Inhalation Injury in Burns Patients in Ibadan

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ABSTRACT

Background: Inhalation injury is one of the most prominent determinants of mortality in major burn patients. This study was undertaken to ascertain the factors that could be used to predict the occurrence of inhalation injury in a burnt patient, with a view to alerting the burn care providers for a reappraisal of the management protocol in this category of patients.
Method: A retrospective study of patients managed for burns in 2 years. Descriptive and logistic regression analyses were performed on the following variables of patients with burns; age, sex, aetiology, extent of the burns, presence or absence of inhalation injury and outcome.
Result: One hundred and sixty four patients with a mean (S. D.) age of 25.0 (16.9) years suffered a total body surface area (TBSA) burn of 35.8% (S. D. 26.9). Twenty-seven (16%) sustained inhalation injury. Among those who suffered inhalation, mean (S. D) TBSA was 50.4% (25.1) while in those without inhalation injury, mean (S. D) TBSA was 32.9% (26.4). While the overall mortality was 36%, the mortality of patients with inhalation injury was 78%. Of the variables, age, sex, aetiology and TBSA, only TBSA could be used to predict an occurrence of inhalation injury.
Conclusion: Reasons for the high mortality included lack of facilities for monitoring blood gasses as well as for ventilatory support and delays in early skin coverage. A high index of suspicion and knowledge of the appropriate management of inhalation injury are important for a good outcome.

KEY WORDS: burns, inhalation injury

Introduction

Inhalation injury is one of the prominent determinants of mortality in major burn patients. The multitude of respiratory complications caused by smoke inhalation, cutaneous burns and their treatment epitomize the clinical challenge, which confronts burn care providers today. Early diagnosis of inhalation injury and prevention or treatment of the associated life threatening complications is necessary to decrease the morbidity and mortality related to inhalation injury. With improvements in the fluid management of cutaneous burns without inhalation injury, mortality has steadily reduced but with added inhalation injury outcome is increasingly dismal. The mortality in patients who have sustained an inhalation injury is variously reported to be 19% - 84%. [1,2] This is a report of burn patients with inhalation injury managed in Ibadan, Nigeria.

Patients and Methods

Patients who sustained thermal injury and were managed by the Division of Plastic Surgery, Department of Surgery and the Department of Anaesthesia, University College Hospital, Ibadan, Nigeria in the period January 1998 - October 2000 were retrospectively studied. A diagnosis of inhalation injury was made on the clinical basis of stridor, hoarseness, circumoral burn and tachypnoea occurring a few hours after burns. The data was analysed using SPSS-9 for Windows statistical package. Frequency, descriptive and cross tabulations was obtained as well as a binary logistic regression for predicting occurrence of inhalation injury. Level of statistical significance was taken to be $p < 0.05$.

Results

A total of 164 cases were analysed, comprising 109 males and 55 females (M: F = 2: 1). The age range was 0.2 - 80 years (mean 25.0 ±16.9 years). There were 42 children aged ≤10 years (M: F = 4:3). Table 1 is a cross tabulation of age group and aetiology. In children, dry heat was a more important cause of burns than scalds. The mean (S. D) total body surface area (TBSA) burnt was 35.8 % (26.9%). Among those who suffered inhalation injury, mean (S. D) TBSA was 50.4% (25.1%) while in those without inhalation injury, mean (S. D) TBSA was 32.9% (26.4%). Twenty-seven (16%) patients suffered inhalation injury. Twenty-one of these (78%) patients succumbed to the injury. Patients who had no inhalation injury had 28% mortality. The overall mortality was 36%. The LA 50 value (the burn size that is lethal in 50% of all patients injured) was 68% while in those with inhalation injury; the LA 50 was 53%. The binary logistic regression in table 2 shows that of all the variables considered (age, sex,

aetiology and total body surface area), only the TBSA could be used to predict the occurrence of inhalation injury.

Table 1: Age and Aetiology of Burns

Age (Yrs)	Aetiology of Burns					Total (%)
	Scald	Dry Heat	Friction	Electrical	Chemical	
≤10	15	21	4	1	1	42
>10	5	89	22	1	5	122
Total	20	110	26	2	6	164

Table 2: Binary Logistic Regression

Variable	Significance (p-value)
Age	0.439
Sex	0.256
Aetiology	0.498
TBSA Burns	0.004•

Dependent Variable - Inhalation Injury
- Significant p-value

Discussion

The incidence of 16% of inhalation injury is similar to the 2.5% - 21% reported by others.[3] Although our diagnosis of inhalation injury was mainly clinical, and therefore an underestimation, the 16% incidence is still high. In the developed world, the use of fibreoptic bronchoscopy[3] in patients suspected of having inhalation injury has to some extent increased the incidence. The mortality of 78% falls within the range of 19% - 84% reported in literature.[1, 2] Inhalation injury has been the main factor responsible for mortality in thermally injured patients[4] being one of the three implicated factors identified by Merrell et al[5] and Zawacki et al.[6] In a recent report, Nottet et al[2] noted a six-fold increase in mortality from skin burns when there is associated

inhalation injury. In 1990, Sobel et al[7] lamented the little progress in reducing the mortality associated with inhalation injury. This concern is expressed in the background of the significantly improved outcome achieved in non-inhalation burn management facilitated by advances in fluid resuscitation, nutrition and burn wound care. Since then, with the vigorous application of new advances in critical care, modest improvements in outcome of inhalation injury have been reported.[2,8]

The pathophysiologic changes that occur in both the upper and lower airways of patients with inhalation injury with the associated respiratory complications account for the persistent poor outcome. In most cases, damage to the upper and lower airways is the result of chemical injury from the products of combustion, such as ammonia, nitrogen dioxide, sulphur dioxide and chlorine. These irritate and damage the mucosa, and cause oedema and airway obstruction. In the pulmonary area, there is an increase in lymphatic flow and extra vascular water.[8] This is the result of the release of neuropeptides (substance P and calcitonin gene-related peptides) when the irritants in smoke (acrolein, aldehydes, free radicals) stimulate the sensory nerves of the airway. The ultimate sequel to these changes is increased airway resistance, reduced compliance and hypoxaemia in the immediate post burn period.

