A Single Centre Review of Outcomes of Delayed admission to a Burns Unit.

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Author: Quentin Isaacs
Student number: 2619916

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine(MMED)

10 Sptember 2025
Johannesburg

Declaration:

I, Quentin Isaacs, declare that this research report is of my own, unaided work. The contents of the paper of my original work. It is being submitted for the degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for and degree or examination at any other University.

Signed on this day of 10th September 2025

Dedication

This project is dedicated to all the patients who suffered injuries and were included in this study. The devastating effects these injuries have on them and their families are devastating. Their courage and perseverance is truly admiral.

Presentation from this study:
This study has not been presented or published in any form.

Abstract

Background: Timely admission to a specialized burn unit is considered crucial for optimizing outcomes in burn patients. However, the impact of delayed admission on hospital length of stay and clinical outcomes remains unclear, particularly in resource-constrained settings such as South Africa. This study aimed to determine whether admission to a burn unit more than 24 hours after injury was associated with increased length of stay, sepsis, or mortality.

Methods: A retrospective cohort study was conducted at the Chris Hani Baragwanath Academic Hospital Adult Burn Unit, Johannesburg, from January 2018 to December 2022. All adult burn patients admitted during this period were included. Patients were categorized into early (≤24 hours) and delayed (>24 hours) admission groups. The primary outcome was length of stay; secondary outcomes included incidence of sepsis and in-hospital mortality..

Results: We found 134 files, and 123 were complete. Of the patients, 71 (58%) were admitted within 24 hours. The median length of stay was 14 days, and no statistical difference in length of stay between the two groups was discovered ($P = .7$). The overall mortality rate was 13%, of with 68% in the early admission group. Sepsis occurred in 27% of patients.

Conclusion: Delayed admission to a burn unit has no effect on length of stay and no statistically significant association with mortality rate or sepsis. Higher mortality in the early admission group reflects the severity of burns requiring prioritization of critical cases. These findings highlight the importance of further prospective research.

Acknowledgements

I would like to thank the staff of the Chris Hani Baragwanath Academic Hospital Adult Burn unit staff and clerks for all their assistance with this project, To the Supervisors and staff of the records department for their assistance with locating these files.

Without my supervisors, this study would not have been possible. To Professors Muganza and Sofianos for their incredible support, assistance and insight.

Declaration of Interests:
I have nothing to declare

Funding:
This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

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Abbreviations

ANZBA: Australian and New Zealand Burn Association

LA-50: Lethal area 50

LMIC: Low- and middle-income countries

LOS: Length of stay

TBSA: Total body surface area

Introduction

Epidemiology

Developing nations account for the vast majority of the burden of disease.[1] In recent years, there has been a focussed effort to develop global surgery initiatives and improve surgical outcomes. The burden of burns in South Africa amounts to 1.6 million cases per year, and research suggests that there are 8140 admissions to burn centres across the country every year, with 2600 occurring in Gauteng alone.[1] There were 54 160 deaths due to trauma in 2018, with burns accounting for 7.2% of these cases,[2] which is lower than Africa's overall mortality rate of 15% for burns.[3] This paper explores the factors that contribute to these deaths.

Cost of care

South African burn surgeons have reported that the cost of managing scald burns occupying 20% of the patient's total body surface area (TBSA) amounts to ZAR 22 394 and almost triples with TBSA rates of 21%-30%, increasing exponentially if over 30%.[4] They also showed that the mechanism responsible for the injury plays a role in the cost of managing paediatric burns – flame burns involve much higher costs than scalds.[4,5]

Surgical timing and length of stay

As burn care has evolved over the decades, metrics for monitoring outcomes have changed. Since the inception and advocacy of early excision and grafting to improve outcomes and mortality, there has been a focus towards in research towards length of stay (LOS) as a marker of centre performance.[6,7] This quantitative and continuous variable helps indicate quality of care and rates of complications, as increased complications are directly correlated with increased lengths of stay.[6,7] As we have no control over burn patients' sex, age, TBSA or presence of inhalational injury – which all contribute to length of stay and mortality – other aspects must be assessed to improve outcomes.[6–10]

Delayed transfer and admission to a burn unit

Providing burn care is costly. Ter Meulen et al.[4] and others have assessed the measures that are within our control and can thus be improved.[4,10,11] These studies have highlighted delayed admission, defined as a wait of greater than 24 hours to enter a burn centre,[11,12] and associated factors.[8,12–14] If these measures can be improved, resulting in shorter stays and better outcomes, it will decrease the cost of managing these patients. Large burns require specialised care, and any delay in that care can be detrimental. Research has shown that delayed management at a Level 1 trauma centre has an adverse effect on trauma patients, particularly burn patients requiring intubation.[15,16] Sheridan et al.[16] found that a transfer delay of more than 24 hours to a burn centre resulted in poorer outcomes, including higher rates of sepsis, organ dysfunction and longer hospital stays.

Studies focused on mortality have noted that age, gender, TBSA, inhalational injury, a delay to intubation more than 16 hours after time of burn, intubation during transfer, need for ventilatory support and those admitted directly to a burn unit had an increased risk of mortality.[5,6,8,10,12,13,15,17] Further scrutiny of these international studies showed that their patients who were classified as delayed admissions were under 24 hours due to very efficient prehospital transfer, while those cases that went over 24 hours were fortunate enough to have adequate management at referring hospitals. The high mortality in direct admissions may have been due to the severe extent of the burns, as severely burned patients with poor prognoses might not have been transferred to these burn centres.[8,10,13,15,17]

In developing countries, patients have presented an average of five days from the date of injury, predominantly exhibiting dehydration, wound infection, systemic sepsis and acute kidney injury, with an overall mortality rate of 11.4%.[5] Bourgi et al.[18] further demonstrated that the need for blood transfusion, excision and grafting, as well as the number of procedures performed, are independent factors that contribute to LOS. Unfortunately, however, mortality and time from burn to admission were not among the outcomes they measured. Meanwhile, other research has contradicted the above and found no statistically significant association between morality, injury severity and length of stay in patients directly transferred from other facilities.[8,15]

Methods and materials

This cross-sectional study was designed to evaluate whether a delay of greater than 24 hours from burn injury to admission to a burn unit increased LOS in a single-centre burn unit, namely, Chris Hani Baragwanath Academic Hospital Burn Unit in Johannesburg, South Africa.

