MASS BURN INJURIES: AN ANALYSIS OF CHARACTERISTICS AND OUTCOMES IN A DEVELOPING COUNTRY

AFFLUX MASSIF DE BRÛLÉS: CARACTÉRISTIQUES ET DEVENIR DANS UN PAYS EN DÉVELOPPEMENT

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SUMMARY. Our aim was to investigate characteristics and outcomes of patients with mass burn injuries admitted to the National Institute of Burns (NIB), Hanoi, Vietnam. A retrospective note audit was conducted on 83 episodes of mass burn injury (MBI) resulting in 332 patients being admitted to the NIB from 1/2009 to 1/2015. Evaluated criteria included occurrence time, causal agents, place, MBI size, and demographic information such as patient age, gender, burn surface area, full thickness burn area, inhalation injury, prehospital management and outcome. Single and multiple variable logistic analyses were performed to find out independent factors affecting the mortality rate of these patients. 66.3% of MBI were work-related accidents. Incidents were mainly located indoors (72.2%). The predominant groups appeared to be adult (92.3%) and male (74.9%). Average burn surface area was 31% total body surface area (TBSA) and average full thickness area was 12% TBSA. Inhalation injury was diagnosed in 24.6% of patients. More than half of the total victims were classified as having moderate and major burns with an overall mortality rate of 19.2%. According to available information, initial management prior to admission to NIB was not efficient. Full thickness burn area and inhalation injury were found to be independent factors affecting the mortality rate of mass burn injury patients. Our results indicate that most mass burn injury patients in Vietnam are male adults in the working environment. Inhalation injury and full thickness burn area were independent factors affecting mortality rate. Continuing medical education should be conducted to eliminate limitations in prehospital care.

Keywords: mass burn injuries, prehospital care, outcome

RÉSUMÉ. *Cette étude a pour but d'évaluer les caractéristiques et le devenir des patients brûlés dans un contexte de catastrophe (BCC) admis dans l'institut national de brûlologie d'Hanoi. Une étude rétrospective sur dossiers de patients hospitalisés entre janvier 2009 et janvier 2015 a été réalisée. Elle concernait 332 patients et 83 catastrophes. Les données évaluées étaient le moment de survenue, l'agent causal, le lieu, l'ampleur de la catastrophe, l'âge, le sexe, les surfaces totale et profonde, l'inhalation de fumées, la prise en charge pré hospitalière et le devenir. Des analyses uni et multivariées ont été réalisées pour trouver des facteurs prédictifs de mortalité. Les BCC étaient pour 66,3% des accidents industriels, en milieu fermé (72,2%). Les hommes (74,9%) adultes (92,3%) représentaient la majeure partie des victimes. La surface brûlée moyenne était de 31% dont 12% profond. Une inhalation était retrouvée chez 24,6% des patients. La mortalité globale était de 19,2%, plus de la moitié des patients ayant des brûlures considérée comme modérées ou étendues. Nous avons considéré que la prise en charge pré hospitalière était inadaptée, justifiant des mesures de formation initiale et continue ciblées. L'existence de brûlure profonde et l'inhalation de fumées sont des facteur indépendants de mortalité dans ce contexte.*

Mots-clés: *brûlures, catastrophe, prise en charge pré hospitalière, devenir*

Introduction

Mass burn injuries are defined as burn injuries involving at least three burn victims in the same incident. This may occur anywhere and at any time due to natural or man-made accidents related to the work or domestic environment.[1,2] All mass burn injuries are unpredictable and involve a large number of victims requiring a higher consumption of labour resources and equipment, as well as medical attention. Medical response tasks in massive burn injuries are much more difficult than those required in separate burn incidents because the events are unexpected and a large number of patients are involved at the same time.[3,4] The features of burns are more complicated. Such situations require the immediate mobilization of a significant number of personnel, means and facilities to cope with the up-coming issues.[5-7]

Assessing the characteristics of massive burn injuries and their victims is essential in order to develop strategies and disaster planning to handle urgent needs and sudden increased demands for medical attention. To date, there have been very few studies conducted on features of mass burn injuries in developing countries. This study attempts to investigate the characteristics and outcomes of patients with mass burn injuries admitted to the National Institute of Burns, Vietnam over a period of 6 years (1/2009 – 1/2015).

