Multidisciplinary team response to a mass burn casualty event: outcomes and implications

Heather J Cleland, David Proud, Anneliese Spinks and Jason Wasiak

ABSTRACT

Objectives: To describe the characteristics of patients with burn injury admitted to a major trauma hospital in Melbourne following the Black Saturday bushfires of 7 February 2009, and to provide a detailed analysis of the hospital’s response to the crisis.

Design, setting and participants: A retrospective chart review of ambulance and hospital records of patients admitted to the Victorian Adult Burns Service (VABS) at The Alfred Hospital (The Alfred) following the bushfires.

Main outcome measures: Patient characteristics and outcomes: age, sex, total and full thickness body surface area burnt, type and site of burn, hospital and intensive care unit length of stay (LOS) and receipt of standard burn care practices. Estimated glomerular filtration rate, theatre time and LOS data for the bushfire cohort compared with corresponding data for historical cohorts from VABS and from a similar institution in New Zealand.

Results: Nineteen patients were admitted to VABS over the first 48 hours after the bushfires. Of these, nine patients were subsequently admitted to The Alfred’s intensive care unit. Most patients (74%) were men with a mean age of 52.7 years (SD, 12.4 years). Seventeen patients (89%) underwent at least one surgical procedure, which resulted in 4355 minutes of theatre time for the bushfire cohort in the first week. Hospital LOS was similar for the bushfire and New Zealand cohorts. Compared with the VABS historical cohort, there was a higher incidence of abnormal renal function among the bushfire cohort patients.

Conclusions: Although relatively few patients with severe burns were admitted to VABS, significant increases in resource allocation were required to manage them in terms of additional theatre time, consumables and staffing. The experience of VABS may aid planning for future mass burns casualty events.

METHODS

Data collection
A retrospective chart review was performed on all patients who were admitted to VABS with burn injuries sustained in the February 2009 bushfires. We collected data from Ambulance Victoria records, and from The Alfred’s VABS data registry and operating theatre and intensive care unit (ICU) databases. This provided information on patients’ age, sex, percentage of total body surface area burned (%TBSA), percentage of full thickness body surface area burned (%FTSA), type and site of burn, hospital and ICU length of stay (LOS), and standard burn care practices, including fluid resuscitation therapies, number of surgical procedures and overall operating theatre time.

For each case patient, a series of historical control patients were selected to compare renal function (measured by estimated glomerular filtration rate [eGFR]) and LOS post-burn injury. The control patients were identified from the VABS database over a 12-month period (April 2008 to April 2009). Each control was matched for age (±10 years), sex, ICU admission and %TBSA burns.

For broader comparison, we obtained additional historical data on inpatient LOS/ %TBSA from the National Burn Centre at Middlemore Hospital, Manukau, New Zealand, which serves a similar population base to that of VABS. The Alfred’s finance department provided data on costs, and individual units and departments provided information on additional resource allocation.

Data analysis
All data were managed and analysed using Microsoft Excel (Microsoft Corporation, Redmond, Wash, USA) and OpenEpi (Open Source Epidemiologic Statistics for Public Health, version 2.3.1; http://www.openepi.com). Continuous data are presented as mean (SD) for symmetrical data, and as median (interquartile range [IQR]) or odds ratio (OR) (95% CI) for asymmetrical data.

Ethics
Our study was approved by The Alfred’s human research ethics committee.
RESULTS
Transport from scene to VABS

Nineteen patients injured in the Black Satur-
day bushfires were admitted to VABS. Each
patient’s trauma triage flow sheet and history
detailing pre-hospital first aid interventions and
treatments by Ambulance Victoria were
analysed (Box 1).

Admission to VABS

The characteristics of patients admitted to
VABS are shown in Box 2. Patients were
mostly men, with a mean age of 52.7 years
(SD, 12.4 years; range, 31–77 years). Nine
of the 19 patients were admitted to the ICU
with burns ranging up to 50% TBSA
(mean = 18.4%; SD, 14.5%). The %FTBSA
ranged up to 39% (mean = 11.0%; SD,
12.6%). All patients received intravenous
fluid resuscitation in the first 24 hours of
injury (mean = 7.26 mL/kg/TBSA; SD, 3.5
mL/kg/TBSA; range, 3.62–16.23 mL/kg/
TBSA). Data on urine output are not pre-
sent, as urine output was not recorded for
all patients. Injuries were predominantly
caused by radiant heat, with most patients
suffering burns to their hands, upper and
lower limbs, and head and neck region (Box
2). Other injuries included four inhalational
injuries (21.1%), two corneal abrasions
(10.5%), one foreign body injury (5.3%),
and a likely episode of severe hypoxia.