Study population

The study population comprised all patients admitted to the burn unit from 1 January 2018 to 31 December 2022. Requirements for admission were in accordance with the American Burn Association (ABA) guidelines (see Appendix F). All patients admitted to the unit were eligible for inclusion in the study. They were identified using records of admission to the burn unit; hard copies of these documents were collected from the records department. To ensure a representative sample and minimise bias, no exclusion criteria were implemented.

We obtained permission to conduct the research from the Medical Advisory Committee and the CEO of Chris Hani Baragwanath Academic Hospital. Once ethical approval was obtained from the University of the Witwatersrand Human Research Ethics Committee (Medical) (HREC[Medical]) under protocol number M2300127, the records department supplied the patient information.

Total of 1410 patient were admitted over the 5 year period and sample size should 336 patients for this study. File retrieval was dependant on the staff of the records department and due to records being stored between the main hospital and the St Johns Eye Hospital, this could further attribute to poor file retrieval

Data collection

A self-generated data sheet was created to record all relevant information from the patient files. Data were collected on patient demographics (sex, age and comorbidities), clinical burn data (time of burn, mechanism, TBSA, length of stay, sepsis, surgery and death). The patients were allocated study numbers, and all identifiers were removed to ensure patient confidentiality. The data were transcribed into Microsoft Excel 365; the hard copies were stored in a locked cupboard and accessed only by the primary investigator. The database was stored on the principal investigator's laptop, which was password protected and only accessible by the investigators.

Data analysis

The data were transferred from Microsoft Excel 365 into R (version 4.5) for statistical analysis. Observations were excluded if the reported LOS was less than 0 or more than 100 days and if there were fewer than 0 or more than 100 days before admission (likely due to data capture errors and/or poor record keeping). We describe the data using medians and interquartile ranges (IQRs) for continuous variables and counts and percentages for categorical variables. The Wilcoxon rank-sum test was used to compare continuous variables between groups and the chi-square test for categorical variables. Analysis used univariate and multivariable linear regression to assess the association between the independent variables and the outcome of interest – LOS in days. We have reported modified Baux and Lethal Area 50 (LA50) scores. The modified Baux score was calculated as TBSA + age (+ 17 if there was inhalation injury), and LA50 was determined by calculating the proportion of patients who died in each TBSA category (in 10% increments).

Results

A total of 134 patient folders were located. After excluding incomplete files, 123 patients were included in the analysis.

Demographics

The patients were mostly male (64%), and the median age was 34 years. The early admission group median age was 32 years old and late admission group was 36 years (*P* = 0.3). A total of 71 patients were admitted under 24 hours from their burn injury, and 52 were admitted after more than 24 hours. Among the latter group, the median time to admission was 4 days (*P* < 0.001). HIV was the most common comorbidity among the study population at 18%. Flame (46%), hot water/scalding (29%) and electricity (17%) were the most frequent burn mechanisms. Of the patients, 86% who sustained electrical burns and 59% with flame burns were in the early admission group.

The median TBSA in the study population was 17%, early admission was 16% and late admission 18%. The initial TBSA assessment from the emergency unit was strongly correlated with the final TBSA determined by the burn unit (Spearman's correlation rho = 0.94). The emergency department overestimated the proportion of patients with TBSA > 50% by 11% (95% confidence interval [CI] 5-16). A total of 43 (34%) patients suffered a TBSA of greater than 20%. A total of 23 patients had inhalational injuries, and the early admission group comprised the vast majority of these patients at 78% (*P* = 0.027; Table 1).

Seventy percent(n=50) of the early admission group were admitted via trauma emergency unit compared to only 25% (N=13) of the late admission group. The late admission group had a further 35% (n=18) were transferred to the burn unit from the trauma ward.

Table 1. Descriptive statistics representing the demographic and clinical characteristics of patients admitted to the adult burn unit at Chris Hani Baragwanath Academic Hospital from 1 January 2018 to 31 December 2022

Characteristic	**Overall** **N = 123**	**Early (≤ 1 day)** **n = 71**	**Late (> 1 day)** **n = 52**	***P*-value**[1]
Length of stay (days), median (IQR)	14 (8-25)	14 (9-24)	15 (7-27)	0.74
Sex, n (%)				0.094
Female	44 (36)	21 (30)	23 (44)	
Male	79 (64)	50 (70)	29 (56)	
Age (years), median (IQR)	34 (26-42)	32 (25-40)	36 (27-44)	0.26
TBSA (%), median (IQR)	17 (10-27)	16 (10-25)	18 (13-29)	0.62
Inhalational injury, n (%)	23 (19)	18 (25)	5 (9.6)	0.027
Baux score, median (IQR)	55 (44-74)	55 (44-77)	60 (45-73)	0.87
Reason for delayed admission, n (%)				0.019
Awaiting Covid-19 result	22 (18)	18 (25)	4 (7.7)	
Awaiting ICU bed	19 (15)	7 (9.9)	12 (23)	
Delayed presentation	5 (4.1)	2 (2.8)	3 (5.8)	
Not Stated	77 (63)	44 (62)	33 (63)	
Sepsis, n (%)	33 (27)	19 (27)	14 (27)	0.98
Had any surgery, n (%)	41 (33)	15 (21)	26 (50)	< 0.001
Has any identified organism, n (%)	24 (20)	13 (18)	11 (21)	0.69
Died, n (%)				0.34
Died	16 (13)	11 (15)	5 (9.6)	
Alive	107 (87)	60 (85)	47 (90)	
Year of admission, n (%)				0.071
2018	6 (4.9)	5 (7.0)	1 (1.9)	
2019	16 (13)	9 (13)	7 (13)	
2020	34 (28)	25 (35)	9 (17)	
2021	57 (46)	26 (37)	31 (60)	
2022	10 (8.1)	6 (8.5)	4 (7.7)	
Comorbidities				
Diabetes mellitus, n (%)	6 (4.9)	3 (4.2)	3 (5.8)	0.70
Hypertension, n (%)	12 (9.8)	6 (8.5)	6 (12)	0.57
Epilepsy, n (%)	5 (4.1)	2 (2.8)	3 (5.8)	0.65
Right ventricular dysfunction, n (%)	22 (18)	10 (14)	12 (23)	0.20
Mechanism of burn				
Chemical burn, n (%)	3 (2.4)	1 (1.4)	2 (3.8)	0.57
Electric burn, n (%)	21 (17)	18 (25)	3 (5.8)	0.004
Flame burn, n (%)	58 (47)	34 (48)	24 (46)	0.85
Hot water burn, n (%)	36 (29)	16 (23)	20 (38)	0.055
Steven Johnson Syndrome, n (%)	2 (1.6)	0 (0)	2 (3.8)	0.18
Parasuicide, n (%)	2 (1.6)	0 (0)	2 (3.8)	0.18

