

Clinical profile of assault burn victims: A 16-year review

P. THEODOROU, M.D.

Department of Plastic and Reconstructive Surgery, Merheim-Hospital University of Witten-Herdecke, Cologne, Germany, and Institute for Research in Operative Medicine (IFOM), University of Witten-Herdecke, Cologne

T. Q. V. PHAN, M.D.

Department of Plastic and Reconstructive Surgery, Merheim-Hospital University of Witten-Herdecke

C. A. MAURER, M.D., PH.D.

Department of General, Visceral, Vascular and Thoracic Surgery, Hospital of Liestal, Liestal, Switzerland

S. LEITSCH, M.D.

W. PERBIX, M.D.

Department of Plastic and Reconstructive Surgery, Merheim-Hospital University of Witten-Herdecke

R. LEFERING, M.D., PH.D.

IFOM, University of Witten-Herdecke

G. SPILKER, M.D., PH.D.

Department of Plastic and Reconstructive Surgery, Merheim-Hospital University of Witten-Herdecke

Summary

Objective. Assaults by burning occur infrequently and are related to the social circumstances and demographics of each population. We aimed to explore the mechanisms, complications, morbidity and mortality associated with assault burn injuries admitted to the Burns Intensive Care Unit of Merheim University Hospital in Cologne.

Methods. A retrospective data analysis of a consecutive series of 1 243 burn patients between 1989 and 2004. The cohort was divided into two groups: AG (assault group) and CG (control group). Analyses were controlled for clinical data, treatment and outcome of all patients involved.

Results. Forty-one patients with assault burn injuries were identified during the study period. Compared with the general burn population (CG), the AG had a significantly larger size of third-degree burns ($p=0.047$), a higher incidence of inhalation injury ($p<0.001$) and a longer intubation period ($p=0.047$). Patients in the AG were also more likely to undergo escharotomy ($p=0.013$) and to receive antibiotics on admission ($p=0.016$). The mortality rate was higher in the AG than in the CG (26.8% v. 19.9%), but this difference was not significant.

Conclusions. Burned patients who were victims of assault tend to have more severe injuries than the general burn population. These injuries are not only physical, and their management requires a multidisciplinary approach to improve outcome.

lack of adequate health care access – assault-related burns remain a socio-medical problem of global reach and significance.

Victims of thermal injury as means of assault represent a patient population with unique clinical features and outcomes.^{2,3} Studies have shown that they have a higher incidence of inhalational injury, a longer hospital stay and a higher mortality rate than the general burn population. Different types of intentional burn trauma tend to correlate with the motives of the assailants, and each type of injury has its own associated management problems.⁴ The course of recovery may be complex owing to the severity of these injuries, and often associated legal issues put the patient under additional stress.

The literature on intentional burns has focused mainly on self-inflicted burns and child abuse.⁵ In Europe, little information has been documented on injury characteristics, clinical profiles and outcomes of adults with assault burn injuries,^{6,7} and so far there has been no study from Germany.

We aimed to review the clinical profile, management and outcome of assault burn injuries from the largest burns unit in Germany. Practitioners need to be aware of the problem of assault burn injuries, to search for 'silent cases', and to improve patient management.

Methods

Patient sample

We retrospectively reviewed the records of 1 461 patients treated in the Burns Intensive Care Unit (BICU) of the University of Witten-Herdecke from January 1989 to December 2004. The centre provides health care to the more than 10 million inhabitants of Cologne and the Rhine-Ruhr metropolitan area.

Exclusion criteria included age <14 years, admission diagnosis of toxic epidermal necrolysis, electrical injuries and a stay in the BICU <3 days, leaving 1 243 patients for further analysis.

The prevalence of violent injury in Western society is high, with dramatic increases in the incidence of personal violence during the past three decades.¹ Assault by burning is not frequent, but is serious enough to warrant investigation. As violence is linked to a number of other major public health problems – drug abuse, poverty and

Assault was defined as the unlawful application of force to another person resulting in bodily injury. The intention to inflict this kind of injury was determined from the medical history and the criminal or civil litigation records following non-accidental injury.

