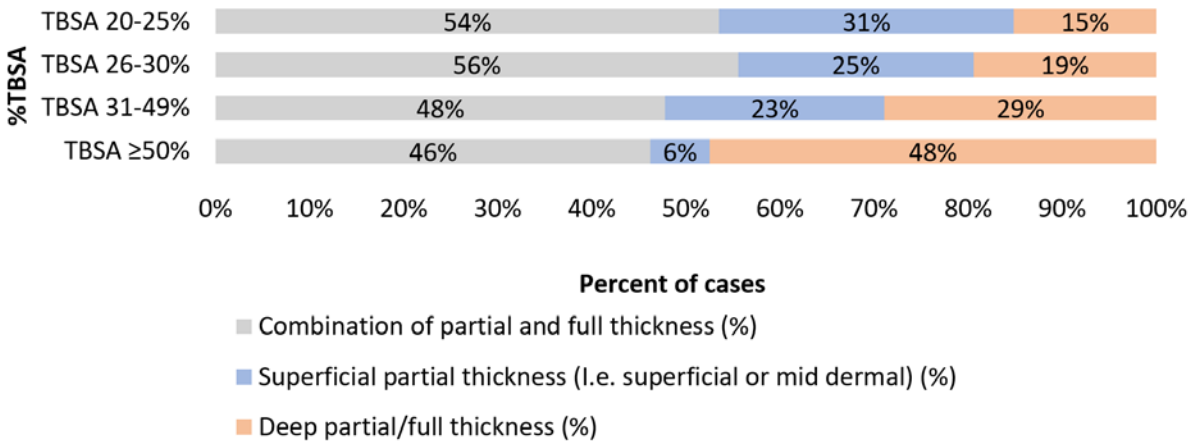

Figure 1 Burn injury depth by %TBSA

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