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Materials and methods

A retrospective study was conducted on all patients with mass burn injuries treated at the National Institute of Burns (NIB), Hanoi from 1/1/2009 to 1/1/2015. Mass burn injuries were defined as in previous studies conducted in Japan and Singapore,[1,2] that is to say, burn injuries involving at least three burn victims in the same accident. The following data were collected: causes of mass burn injuries, occurrence time, location, and the number of victims admitted to the National Institute of Burns, as well as burn patient characteristics including age, gender and inhalation injury. Details of prehospital management as well as outcomes in terms of complications and survival were also recorded. Burn severity was classified according to the definition of the American Burn Association in 1984.[8] Collected data were sub-classified according to age, burn surface area, full thickness area, inhalation injury and admission time from burn occurrence; changes in assessment criteria were assessed using Chi-square and T-test. Single and multiple variable logistic analyses were performed to identify independent factors affecting the mortality of the patients using Stata Intercool 11.0 software. P value ≤.05 was set as a significant level.

Results

There were 83 mass burn incidents with 332 patients admitted to the NIB over the 6-year period. MBI characteristics are shown in *Table I*. Among the 83 mass burn incidents, work-related burns were predominant with 55 casualties, accounting for 66.3%: the remainder were domestic-related accidents. Common causes were dry heat including fire and explosion (82.1%) followed by high voltage electricity accidents (13.3%). The occurrence time was between 2pm and 10pm (51.8%). Most accidents happened indoors (70.2%). The average number of patients with MBI was 4 per incident, ranging from 3 to 22 (*Table II*).

Characteristics of the patients are indicated in *Table III*. Of the total 332 patients transferred to the NIB, 92.5% were adult (ranging from 16 to 60 years old) and they were predominantly male (73.8%). Average burn surface area was 31.5% total body surface area (TBSA) and average full thickness burn area was 12% TBSA. Inhalation injury was diagnosed in 83 patients, accounting for 24.6% of total cases. Co-injuries were recorded in 19 cases (5.7%): these included soft tissue injury (3.6%), long bone fracture (0.6%) and visceral injury (1.5%). Severity of patients was classified according to the American Burn Association, as follows: 49% major, 16% moderate and 35% mild injuries.

Table IV indicates details of prehospital care for 289 patients at peripheral hospitals before being transferred to the NBI. Burn surface area was diagnosed in 31.5% of cases, while inhalation injury was determined in only 7 cases, accounting for 2.4%. Regarding fluid resuscitation, 66.8% of the patients were not given fluid resuscitation intravenously or orally. Over a half of the cases (55.7%) did not have any burn wound dressings applied before being transferred to the NIB. In addition, 43 out of 332 patients (14.8%) were directly transferred from the site of the accident to the NBI without any initial management (data not shown).

Table V displays leading complications of the mass burn injury patients, with acute respiratory distress syndrome (ARDS) affecting 56 cases, accounting for 16.9%, followed by

Table I - Characteristics of mass burn casualties (n=83)

Criteria		n (%)	p
Incident circumstance	Domestic accident	28 (33.7)	< .01
	Working environment	55 (66.3)	
Cause of casualties	Fire and explosion	69 (82.1)	< .05
	Chemical agents	3 (3.6)	
	Electricity	11 (13.3)	
Time point of occurrence (%)	6 – 14	30 (36.2)	< .01
	14 – 22	43 (51.8)	
	22 - 6	10 (12.0)	
Places of occurrence (%)	Indoors	60 (70.2)	< .01
	Outdoors	23 (29.8)	

Table II - Burn patients admitted to NIB after mass burn injuries (n=332)

Number of patients	MBI frequency (%)
3	47 (56.6)
4	22 (25.5)
5	6 (7.2)
6	2 (2.4)
7	1 (1.2)
8	1 (1.2)
9	1 (1.2)
12	2 (2.4)
22	1 (1.2)
Mean (SD)	4 (1.1)

Table III - Patient characteristics (n=332)