Data collection

Burn size and depth were assessed by the attending surgeon, who used the Lund-Browder diagram to document the extent of injury in each body region. Inhalation injury was defined as a history consistent with inhaled toxic fumes and bronchoscopic verification of tracheal and bronchial damage. An abbreviated burn severity index was calculated from the medical records. Demographics, length of stay in the BICU, intubation status on admission, acute renal failure with haemodialysis, and antibiotic treatment including prophylactic antibiotics on the day of admission were recorded from the medical notes. The number of surgical procedures, duration of ventilatory support, sepsis, catecholamine levels and blood transfusion requirements were documented throughout the stay in the BICU. Sepsis was diagnosed using the criteria of the Society of Critical Care Medicine,⁸ in conjunction with positive blood cultures or presence of organisms in the organs at autopsy. Institutional permission for the study was obtained and confidentiality of the information was maintained.

A Medline search of the English-language literature using the key words 'assault burn' produced 103 references. We reviewed the abstracts of all these articles and further reviewed the full text of articles that described clinical features of assault burn injuries. The review was expedited by targeting phrases such as 'thermal injury', 'deliberately caused', 'inflicted', 'caused by' and 'non-accidental'.

Statistical analysis

Comprehensive descriptive statistics including number, mean, standard deviation (SD), minimum and maximum were used for quantitative data. A bivariate comparison of the two groups was performed using Fisher's exact test for counts and the Mann-Whitney U-test for continuous variables. Absolute counts and percentages were given for nominal and ordinal data. All *p*-values are two-tailed, and *p*<0.05 was considered to be statistically significant. Statistical calculations were performed with SPSS for Windows (Version 14.0, SPSS Inc., 2005).

Results

Injury characteristics

A total of 1 243 patients with severe burn injuries were enrolled in this study for the years 1989 - 2004. Only 41 patients had burn injuries related to assault. The characteristics of the injuries in the two groups (AG = assault group, CG = control group) are summarised in Table I.

At the time of admission, 17/41 of the victims volunteered the information that their injury was the result of assault. Only 2 victims admitted the true circumstances of their injury more than 48 hours after admission.

The circumstances surrounding the assault were variable. In 15 cases there had been a domestic quarrel. Other circumstances included arson (14 cases) and attempted murder (5 cases). Twenty victims described their assailants as 'friends' or family members.

Referral patterns

Almost 55% of AG patients were admitted directly to the unit (as opposed to 45% of the CG), 9% were referred from primary care facilities, and 36% were referred from secondary and tertiary care facilities.

Burn characteristics

The causes of the burns (flame, scald or chemical) in the AG and the CG are shown in Fig. 1, and were found to be significantly different (*p*<0.001). The abbreviated burn severity index ranged from 2 to 16 in assault victims, which was similar to the rest of the patient cohort.

The mean burn extent was 28.5% total body surface area in the AG (median 20.5%) as opposed to 23.4% in the CG (median 16.0%), and the burns in the AG had a significantly larger mean full-thickness component. There were no differences between the groups in terms of which part of the body was burnt, the face and anterior trunk being the commonest sites. Compared with the general burn population, the AG had a significantly higher prevalence of inhalation injury (*p*<0.001).

Clinical features

Table II summarises clinical features during the BICU stay. Although not statistically significant, there was a trend toward a longer BICU stay in the AG (mean 25 days, range 3 - 106 days; *p*=0.15) compared with the rest of the burn population. Patients in the AG were more

TABLE I. BASELINE CHARACTERISTICS

Injury variables	AG	CG	<i>p</i>
<i>N</i>	4	1 202	
ABSI score (mean (SD))	7.5 (3.6)	6.4 (3.0)	0.069 [†]
TBSA (%) (mean (SD))	28.5 (26.3)	23.4 (22.0)	0.295 [†]
Degree of burn (%) (mean (SD))			
2a	10.0 (9.4)	10.6 (10.8)	0.922 [†]
2b	8.3 (11.7)	6.1 (9.9)	0.055 [†]
3	10.2 (21.6)	6.7 (15.3)	<u>0.047</u> [†]
Inhalation injury (<i>N</i> (%))	25 (61.0)	344 (28.6)	<u><0.001</u> [*]
Admitted on ventilator (<i>N</i> (%))	19 (46.3)	479 (39.9)	0.421 [*]

* Fisher's exact test.
[†] Mann-Whitney U-test.
 AG = assault burn injury group; CG = control group (rest of the burn patient cohort); ABSI = abbreviated burn severity index; TBSA = total body surface area.
 Underlined *p*-values are significant.