Approximately 80% of fire-related death results not from burn injury but from inhalation of the toxic products of combustion, [9] including carbon monoxide and cyanide. Carbon monoxide strongly combines with haemoglobin causing impaired oxygen transport, while cyanide paralyses mitochondrial respiration by binding reversibly with cytochrome oxidase to stop oxidative phosphorylation. Thus inhalation of both gases increase tissue hypoxia and acidosis.[10]

A high index of suspicion for inhalation injury is necessary to avoid missed injuries. A history of closed space smoke exposure is common among patients with inhalation injury, as is concurrent cutaneous burn injury. Stridor, hoarseness, facial and circumoral burn and tachypnoea occurring few hours after burn injury are pointers to the diagnosis. Confused or aggressive behaviour may be due to cerebral hypoxia and should not always be attributed to pain. The specificity of the clinical features in a patient with inhalation injury is poor, hence the importance of fibre optic bronchoscopy[11] and intravenous xenon-133 ventilation scanning in establishing diagnosis.
Despite the lack of specific interventions, assiduous supportive care is essential to decreasing morbidity and mortality resulting from the injury and this follows the standard principle of management of trauma and burn patients. First, the patient must be removed from the danger area, rapid assessment made and if necessary, life-support measures instituted. A patent airway must be secured early especially in

upper airway burn when respiratory obstruction may develop rapidly.

In Nigeria, there are no rescue teams and the patients do not receive any form of oxygenation before arriving in hospital. Except for the very mild inhalation injury, most of our patients are moved to the intensive care unit after review by the plastic surgical and anaesthetic registrar where they are intubated to maintain the airway and also administer oxygen. We do not delay because subsequent oedema may prevent intubation. The head of the bed is elevated to 30° to help decrease airway oedema and minimize pressure from abdominal contents, which may limit diaphragmatic excursion. Circumferential full thickness burns of the thorax, when present requires escharotomies. Therapeutic coughing chest physiotherapy and early ambulation are encouraged in the management of these patients. Appropriate and adequate fluid resuscitation is given to avoid hypovolaemic shock, renal failure, and death in the early post burn period. We use the Parkland formula to calculate the amount of fluid to be given; crystalloids such as Ringers Lactate solution and normal saline are administered and adequacy of fluid resuscitation monitored by the urinary output. Inhalation injury increases the fluid resuscitation requirements of patients with burn injury by 40-75% in the first 24 hours. [12] Broad-spectrum prophylactic antibiotics are commenced before transfer to the intensive care unit.

Despite the joint efforts of plastic surgeons, the anaesthetists, physiotherapists and nurses in the management of our patients, we still recorded 78% mortality. This is rather high and can be improved upon. The public should be educated on the need for immediate evacuation of patients from the source of the injury and the immediate transfer to the nearest hospital. Oxygen by facemask or nasal catheter must be given to the patient while on transit to the hospital[13] and while awaiting the insertion of nasotracheal tube. A high index of suspicion and a thorough knowledge of the appropriate management of smoke inhalation victims are essential in assuring a good outcome. Facilities for monitoring blood gasses as well as for ventilatory support should be acquired. Finally, concomitant early skin coverage will ensure reduction of septic complications.

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References

1. Herndon DN, Thompson PB, Linares HA, Traber DL. Postgraduate Course: Respiratory injury. JBCR.1986; 7: 185-190.
2. Nottet JB, Duruisseau O, Herve

S et al. Inhalation burns: apropos of 198 cases. Incidence of laryngotracheal involvement (French). Ann d Oto-Laryngologie et de Chirurgie Cervico-Faciale. 1997; 114: 220-225.
2. Langford RM, Armstrong RF. Algorithm for managing injury from smoke inhalation. Br Med J 1989; 299: 902-905.
3. Herndon DN, Thompson PB, Traber DL, Abslon S. Effect on mortality of inhalation injury. J Trauma 1986; 26: 163-165.
4. Merrell SW, Saffle JR, Sullivan JJ, Larsen CM, Warden GD. Increased survival after major thermal injury: a nine-year review. Am J Surg. 1987; 154: 623-627.
5. Zawacki BE, Azen SP, Imbus SH, Chang YC. Multifactorial probit analysis of mortality in burned patients. Ann Surg 1979; 189: 1-5.
6. Sobel JB, Goldfaib IW, Slates H, Hammel EJ. Inhalation Injury: a decade without progress. J Burn Care Rehabil 1992; 13: 573-575.
7. Rue III LW, Cioffi WG, Mason AO, et al. Improved survival of burned patients with inhalation injury. Arch Surg 1993; 128: 772-780.
8. Birky MM, Clarke FB. Inhalation of toxic products from fires. Bulletin NY Acad Med 1981; 57: 997-1013.
9. Prieu T, Traber OL. Toxic smoke compounds and inhalation injury: a review. Burn Incl Therm Inj. 1988; 14: 451-460.
10. Ager RN, Long JM, Hunt JL, et al. Use of 133Xenon in early diagnosis of inhalation injury. J Trauma 1976; 16: 218-224.
11. Navar PD Saffle JR, Warden GD. Effect of inhalation injury on fluid resuscitation requirement after thermal injury. Am J Surg 1985; 150: 716-720.
12. Grapo RO. Smoke inhalation injuries. JAMA 1981; 246: 1694 – 1696.