[1]Wilcoxon rank sum test; Pearson’s chi-squared test; Fisher’s exact test.

Primary outcome

The median LOS was 14 days for the entire study population, and this did not differ between those who experienced early or late admission ($P = 0.7$). There was no difference in median Baux scores between the early and late admission groups. The Baux score for those who died was 88. As Figure 1 shows, there was no correlation between days to admission and length of stay.

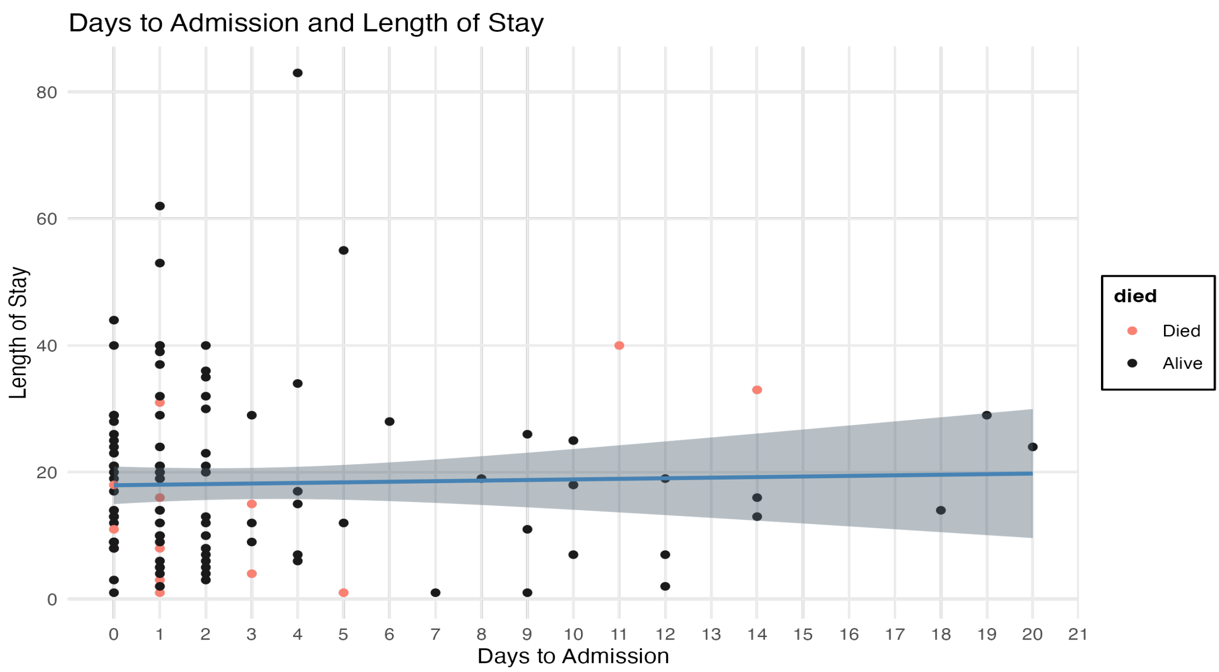

Figure 1. Scatterplot and linear regression with confidence intervals of length of stay in days (y) by days to admission (x)

Reasons for delayed admission to the unit included awaiting COVID results (18%, n = 22), awaiting an ICU bed (15%, n = 19) and delayed presentation (4%, n = 5). For most patients, no reason was stipulated in the files. Of the late admission group, 23% were due to pending ICU beds, 7% were related to pending COVID-19 results, 5% were due to delayed presentation and the remaining had no documented reason.

A decreased time to admission was associated with an increased LOS. In the univariate analysis, a need for surgery was associated with an increased LOS and particularly a need for debridement and skin grafting. An increased Baux score was associated with an increased LOS. For each unit increase in Baux score, the LOS demonstrated a 0.15 day increase (95% CI: 0.05-0.26; $P = 0.005$).

Under univariate conditions, significant predictors of LOS included age (*P* < 0.001), TBSA (*P* < 0.002), need for surgery (*P* < 0.001) and early admission (*P* < 0.004). When controlling for other factors, only age, TBSA, death and early admission were associated with LOS (Table 2).

Table 2. Univariate and multivariate regression of factors associated with length of stay

	Univariate			Multivariable	
Characteristic	**N**	**Beta (95% CI)**	***P*-value**	**Beta (95% CI)**	***P*-value**
Age (years)	123	0.20 (0.04 to 0.35)	0.017	0.36 (0.18 to 0.54)	< 0.001
TBSA (%)	123	0.13 (-0.06 to 0.33)	0.17	0.26 (0.00 to 0.53)	0.054
Inhalational Injury	123	5.5 (-0.77 to 12)	0.085	0.98 (-5.4 to 7.3)	0.76
Baux Score	123	0.15 (0.05 to 0.26)	0.005		
Early Admission	123				
Early (≤ 1 day)		—		—	
Late (> 1 day)		0.27 (-4.7 to 5.2)	0.92	-5.8 (-11 to -0.80)	0.024
Sepsis	123	9.2 (3.9 to 14)	<0.001	1.1 (-5.6 to 7.8)	0.75
Died	123	-5.1 (-12 to 2.2)	0.17	-21 (-31 to -11)	< 0.001
Abbreviations: CI = Confidence interval					