Surgical response

Seventeen patients (89%) underwent at least
one surgical procedure (mean = 2.6; SD,
2.04; range, 0–8), with a mean total operat-
ing time of 350.1 minutes (SD, 292.9 minutes).
Thirteen patients (68%) underwent a surgical procedure in the first
24 hours after injury, of which two occurred
at other hospitals. Six patients required at
least one emergency escharotomy, and eight
patients required transfusion of packed red
blood cells during their admission (mean =
17.5 units; SD, 13.1 units; range, 1–
42 units). Synthetic skin substitutes were
used in nine patients (47.3%) and six
patients (32%) required the use of cadaver
skin due to contaminated wound sites. Total
operating theatre time and operating time by
%TBSA are shown in Box 3. There was an
average requirement of 16.5 minutes of
operating time and 26.1 minutes of total
theatre time per %TBSA. All primary surgery
was completed by Day 33 (Box 4). After the
first week, there was a rapid decrease in
theatre-time requirements (Box 5). Histori-
cal data from Middlemore Hospital shows a
comparable theatre-time requirement of
22.8 minutes/%TBSA burn for patients with
burns >10% TBSA, with operating time
greatest in the first week and roughly halv-
ing in each subsequent week.12

Complications

Complications are summarised in Box 6. Many
patients had a common history of wound
contamination through contact with water in
dams and cattle troughs, or with dirt and ash
after injury. Given delays in transfer and
difficulty ensuring adequate clinical wound sur-
veillance, we considered infection risk to be
elevated. Thus wound cultures and specimens
were obtained at every dressing change and
theatre visit, with all positive cultures treated
with antibiotics. Repeated bronchoscopies
were performed in patients with evidence of
inhalation of dust and smoke.

Hospital and recovery outcomes

Of the 19 patients admitted to VABS, two
died in hospital: one presented with multi-
system organ failure and did not recover; the
second died of respiratory failure due to
fungal airway infection superimposed on
severe inhalation injury.

Duration of hospital LOS ranged from 0
to 46 days (median = 22 days; IQR, 11.75–
29.5 days). Nine patients were admitted to the
ICU, with LOS ranging from 2 to 24
days (median = 13.5 days; IQR, 6.25–16.5 days).
Nineteen patients required mechanical
ventilation (mean hours ventilated = 222.2
SD, 118.9). Time to wound healing in days
was reported in 13 patients (mean = 39.7
days; SD, 13.6 days).

Eleven of the 17 surviving patients were
discharged to a hospital-in-the-home pro-
gram. The LOS in this program ranged from
7 to 29 days (mean = 17 days; SD, 6.3 days).
Three patients were discharged to another
hospital or rehabilitation facility, and three
were discharged home.

The extra resource allocations required in
various departments are shown in Box 7.
Additional costs for hospital medical officers
and consultants were estimated at
A$64,000, and extra operating theatre costs
(staffing and consumables) for the month of
February were estimated to be A$61,500.
Inpatient LOS/%TBSA was similar for
both the VABS bushfire and the Middlemore
Hospital cohorts (1.0 days and 1.1 days,
respectively).

Median hospital LOS was greater for the
VABS bushfire cohort than for the VABS
historical cohort (21 days [IQR, 12–27 days]
v 13 days [IQR, 4–28.5 days]). The VABS
bushfire cohort had a higher incidence of acute renal impairment (defined by abnormal eGFR levels) compared with those of the VABS historical cohort (68% v 55%; OR, 1.75 [95% CI, 0.55–5.59]).

### DISCUSSION

Burns >20% TBSA are considered “severe” in the setting of a mass casualty incident, and seven patients admitted to VABS as a result of the bushfires had what is defined as a severe burn injury. To put this in context, an average of 35 patients a year in the state of Victoria received burns of >20% TBSA in the years 2000–2006.\(^1\)

The requirement for ICU beds when treating burn patients is frequently the limiting factor in the acute response to mass casualty incidents,\(^1\) as patients with airway injury or extensive burns necessitating large doses of opiates for analgesia require intubation and ventilation. The acute creation of 10 additional ICU ventilator beds at The Alfred has been documented elsewhere.\(^1\)

Disaster plans focus on the triage and distribution of casualties to hospitals. While it has been increasingly recognised in recent years that burns patients require large amounts of resources — human, infrastructural and consumable — what this actually means in terms of capacity is difficult to quantify. The delayed demands on such resources are increasingly difficult to measure as time from the incident elapses, yet burns patients have notoriously prolonged and complex hospital stays, and require lengthy rehabilitation and secondary surgery.