Criteria		Value
Age (%)	Children	22 (6.6)
	Adult	307 (92.5)
	Elderly	3 (0.9)
Gender (%)	Male	245 (73.8)
	Female	87 (26.2)
Burn surface area, % TBSA (SD)		31.5 (27.7)
Full thickness burn area, % TBSA (SD)		12 (5.0)
Inhalation injury (%)		83 (24.6)
Co–injuries	Fracture	2 (0.6)
	Soft tissue injury	12 (3.6)
	Visceral trauma	5 (1.5)
Burn severity (%)	Mild	116 (35)
	Moderate	54 (16)
	Major	162 (49)

Table IV - Prehospital management (n=289)

Criteria	Yes (%)	No (%)
Burn surface area diagnosis	91 (31.5)	198 (68.5)
Inhalation injury	7 (2.4)	282 (97.6)
Fluid resuscitation	96 (33.2)	203 (66.8)
Pain relief	151 (52.3)	138 (47.7)
Burn wound dressing	128 (44.3)	161 (55.7)

Table V - Patient complications (n=332)

Complication	Number of patients (%)
Septic shock	53 (15.9)
GI haemorrhage	14 (4.2)
ARDS	56 (16.9)
Acute renal failure	48 (14.6)
Multiple organ failure	54 (16.4)

Table VI - Outcome of mass burn injury patients (n=332)

Criteria	Survived (%)	Death (%)	p value
All patients	267 (80.4)	65 (19.6)	
Inhalation injury	23 (27.7)	60 (72.3)	< .01
Non-inhalation injury	244 (98)	5 (2)	
Male	191 (77.3)	56 (22.7)	< .05
Female	76 (89.4)	09 (10.6)	
Children	19 (86.4)	03 (13.7)	< .01
Adult	246 (80.1)	61 (19.9)	
Elderly	2 (66.7)	1 (33.3)	
Mild burn	116 (100)	0	< .05
Moderate burn	53 (98.2)	1 (1.8)	
Major burn	98 (60.5)	64 (38.5)	
Burn surface area, % TBSA (SD)	21 (17.8)	74.5 (17.9)	< .001
Full thickness area, % TBSA (SD)	4.5 (3.6)	42.7 (14.9)	< .001

Table VII - Multiple variable logistic analyses

Death	Coefficient	p value	95% Confidence Interval
Age	-0.17	.53	-.07 ÷ .03
Gender	0.62	.49	-1.2 ÷ 2.4
Burn surface area	-.036	.06	-.07 ÷ .001
Deep burn area	-1.1	.00	-1.7 ÷ .05
Inhalation injury	-3.3	.00	-4.8 ÷ -1.9
Constant	6.62		

multiple organ failure (16.3%), acute renal failure (14.6%) and gastrointestinal haemorrhage (4.2%).

The total number of deaths was 65, with an overall mortality rate of 19.6%. Sub-group analysis showed that 72.3% of patients with inhalation injury died, compared to 2% of those without inhalation injury ($p<0.001$). A higher death rate was seen in male patients (22.7% versus 10.6% respectively; $p<0.05$). In addition, burn surface area was significantly higher among the death patients (74.5% versus 21% TBSA respectively; $p< 0.01$). The same relationship was seen for full thickness burn area (42.7% versus 4.5% TBSA respectively; $p<0.001$). Thus the highest death rate was in the group with major burns (38.5%); no death was recorded in the group with mild burns (*Table VI*). However, multiple variable logistic analyses for death prediction using age, burn surface area, full thickness burn area, gender and inhalation injury indicated that only inhalation injury and extent of full thickness burn injury were the independent predicted factors for death of mass burn injury patients (*Table VII*).

Discussion

To date, the largest review of burn-related disasters and mass casualties was carried out by Barillo and Wolf, reviewing the history of fire disasters occurring in the United States over the 100 years of the 20th century.[9] According to the review, many injury victims died on the scene or within 24 hours of admission to hospital, accounting for a small proportion of the total number. Moreover, MBI patients consumed a huge amount of resources during hospitalization. According to worldwide reports, MBI accounted for 20-30% of total mass casualty incidents. In 2013, Kim et al. showed that burn injuries were the leading cause of death (35.9%) among all disasters in South Korea over a 9-year period.[10] In this current report, 83 mass burn injury events with 332 patients admitted to the NIB during a 6-year period were analysed. The average number of patients involved was 4, ranging from 3 to 27. In fact, the number of patients might be under-estimated. Many victims may have died before reaching a burn centre and/or being transferred to other facilities.