Secondary outcomes

The sepsis rate in the study population was 27% (n = 33), and there was no difference between the early and late admission groups. The overall mortality rate was 13% (n = 16), and 69% (n = 11) of the deaths were early admission cases. The median age of the patients who died was 45, compared to 33 for those who survived (*P* = 0.004). Males made up 69% (n = 11) of those who died, and only 25% (n = 4) of patients with inhalational injuries died (*P* = 0.5). Of the patients who died, flame burns impacted 88% (n = 14), with hot water creating the remaining burns (*P* < 0.001). No electrical burn victims died. The vast majority of the deaths occurred in 2020 (n = 15, 96%). Ninety-four percent of the patients who died developed gram-negative sepsis. The median TBSA of the patients who died was 37%, compared to 15% in those who survived – a statistically significant difference ($P < 0.001$). The LA50 for the study population was 30%-40%.

Table 3 presents an overview of the study characteristics related to mortality. A total of 58 patients required surgery, with late admissions comprising 67% of this patient population. Debridement was required by 33% (n=17) in the late admission group and 12,5 % (n=9)in the early admission group, while 18 in the late group required skin grafts, and 8 required grafts in the early group.

Table 3. Table of descriptive statistics by death

Characteristic	**Overall** N = 123	**Died** n = 16	**Alive** n = 107	***P*-value**[1]
Length of stay(IQR)	14(8-25)	10(9-24)	15(9-26)	0.12
Age (years), median (IQR)	34 (26-42)	45 (34-69)	33 (25-39)	0.004
TBSA (%), median (IQR)	17 (10-27)	37 (34-50)	15 (10-22)	< 0.001
Inhalational injury, n (%)	23 (19)	4 (25)	19 (18)	0.50
Baux Score, median (IQR)	55 (44-74)	88 (81-101)	53 (42-69)	< 0.001
Early admission, n (%)				0.34
Early (≤ 1 day)	71 (58)	11 (69)	60 (56)	
Late (>1 day)	52 (42)	5 (31)	47 (44)	
Sepsis, n (%)	33 (27)	4 (25)	29 (27)	> 0.99

[1]Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test.

Summary of Multivariate analysis

Multivariate analysis showed that LOS was associated with age, TBSA, death and early admission. Multivariate analysis with respect to death identified the factors that increased mortality as age, TBSA, flame burns and gram-negative sepsis, particularly pseudomonas and klebsiella. Sepsis was only associated with increased LOS under univariate conditions. Table 2 further summarises the analysis.

Discussion

The study population had a similar distribution of demographic characteristics as those in studies of both developing and developed centres.[3,19] The median age and sex predominance is what would be expected based on past research.[3,8,11,17,19] The overall mechanisms were also similar to other findings in the South African context, despite a slight difference in flame and electrical burns compared to developed nations.[3,10–12,19] The study population exhibited a lower incidence of flame and a higher number of electrical burns. Due to the limited bed numbers in the burn unit and the hospitals status as a Level 1 trauma centre, the trauma unit manages burn patients who are not admitted to the burn unit. This could account for the discrepancies in our patient demographics. Notably, the overall TBSA of this study population was substantially larger than the Australian and New Zealand Burn Association (ANZBA) population.[8,10] Of the ANZBA population, less than 10% of the patients had TBSA values greater than 20%, while among our study population, 34% had TBSA values greater than 20%.[8,10] Further demonstrating the disparity in burn severity between developing and developed nations.

This study did not link long hospital stays to delayed burn unit admission as hypothesised, but this trend has become evident in recent literature.[8,14] In fact, the opposite has often been proven: patients admitted early to a burn unit have increased LOSs as well as higher mortality and burn severity.[8,10,14] This is a positive finding, as it indicates that severe cases were identified early and transferred timeously to burn centres. Compared to Sheriden et al.,[16] who previously reported poor outcomes following delayed admission to a burn unit, this indicates progress over the past few decades. Their study's TBSA was larger and had a longer delay than this study population.[16]

This study found no statistically significant difference in TBSAs between the two groups to help explain why late admission had no effect on LOS. In fact, the late-admission group had a slightly higher TBSA than the group admitted early. The lack of significance could be due to the small sample size, and perhaps the number of delayed days was not enough to affect LOS. There was a small difference (5 days) in LOS for the mortality group, between those admitted early and those admitted late. The shorter LOS could be due to the early admission group having higher numbers of inhalational injuries and flame burns, indicating greater burn severity.

Under univariate conditions, inhalational injury influenced LOS, and as the early admission group had more inhalation injuries requiring intubation and ventilation, this could have contributed to a longer hospital stay.[7,9,18] This helps explain the lack of a significant difference in LOS between the two groups, but if we control for other factors, there was no correlation. Other authors, however, have found no correlation between inhalational injury and LOS, instead identifying age, TBSA and need for surgery as more significant contributors.[3,6–8,18]

Another explanation for why delayed admission produced no statistical difference in LOS could be that the early admission group had a higher rate of sepsis, possibly due to a higher percentage of flame and electrical burns. These burns are typically more extensive, placing victims at a higher risk of sepsis.[20,21] As this study has shown under univariate conditions, sepsis was associated with a 9.2-day-longer hospital stay. However, no association was noted between sepsis and delayed admission in this study population. This differentiates this study from other literature in developing countries, which has shown a clear link[5,14]. This could be because the delay durations were shorter, vast majority of the patients came from within the trauma unit or because of the small sample size. The investigators also noted a higher rate of gram-negative sepsis in the mortality group. Gram-negative sepsis produces more severe systemic sepsis, resulting in deeper penetration into wound beds and ultimately increasing the depth of burns.[20] These cases required multiple debridement and thus multiple blood transfusions, which negatively affect patient outcomes.[9,20]

Because LOS is a continuous and quantitative variable, it reflects rather well the quality of care and management of complications in a burn centre, as delayed admission in this population did not negatively impact patients. This further supports the need for expert management of patients in a certified burn centre. Another reason why delayed admission did not impact LOS could be that they received adequate care at referral centres. In cases of telemedicine, adequate management may have been discussed with the receiving unit.