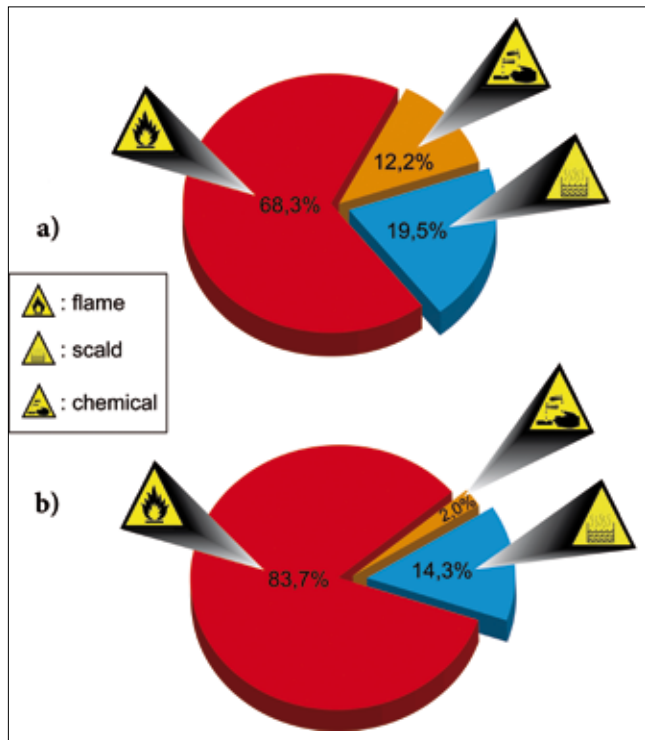


Fig. 1. Distribution of causes of the burn injuries, (a) for the assault group and (b) for the control group.

likely to receive antibiotics on admission ($p=0.016$) and required longer positive end-expiratory pressure ventilation than those in the CG ($p=0.047$).

Therapeutic modalities and outcomes

In many respects the two groups were similar: single/multiple operations required (43.9% (AG) v. 40.2% (CG)); procedures required (1.98 v. 1.57, lavages and dressing changes not included); and skin grafts (68.2% v. 61.7%).

Escharotomy was performed in a significantly higher proportion of patients in the AG (34.1%, v. 18% in the CG). Eleven patients in the AG died from their injury. Mortality was higher in the AG than in the CG (26.8% v. 19.9%), but this difference was not statistically significant.

Before discharge, all cases of arson, robbery and assault were reported to the appropriate authorities. The 11 deaths were investigated by the local homicide division. Nine of the patients involved in a domestic quarrel pressed charges against their assailants.

Discussion

Assault by burning is a rare but severe form of trauma. The different types of injury inflicted often correlate closely with the motives of the assailants, and each type of injury has its own unique characteristics. We report on victims treated in the BICU in Cologne, Germany.

Although only 3.3% of over 1 200 patients had assault burns, they were associated with a higher frequency of inhalation injury, a larger size of third-degree burns and a longer intubation period, indicating a more severe clinical course than accidental burns. These findings confirm those in previous series.^{4,9} The higher proportion of patients requiring escharotomy is associated with the larger size of full-thickness burns in the AG.

As reported in earlier studies, flame was the main mechanism of injury in the AG (68.3%), which explains the high incidence of inhalation injuries. Assault by fire is often related to poverty and criminal activity. Patients sustaining this form of assault have been reported to have larger burns, longer stays in the burns unit and higher mortality rates than the general population.⁴ This may be because of the assailant's intent to harm or kill the individual. The high proportion of third-degree burns among assault victims corresponded with past studies, but we were unable to show any correlation between the severity of burns and the different mechanisms used to cause them.