In terms of calculating what the theatre requirements of a particular burn patient are likely to be, for the group with burns between 10% and 50% TBSA, 21 minutes of theatre time per %TBSA burn for the whole inpatient stay would seem to provide a reasonable estimate, based on experiences at Middlemore Hospital and VABS. This estimate can be used in the event of a mass burn casualty event to determine the ability of a hospital to provide appropriate care for the cohort of patients with 10%–50% TBSA burns. Theatre demands are maximal in the first week and decrease rapidly thereafter, at least halving in each subsequent week.

However, attempts to predict the requirements of patients with massive burns are far more problematic and uncertain. It has been estimated that for the state of South Australia, five adult patients with massive burns would consume all normal burns unit resources for at least 3 months, after requiring a minimum of 5 hours each of surgery per week for the first 3 weeks.\(^1\) A patient with >50% TBSA burns has insufficient donor sites to provide early definitive wound closure, and is prone to a multitude of complications, making for a highly idiosyncratic clinical course. Add to this the fact that these are relatively uncommon injuries (most Australian burns units would admit around three to four such patients a year, some of whom might be treated palliatively), and it becomes very difficult to produce meaningful average data. The presence of people with burns >50% TBSA in a mass casualty cohort increases both acute and longer-term resource requirements exponentially, as well as greatly extending the length of time of increased demands, and would significantly complicate decision making with respect to resource allocation. The recently established Australia and New Zealand Bi-National Burns Registry will provide comprehensive data on these uncommon injuries and aid in predicting resource requirements.

The ability to provide early total burn wound excision is crucial in minimising complications in burns patients — especially in those with severe burns (>20% TBSA) who are at risk of developing systemic complications — which consume extra resources over increasing time periods in an already pressured environment. A hospital responding to a mass burn casualty event must, as a priority, ensure that theatres and surgeons are acutely available to enable early excision of severe burns. This strategy will minimise ongoing demands for resources and ensure best outcomes for patients. If excision is delayed, complications increase, hospital stays drag out, and the drain on resources limits the institution’s ability to return to business as usual quickly.

In the aftermath of the 2009 bushfires, VABS was able to continue to admit and...
Post-burn injury complications in patients admitted to the Victorian Adult Burns Service

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infected</strong></td>
<td></td>
</tr>
<tr>
<td>Blood stream infection</td>
<td>2 (10.5%)</td>
</tr>
<tr>
<td>External auricular abscess</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Urine</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Chest infection</td>
<td></td>
</tr>
<tr>
<td>3 organisms</td>
<td>2 (10.5%)</td>
</tr>
<tr>
<td>2 organisms</td>
<td>2 (10.5%)</td>
</tr>
<tr>
<td>1 organism</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Positive wound culture donor site</td>
<td>4 (21.1%)</td>
</tr>
<tr>
<td><strong>Non-infected</strong></td>
<td></td>
</tr>
<tr>
<td>Perioperative respiratory arrest</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Missed subcutaneous foreign body</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Non-healing wound requiring split skin graft</td>
<td>2 (10.5%)</td>
</tr>
<tr>
<td>Failed grafting requiring regrafting</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Retained staples requiring anaesthetic for removal</td>
<td>2 (10.5%)</td>
</tr>
</tbody>
</table>

It is important to recognise that victims of a mass casualty event have needs beyond medical treatment. Many of our patients had lost family members, homes, livestock and their livelihoods. They had significant loss and grief issues. In addition to the provision of medical treatment, The Alfred dealt with media issues, provided psychological support, and responded to the social needs of these patients and their families as part of the statewide response to this unprecedented catastrophe.

There were relatively few patients with severe burns admitted as a result of the bushfires when compared with the number of lives lost. This may reflect the extreme conditions created by the firestorms experienced on 7 February 2009 and that most people trapped by the fires perished. Nonetheless, significant increases in resource allocation were required to manage the survivors with burn injuries. Analysis of this resource allocation can assist in planning for future mass burn casualty incidents.

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COMPETING INTERESTS

None identified.

AUTHOR DETAILS

Heather J Cleland, MB BS, FRACS, Director1
David Proud, MB BS, Surgical Trainee1
Anneliese Spinks, PhD, Research Fellow2,3
Jason Wasiak, MPH, Research Fellow4
1 Victorian Adult Burns Service, The Alfred Hospital, Melbourne, VIC.
2 CSIRO Ecosystem Sciences, Brisbane, QLD.
3 School of Medicine, Griffith University, Meadowbrook, QLD.
Correspondence: J.Wasiak@alfred.org.au

REFERENCES

12 Phua YS, Miller JD, Wong She RB. Total care requirements of burn patients: implications for a disaster management plan. J Burn Care Res 2010; 31: 935-941.

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