Turning to mortality rate, females had better outcomes than those reported in previous literature.[3,8,10] The higher rate of death in the early admission group could be attributable to their having a TBSA of more than double that of the TBSA in those that survived. Again, multiple studies have identified a relationship between age, TBSA and – particularly in older studies –inhalational injury and mortality.[3,6,8,10,12] This study observed that most patients with inhalational injuries survived. The key difference compared to older studies is that these patients either underwent delayed intubation (> 16 hours) or were intubated during transfer, accounting for the worse outcome.[10] Although the investigators did not measure the time from injury to the time of intubation, as only a small number of inhalational injury patients died, the authors' hypothesis is that they experienced early intervention. As the unit does not routinely perform bronchoscopy, there were no clear findings documented in the files. Although this was not the main outcome of the study, it could be further explored in subsequent research.

Those who experienced delays in admission required surgery more often than those admitted early, corroborating previous literature from other developing countries.[5,18] In an international context, various authors have found that a need for surgery is a significant predictor of length of stay.[7,8] This contradicts previous guidance, however.[6,21] This may be due to certain patients presenting with intermediate depth and healthcare staff allowing a watchful waiting period to avoid extensive excision and the need for large grafts. The unit's policy on managing superficial partial thickness burn is to dress patients with skin substitutes (Smith and Nephew, Biobrane™ or Melcura, Keragentrix™), while patients with deep partial and large intermediate depths are dressed with honey-based ointments(Sanomed, Melladerm™) to demarcate those areas before excision and grafting. Minimising large excisions, which result in considerable blood loss and the need for transfusions.[9] Additionally, due to the resource-constrained setting, theatre time is limited. Moreover, performing after-hour debridement is often logistically taxing since the burn unit is separate from the main theatre complex, which can result in delayed first excisions and/or grafting.

Limitations

This study faced limitations in terms of the sample size and single-centre design. Due to the limited number of files found by the records department and missing details in some files, we had a limited ability to draw adequate conclusions from the data. Missing data in the files resulted in those patients being excluded, further decreasing the patient numbers and study accuracy. The limited time available to perform a research report placed further strain on the record department staff and researchers to gather all necessary files.

Recommendations

Performing prospective data collection in real time ensures the accuracy of the data collected. Developing burn admission sheets, including Lund and Browder charts, for TBSA estimation is essential in ensuring that all necessary details are captured and that TBSA is accurately estimated. Digital records should be kept, and a REDCap database that includes all burn centre data could be used to formulate a national repository. This would ensure easy access to data and a more efficient research process. With more robust data and research, performing and implementing quality improvement strategies is easier, and this is a fundamental step towards improving burn care. Burn care is costly, and robust data allow for accurate budgets to be calculated.

Clinical implications

The authors have assumed that the referral centres have well-trained staff with sufficient knowledge about emergent burn care. This based on finding no statistical difference between the two groups and that vast majority of patients were transferred from surgical training centres. Due to limited bed numbers in the unit, de-centralizing burn care could decrease the burden and waiting time to be admitted. Focussing on continuing education, engaging via telemedicine and upskilling regional centres in managing severe burns would ensure adequate management. Measures include early intervention for inhalational injury, correct fluid administration, and advocating for early excision and grafting to minimise sepsis in cases of delayed transfers.

Developing standardised protocols to minimise the risk of sepsis is also key. Patients should be washed and dressed in the unit upon admission. Adequate infection control measures must be upheld, especially when inserting indwelling lines and catheters. A unit protocol should be fixed regarding the management of indwelling lines. Finally, outpatient management of minor burns is important to minimise LOSs and the risk of nosocomial infections.

Conclusion

In a burn centre in Johannesburg, South Africa, delayed admission had no effect on LOS, and early admission was linked with a higher mortality rate. This could be due to early recognition of severity, resulting in expedited transfer. We did note that age, TBSA and surgery were strong predictors of LOS. This study highlighted the need for prospective data collection to formulate robust data for future research.

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Appendix List

Appendix A: Approved Study Protocol

<u>Title</u>

A single centre review of outcomes of delayed admission to a burns unit.

Name: Quentin Isaacs (Student Number 2619926)

Degree: MMed (Wits)

Supervisors:

1) Professor Chrysis Sofianos, MBBCh (Wits), MSc (Ed), FC Plast Surg (SA)
MMed (Wits), FRCS Plast (Eng), FACS, FEBOPRAS
Head of Division of Plastic and Reconstructive Surgery and Adjunct Professor
University of Witwatersrand, Johannesburg, South Africa
Supervising capacity: 50%

2) Prof A Muganza, MD, FRCS (Ireland), FCS (SA), FACS (USA)
Head of Surgery, Chris Hani Baragwanath Academic Hospital
Head of Adult Burns Unit Chris Hani Baragwanath Academic Hospital
University of Witwatersrand, Johannesburg, South Africa
Supervising capacity: 50%

Table of Contents

List of Abbreviations

HIC: High income countries

LMIC: Low Middle-Income Country

LOS: Length of stay

TBSA: Total body surface area

Literature Review

Over the past few years, a shift has taken place focusing efforts on Global Surgery initiatives and improving surgical outcomes. Of note, low and middle income countries (LMIC) occupy the vast majority of the burden of disease[1] The burden of burns in South Africa amounts to 1.6 million per year and a recent publication revealed that there are 8140 admissions to Burn Centres across the country per year with 2600 occurring in Gauteng [1]Deaths due to trauma amount to 54160 in 2018 and Burns comprise 7.2% of these deaths[2], which is lower when compared to Africa's mortality rate of 15%[3]. Various factors contribute to these deaths which will be explored below.