Assault of children using hot liquid, and the predisposing factors, patterns of injury and outcome, have been extensively document-

TABLE II. CLINICAL FEATURES

	AG	CG	<i>p</i>
Clinical data			
Antibiotics on admission (N (%))	17 (41.5)	289 (24.0)	<u>0.016</u> *
Escharotomy (N (%))	14 (34.1)	216 (18.0)	<u>0.013</u> *
BT (N (%))	24 (58.5)	537 (44.7)	<u>0.109</u> *
Antibiotics (N (%))	29 (70.7)	700 (58.2)	<u>0.259</u> *
Catecholamines (N (%))	13 (31.7)	369 (30.7)	<u>0.931</u> *
PEEP ventilation (N (%))	19 (46.3)	479 (39.9)	<u>0.421</u> *
Sepsis (N (%))	4 (9.8)	186 (15.5)	<u>0.385</u> *
Haemofiltration (N (%))	4 (9.8)	90 (7.5)	<u>0.651</u> *
BICU stay (d) (mean (SD))	25.15 (27.2)	20.87 (27.3)	<u>0.150</u> †
Ventilator days (mean (SD))	17.3 (22.4)	12.1 (22.0)	<u>0.047</u> †
Surgical procedures (mean (SD))	2.0 (2.6)	1.6 (2.5)	<u>0.168</u> †
Outcome			
Mortality (N (%))	11 (26.8)	239 (19.9)	<u>0.320</u> *

*Fisher's exact test.

†Mann-Whitney U-test.

AG = assault burn injury group; CG = control group (rest of the burn patient cohort); BT = blood transfusion; PEEP = positive end-expiratory pressure; BICU = Burn Intensive Care Unit.

Underlined *p*-values are significant.

ed.¹⁰⁻¹³ In contrast, injury to adults inflicted in this way has received little attention in the literature. Assault by scalding is usually an impulsive violent act and has been associated with alcohol abuse^{9,14} and low socio-economic status.^{15,16} Most assaults using hot fluid cause partial skin thickness burns. Patients tend to have a smaller burn size and a shorter hospital stay, and recover well from the insult without significant functional or psychosocial disturbances.⁹ The incidence varies worldwide owing to different demographic and socio-economic factors. Duminy and Hudson⁹ found that assault by hot fluids is underestimated. They reported that many female victims claimed that the assailant was unknown, when the spouse was suspected to be responsible and his identity was protected by his wife.⁹ In Hong Kong, Ho *et al.* reported that hot liquid was used in 21% of assault burns.⁴ In a report from Washington, DC, 61% of assault thermal injuries involved scalding.¹⁷ In our series, scalding was reported in 19.5% of assault cases, which was similar to previous studies.⁴ Hot water and hot food were commonly used. The proportion of AG patients sustaining burn injury by scalding was higher than that in the general burn population.

The use of chemicals in assault has been recognised as being typically a crime of passion, particularly in developing countries. It often results in severe disfigurement, facial and non-facial, and even in blindness. Common reasons for chemical attacks have been reported to be disputes over rejected sexual advances or marital disputes, land and family disputes and dowry dissatisfaction.¹⁸ Acids rather than alkalis are favoured in these attacks. In Cambodia, acid burns comprise 20% of all burns; the assailant is usually a woman who attacks her unfaithful husband. In Taiwan, financial and domestic disputes were the main trigger in 80% of cases.¹⁹ In Jamaica, the assailant is often a woman who has been responsible for a significant number of attacks on other women on account of infidelity.²⁰ In Uganda, robbery and burglary accounted for 47% of attacks.²¹ The face is the most common site of injury, while the genital region has also been documented in several studies and is important in the context of gender crime/spousal abuse.²²⁻²⁴ Chemical attack was the least common assault mechanism in our series (12.2%), but the figure was noticeably higher than that in the rest of the burn patient cohort.

Few studies have considered the distribution of partial- and full-thickness burns. In assault groups, burns tend to be deeper and more extensive, with full-thickness burns being predominant. This was the case in our series. Considering that the extent and depth of a burn has a direct influence on mortality and morbidity, it was not surprising that our AG had a longer intubation period and were more likely to undergo escharotomy than the rest of the burn patient cohort.

Mortality is a reflection of various factors that influence the evolution of burns. Although the mortality rate was higher in the AG in our series, it was not significantly different from mortality in the rest of the burn population.

All forms of assault and abuse, especially within families, represent complex behaviours by the abuser, often rooted in a dysfunctional past with links to poverty, desperation, substance dependency

and early abuse of the assailant. This type of injury is highly prevalent in disadvantaged subgroups, and social disadvantage is usually associated with life circumstances that place an individual at an increased risk of sustaining certain types of injuries.^{25,26} It is therefore obvious that intentionally inflicted burn injuries are not simply physical injuries. Their management requires a multidisciplinary approach with significant medical, psychological, occupational and social support to improve outcomes.