Regarding location of occurrence, our results show that MBI commonly happened in the work environment (66.27%) and indoors (70.2%). In reports from other countries, authors indicated that 55% MBI in Singapore in the period 1982-1991 was due to work-related accidents, while in Japan only 27.2% of injuries occurred in the working environment, reflecting higher safety standards and regulations.[1,2]

The most common causes of MBI were fire and explosion.[11,12] O'ya reported that explosion and fire accounted for 54% of total mass casualty events in Japan.[2] The same situation was reported in the review by Ngim in Singapore, covering three decades.[1] In the current study, 82.1% of total MBI was caused by fire and explosion, and 70.2% of incidents occurred indoors. This explains the high proportion of inhalation injury (24.6%): 49% of patients in this report were classified as having major injuries and most of them required intubation and ventilation. Hence, they were admitted to the burn intensive care unit. This was an additional burden for heath care providers and resources.

Vietnam is a developing country. Hence, infrastructure may not match the demand of the fast-growing industries and services. Moreover, the medical structure and services of Vietnam are very diverse, and not as united compared to developed countries. The time to definite care is often delayed due to complicated negotiation within the system. Among the mass burn injury victims, a great number of workers were in the construction and mining sectors, which have poor safety regulations. As a result, dry thermal burns accounted for a high proportion of 79.52% of injuries and high voltage injuries made up 13.25%. Another associated feature may be related to the special building structure in Vietnam. Many workplaces, braziers or tubular houses have a single entrance door only. There is no emergency exit; therefore, many burn victims present with severe burn and inhalation injury. Although the number of MBI casualties has decreased gradually and most incidents result in fewer than 50 victims requiring admission to burn centres, the mortality rate of patients with MBI remains significantly high due to the characteristics of the patients and the sudden increase in the number of patients requiring medical attention at the same time, as well as limited experienced professionals and medical equipment resources.[5,12] In 2013, Kim et al. reported that MBI events were the second most common mass casualty incidents (7.5% versus 78.6% for traffic accidents) but were the leading cause of death (35.9%) resulting from disasters.[10] Results from the current study showed that the number of admitted patients from each incident varied from 3 to 22. It also indicated that over a half of patients admitted to the NBI with MBI were classified as having moderate and major burns (with a large burn surface area and/or inhalation injury). The reason could be that the causal agent was dry heat (79.52%), including fire and explosions in enclosed spaces. This finding is in agreement with other reports. For example, in the case of the World Trade Centre terrorist attack in New York in September 2011, nearly a half of deaths resulted from inhalation injury.[9,11] In 2005, Mahoney et al. also reported that 60% of admitted patients injured during a nightclub fire suffered from inhalation injury.[12]

Severity of the burn patient not only depends on the treatment regime at the burn centre but also on initial management at a peripheral hospital and during transfer to the burn centre. Results from various studies have shown that an appropriate initial treatment, which is correctly applied, can reduce the depth of injury, pain and complications of burn injury.[13-15] Currently, initial management of MBI patients is a real challenge for health care systems in developing countries such as Vietnam. The fact is that a significant number of health care providers, primarily medical staff in peripheral hospitals, may not have updated burn care knowledge and skills. In addition, many burn units or centres have limited resources, especially when it comes to dealing with MBI. In order to improve the care of MBI patients, a continuous education programme should be available for all medical staff, especially for emergency care ambulance teams and those working in peripheral hospitals. A 'hot line' service is highly recommended to connect burn centres and peripheral hospitals. This allows timely consultation on burn management. Finally, a regular feedback system reporting avoidable errors should be in place, which is of paramount importance for learning from mistakes.

Conclusion

Current results show that most mass burn injury patients were adult males. The location of injury was in an enclosed space, either at work or inside a building. Over a half of cases were classified as having major burns. Inhalation injury and full thickness burn area were identified as independent factors affecting the mortality rate of mass burn injury patients. An ongoing continuous education programme, setting up a 'hot line', and regular reporting are suggested ways to minimise the barriers of initial management and to provide immediate care for MBI patients.

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