Cost associated with Burn Care

The cost associated with adequate burn care is high and in a resourced constraint country, one cannot allow any factors that may lead to an exponential increase in these costs. These costs include, and are not limited to, health professionals' salaries, medication, hospital stay per day, wound dressings, and theatre costs. Ter Meulen et al[4] showed that the cost for managing burns up to 20% amounts to R22394 and almost triples with total body surface area (TBSA) from 21-30% and progresses to increase exponentially over 30%. They also showed that the mechanism of injury also plays a role in the cost implications for the management of paediatric burns – flame burns involved much higher input in terms of patient management than scalds.

Effects of Delayed admission

Large burns require specialised care and any delay to that care can be detrimental, with literature showing that delayed management at a Level 1 Trauma Centre has an adverse effect on trauma patients[15,16]. Sheridan et al showed that a delay in a transfer to a burn centre in the United States resulted in poor outcomes. Other studies however contradict this, stating that there is no statistically significant association in length of stay, injury severity and mortality between patients that are transferred directly to the facility or transferred from other facilities[15] . Upon further inspection of their data, vast majority of the direct admission patients arrived at the burn centre in under an hour from time of burn and the interfacility transfer groups typically takes 3-4 or more than 4 hours to arrive.

In our setting, this is often not the case due to our limited resources and experienced first responders or advanced life support paramedics. A more recent publication found no difference in the length of stay of their patients, but this study was underpowered with small patient numbers [13]They did however find a higher mortality rate in the direct admission group, but this could be explained by higher TBSA range in this group and higher rate of inhalation injury.

One of the fundamental principles of burn care is to correctly identify or estimate the TBSA of the burn. Various authors over the past few decades have investigated various negative sequalae that come into the fold when the TBSA is incorrectly assessed. [22,23]Due to the complex pathophysiology related to burn injuries, especially with regards to hypovolaemic and distributive shock that can ensue, incorrect estimation of TBSA results in incorrect fluid management[22–24] . Collis et al showed that there is a standard distribution error of 20.3% in TBSA assessment, with small burns typically over-estimated and large burns under-estimated. This can often lead to incorrect patient transfers, and this has implications for resource distribution[22,25] Fluid management of these patients were also found wanting as 55% of their patients received more than 125% of their fluid requirement and in comparison, between emergency unit estimation and burn surgeon estimation, the volume increased to 145% and 204% respectively. A later publication found that 58% of patients received more than 4ml/kg/TBSA and that there was a shift from renal failure (due to insufficient fluids given) to pulmonary oedema. This further increased the need for ventilatory support for these patients [24]. They also showed this trend of over-estimation resulted in fluid creep, which led to increased abdominal pressures which then developed abdominal compartment syndrome and orbital compartment syndrome.

Dulhunty et al also reiterated this fact but went a step further. They confirmed the ongoing trend of TBSA over-estimation, with this occurring in 21% of their patients. More than a third of their patients had more than 10% difference between initial assessment and burn surgeon assessment. They also showed an over-estimation in body weight estimates in a fifth of their patients and 7.5 under-estimation. They also proved that a delay of more than four hours resulted in patients only receiving 52-55% of the Parklands formula in the first 24 hours[23].

Delay in surgical management

A delay in fluid management is only the tip of the iceberg when looking at the effects that delayed care has on burns patients. The Galveston group demonstrated that there is an increased incidence of bacterial infections when excision and grafting only took place on the 3-6 and day 7-16 subgroup when compared to the 0–2-day subgroup. They however did not find any difference of statistical significance when comparing their mortality rates, rates of blood transfusion, number of surgeries and length of stay although the LOS was increased in the 7-14 days subgroup when compared to the 0-2 days subgroup[21]. However, one does have to account for this study's limited number of patients when evaluating their evidence. A recent CME further echoed the points in Wu et al's study and noted that blood culture confirmed infections increase hospital stay and ventilatory support which again have cost implications [20]They highlighted the shift in organism profile from gram positive culprits to gram negative organisms and that this shift towards invasive gram negative sepsis has an increased effect in length of stay and mortality[20]. In comparison to our resource limited setting, the above study had readily available access to theatre and allografts that allowed for early excision and grafting.

Effects of Covid Pandemic on Burns

In this post-COVID era, one cannot ignore the effect the COVID-19 pandemic has had on healthcare. A Burn Centre in the United States showed a 51,8% decrease in admission volumes during the pandemic and also reported that during this time, 68% of their patients presented the day after their injury[26]. However, the length of stay was decreased in their pandemic group by one day for burns under 20%. They also showed similar numbers of patients requiring operations between their pandemic and non-pandemic group. Reasons for delay in presentation or admission were not investigated, and they failed to illustrate how many of their patients were COVID19 positive and whether or a delay in obtaining these results played any role.

In conclusion, the vast majority of research originates in high income countries (HIC) and there is often a paucity of data from LMIC but attempts have been made at quantifying burn care in our resource limited setting. We hope to expand that body of knowledge and assess whether a delay in admissions to a burn centre in Johannesburg has negative effect on the outcomes of our patients, particularly their length of stay. In doing so, this will better equip us and ensure quality improvement interventions can occur to improve the outcomes for our patients.

Study Objectives

To determine if a delay in admission to a burn centre in South Africa increases the length of stay in burns patients.

Methodology

Research Question:

Does a delay of greater than 24 hours from time of burn to admission to a burn unit increase the length of stay in a single-centre , South African Burn Unit?

Research design:

This is a cross-sectional study. Data will be collected via retrospective record review.

Study Population:

All burn patients admitted to Chris Hani Baragwanath Academic Hospital Adult Burn Unit from 1 January 2018 until 31 December 2022. They will be identified from admission records to the burn unit. We will define early admission as those within 24 hours and those 24 hours and over. Length of stay (LOS) will be measured in days. The end points of this will be either time of discharge home or death. Secondary outcomes include confirmed sepsis as dictated by ABA SIRS and Sepsis log, pneumonia confirmed radiographically, or on clinical diagnosis.

Exclusion criteria:

No exclusion criteria have been implemented in this study to minimize research bias and ensure more representative sample.

Sample Size:

The sample size required is 302 out of 1400 patients. This was calculated using a z-score of 1.96 (95% confidence), a 5 % margin of error and 0.5 standard deviation.