Only through determined collection and analysis of data related to assault burn injuries can we become more efficient in identifying 'silent cases' of such injuries in order to bring about the appropriate medical, psychosocial and judicial interventions.

Acknowledgments. The authors thank Sascha Becker for technical assistance.

REFERENCES

1. US Department of Justice. <http://www.ojp.usdoj.gov/bjs>.
2. Reiland A, Hovater M, McGwin G, et al. The epidemiology of intentional burns. *J Burn Care Res* 2006;27:276-280.
3. Purdue GF, Hunt JL. Adult assault as a mechanism of burn injury. *Arch Surg* 1990;125:268-269.
4. Ho WS, Ying SY, Chan HH, Chow CM. Assault by burning – a reappraisal. *Burns* 2001;27:471-474.
5. Jacobson R, Jackson M, Berelowitz M. Self-incineration: a controlled comparison of in-patient suicide attempts. Clinical features and history of self-harm. *Psychol Med* 1986;16:107-116.
6. Malic CC, Karoo RO, Austin O, Phipps A. Burns inflicted by self or by others – an 11-year snapshot. *Burns* 2007;33:92-97.
7. Greenbaum AR, Donne J, Wilson D, Dunn KW. Intentional burn injury: an evidence-based, clinical and forensic review. *Burns* 2004;30:628-642.
8. American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Crit Care Med* 1992;20:864-874.
9. Duminy FJ, Hudson DA. Assault inflicted by hot water. *Burns* 1993;19:426-428.
10. Stone NH, Rinaldo L, Humphrey CR, Brown RH. Child abuse by burning. *Surg Clin North Am* 1970;50:1419-1424.
11. Lenoski EF, Hunter KA. Specific patterns of inflicted burn injuries. *J Trauma* 1977;17:842-846.
12. Hight DW, Bakalar HR, Lloyd JR. Inflicted burns in children. Recognition and treatment. *JAMA* 1979;242:517-520.
13. Hobbs CJ. When are burns not accidental? *Arch Dis Child* 1986;61:357-361.
14. Darko DF, Wachtel TL, Ward HW, Frank HA. Analysis of 585 burn patients hospitalized over a 6-year period. Part III: Psychosocial data. *Burns Incl Therm Inj* 1986;12:395-401.
15. Glasheen WP, Attinger EO, Anne A, et al. Identification of the high-risk population for serious burn injuries. *Burns Incl Therm Inj* 1983;9:193-200.
16. Stone MJ. Assault by burning and its relationship to social circumstances. *Burns Incl Therm Inj* 1988;14:461-467.
17. Krob MJ, Johnson A, Jordan MH. Burned-and-battered adults. *J Burn Care Rehabil* 1986;7:529-531.
18. Morrison J. Statistical facts on acid attacks. In: *Acid Survivors Foundation*, 2003.
19. Yeong EK, Chen MT, Mann R, et al. Facial mutilation after an assault with chemicals: 15 cases and literature review. *J Burn Care Rehabil* 1997;18:234-237.
20. Branday J, Arcscott GD, Smoot EC, et al. Chemical burns as assault injuries in Jamaica. *Burns* 1996;22:154-155.
21. Asaria J, Kobusingye OC, Khingi BA, et al. Acid burns from personal assault in Uganda. *Burns* 2004;30:78-81.
22. Faga A, Scevola D, Mezzetti MG, Scevola S. Sulphuric acid burned women in Bangladesh: a social and medical problem. *Burns* 2000;26:701-709.
23. Balakrishnan C, Imel L, Prasad JK. Burns in men secondary to spouse abuse. *J Burn Care Rehabil* 1994;15:449-451.
24. Balakrishnan C, Imel LL, Bandy AT, Prasad JK. Perineal burns in males secondary to spouse abuse. *Burns* 1995;21:34-35.
25. Pomerantz WJ, Dowd MD, Buncher CR. Relationship between socioeconomic factors and severe childhood injuries. *J Urban Health* 2001;78:141-151.
26. Cubbin C, LeClere FB, Smith GS. Socioeconomic status and the occurrence of fatal and nonfatal injury in the United States. *Am J Public Health* 2000;90:70-77.