Sample Size = [z2 * p(1-p)] / e2 / 1 + [z2 * p(1-p)] / e2 * N]

Study site:

Chris Hani Baragwanath Academic Hospital, Johannesburg, South Africa.

Data Collection:

A self -generated data sheet was formulated to obtain all relevant information from patient files.

Ethics approval from the University of the Witwatersrand HREC, as well as permission from the Medical Advisory Committee of Chris Hani Baragwanath Academic Hospital will be obtained.

Once Ethics approval has been obtained, data collection will be obtained.

See data sheet attached.

Data Storage:

All data captured will be kept anonymous using study IDs. All data collected will be stored on a password-protected Microsoft Excel 365 spreadsheet and once completed to facilitate universal data transfer to statistical analysis software for analysis. Physical copies of consent form will be stored in a locked cabinet with the principal investigator's office for 10 years. Digital data will be encrypted and backed up regularly, on a password protected laptop, to prevent data loss. Access to the data will be restricted to authorised personnel only, ensuring confidentiality and data integrity.

Data Analysis:

The data will be collected using a data collection sheet (see attached). No identifying data will be recorded on the sheet and a unique study number will be assigned to each participant. Data will then be processed in Microsoft Excel 365. Continuous variables will be analysed with regards to the mean, median and their ranges within the study population and assessing measurement of variance (i.e. standard deviation). Depending if our continuous variables are independent or related, this will dictate what test is used to make inferences. The distribution of our data will then dictate how the correlation is assessed with regards to our continuous variables. Categorical variables will be analyzed using frequencies and proportions. Inferences will be deduced with the use of Chi2 test and Fischer test. We shall regard a p-value less than 0.5 as significant and confirm our hypothesis. The two supervisors of the MMed will verify the data analysis.

Ethical Considerations

The study participants do include paediatric population but due to the nature of the study, no tests are performed on the children and is retrospective in nature. Patient details will be kept confidential on the data collection spread sheet. Ethics approval from the University of the Witwatersrand HREC, as well as permission from the Medical Advisory Committee of Chris Hani Baragwanath Academic Hospital will be obtained.

Timeline

	2022					2023											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Literature review																	
Preparing protocol																	
Protocol assessment																	
Ethics application																	
Data collection																	
Data analysis																	
Writing up paper																	
Examination/Publication																	

Funding

Expenses for the research project entail photocopying data sheets and petrol to Chris Hani Baragwanath Academic Hospital to obtain perform data collection. Cost for photocopying amounts to R4800 (R1.20 D/S for 4000 pages). Rough estimates for petrol amount R893 per month of data collection (1 tank per month). Total costs amount to R8372. Costs will be covered by the registrar as these will not be covered by SOCM MMed Fund.

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Appendix: Data collection sheet

Study No:

Delay in admission to burn unit

Patient details:

Adult / Paediatric
Male / Female

Age	Co-morbidities

Date of burn:
Time of Burn:

Hot water	Fire	Chemical	Electrical	Contact

Total Body Surface Area

Initial Assessment:
Burn Unit assessment:
Date of admission to Burn unit:
Time of admission to burn unit:

Time between burn to admission to burn unit (Hrs) :
Transferred : Y / N
If Transferred in, from where:
Reason for delay in Transfer: EMS / Bed status / other(specify):
Inhalational injury : Y / N
Initial dressing prior to burn unit admission:
Covid: Pos/Neg

Complications		
Sepsis : Y / N	Day of burn:	Organisms:
Nosocomial Pneumonia: Y / N	Day of burn:	
Other(Specify):	Day of burn:	

Surgery Y / N

Date	Procedure	Day post burn

Alive	**Deceased**
Date discharge:	Date of death (Indicate hours after arrival if same day)

Appendix B: CHBAH CEO Permission letter

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 19th December 2022

TITLE OF PROJECT:

A single centre review of outcomes of delayed admission to a burns unit at CHBA Hospital.

UNIVERSITY: Witwatersrand

Principal Investigator: Dr Q Isaacs

Department: Surgery

Supervisor : Dr C Sofianos/Prof A Muganza

Permission Head Department (where research conducted): Yes

NHRD No. GP_202211_ 073

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Academic Hospital. The CEO / management of Chris Hani Baragwanath Academic Hospital is accordingly informed and the study is subject to:-

- **Permission having been granted by the Committee for Research on Human Subjects of the University of Witwatersrand.**
- The Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- The MAC will be informed of any serious adverse events as soon as they occur
- Permission is granted for the duration of the Ethics Committee Approval.

....
Recommended
(On behalf of the MAC)
Date: 19/12/2022

....
Approved/~~Not Approved~~
Hospital Management
Date: 21/12/202

Appendix C: Human Research Ethics Committee(Medical) Ethics Clearance

M230127 MED22-10-068

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Quentin Isaacs

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M230127 MED22-10-068

NAME: (Principal Investigator)	Dr Quentin Isaacs
DEPARTMENT:	Plastic and Reconstructive Surgery Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	A single centre review of outcomes of delayed admission to a burns unit
DATE CONSIDERED:	27/01/2023
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Chrysis Sofianos and Prof Adelin Muganza
APPROVED BY:	Prof P Ruff, Chairperson, HREC (Medical)
DATE OF APPROVAL:	22/08/2028 **EXPIRY DATE:** 22/08/2028

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report** in January each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in January and will therefore be due in the month of January each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Email signed copy of this ethics clearance certificate prior to commencing with the study hrec-medical.researchoffice@wits.ac.za

Principal Investigator Signature

24/02/2024
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix D: Turnitin report

Isaacs MMed Write Up Turn it in format.docx

ORIGINALITY REPORT

13%	11%	9%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	wiredspace.wits.ac.za Internet Source	4%
2	pmc.ncbi.nlm.nih.gov Internet Source	1%
3	Thomas, Preetha. "Assessment of African Patients With Fragility Fractures in the Orthopaedic Department at Chris Hani Baragwanath Academic Hospital", University of the Witwatersrand, Johannesburg (South Africa), 2025 Publication	1%
4	"Handbook of Burns Volume 1", Springer Science and Business Media LLC, 2020 Publication	1%
5	www.medrxiv.org Internet Source	1%
6	www.plasticsurgery.org Internet Source	<1%
7	Gamede, Nomdumiso. "An Audit of Cancellation of Elective Surgery in Paediatric Patients at Chris Hani Baragwanath Academic Hospital.", University of the Witwatersrand, Johannesburg (South Africa), 2024 Publication	<1%
8	Dorcus Acan, Robert Opiro, Benson Musinguzi, Bosco B. Agaba, Simon Peter Alarakol. "Prevalence of Malaria and	<1%

Appendix E: Journal Guidelines

Journal of
Burn Care & Research

American Burn Association

Issues | More Content ▾ | Submit ▾ | Purchase | Alerts | About ▾ | Journal of Burn Care & Res ▼ | AI Discovery Assistant

Contents

Author guidelines

Scope and purpose

As the official publication of the American Burn Association, the *Journal of Burn Care & Research* is the only U.S. journal devoted exclusively to the treatment and research of patients with burns. Original, peer-reviewed articles present the latest information on surgical procedures, acute care, reconstruction, burn prevention, and research and education. Other topics include physical therapy/occupational therapy, nutrition, current events in the evolving healthcare debate, and reports on the newest tools for diagnostics and treatment. The goal of the Journal is to provide the latest information on advances in burn prevention, research, education, delivery of acute care, rehabilitation, and research to all members of the burn care team. Authors are encouraged to submit original articles on any aspect of burn care for publication.

Authors should submit manuscripts online through the Journal's submission site.

How we publish

Journal of Burn Care & Research is a peer-reviewed journal publishing 6 issues per year online and in print.

Latest | **Most Read** | **Most Cited**

Marijuana Use in a Nationwide Survey of Burn Survivors

A Comprehensive Tool to Support Family Physicians and Burn Survivors in the Provision of Long-term Burn Survivor Care

Friction Burns and the E-scooter: an evolving trend

Development for the Teen-Aged Life Impact

Article Types

Original Article

Original Articles present original research findings in the burn field. There is no minimum or maximum length for Original Articles. They must include an abstract.

Case Report

These articles report conditions that provide new insight, or present new treatments or understanding relevant to the burn community. Must not exceed 2,000 words, (excluding references, figures and tables), 25 references and a total of 3 figures or tables. No abstract.

Summary Article

Critical, timely and balanced evaluations of material that has already been published

Short Communication

A brief report of research findings relevant to the journal's scope and of particular interest to the community. They can represent either a preliminary report or provide the publication of potentially important results and up to date information. Must include an abstract and a maximum of 1,500 words.

Editorial

Uninvited Editorials may address standards of research or clinical practice, funding agency priorities, or public policy issues of relevance to the field. There is no length limit.

Letter to the Editor

These are letters published in response to articles published in *JBCR* and should be submitted within 3 months of the online publication date of the article the letter refers to. The letter will be shown to the authors of the original article, who will be offered the chance to reply. A reference to the original article must be included in the paper. Maximum 300 words and 6 references, no figures or tables.

See this link for a detailed guideline: https://academic.oup.com/jbcr/pages/author-guidelines

Appendix F: ABA Referral criteria

Guidelines for Burn Patient Referral

(Advice on Transfer and Consultation)

- These guidelines are designed to be used to aid in clinical decision making. If you have sustained a burn injury, please seek medical advice from a medical professional.
- Local and regional infrastructure, resources, and relationships may determine the necessity and timeliness of burn center referral.
- These guidelines are not meant to be definitive care recommendations. They may facilitate building the proper referral network within the local healthcare community.

	Immediate Consultation with Consideration for Transfer	Consultation Recommendation
Thermal Burns	• Full thickness burns • Partial thickness ≥10% TBSA* • Any deep partial or full thickness burns involving the face, hands, genitalia, feet, perineum, or over any joints • Patients with burns and other comorbidities • Patients with concomitant traumatic injuries • Poorly controlled pain	• Partial thickness burns <10% TBSA* • All potentially deep burns of any size
Inhalation Injury	• All patients with suspected inhalation injury	• Patients with signs of potential inhalation such as facial flash burns, singed facial hairs, or smoke exposure
Pediatrics (≤14 years, or <30 kg)	• All pediatric burns may benefit from burn center referral due to pain, dressing change needs, rehabilitation, patient/caregiver needs, or non-accidental trauma	
Chemical Injuries	• All chemical injuries	
Electrical Injuries	• All high voltage (≥1,000V) electrical injuries • Lightning injury	• Low voltage (<1,000V) electrical injuries should receive consultation and consideration for follow-up in a burn center to screen for delayed symptom onset and vision problems

Burn Severity Determination

SUPERFICIAL

- Dry, red, easily blanching, sometimes painful
- Example: Sunburn
- NOT counted in calculations of total burn surface area (TBSA)

SUPERFICIAL PARTIAL THICKNESS

- Moist, red, blanching, blisters, very painful
- Counted in calculations of total burn surface area (TBSA)

DEEP PARTIAL THICKNESS

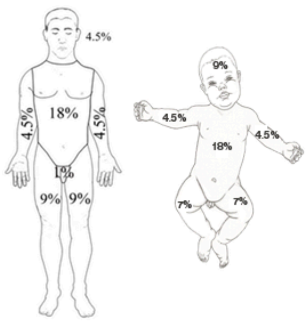
- Drier, more pale, less blanching, less pain
- Counted in calculations of total burn surface area (TBSA)

FULL THICKNESS

- Dry, leathery texture, variable color (white, brown, black), loss of pin prick sensation
- Counted in calculations of total burn surface area (TBSA)

*Percentage Total Body Surface Area (TBSA)

"RULE OF NINES"



"PALMAR METHOD"

Patient's entire palmar surface is approximately 1%

For more information visit **ameriburn.org/burnreferral**

https://academic.oup.com/jbcr/advance-article-abstract/doi/10.1093/jbcr/iraa038/5775361?redirectedFrom=fulltext

American Burn Association | 311 S. Wacker Drive, Suite 950 | Chicago, IL 60606 | ameriburn.org