Comparative Review of Burns With Inhalation Injury in a Tertiary Hospital in a Developing Country

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Wounds 2016;28(1):1-6

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Disclosure: The authors disclose no financial or other conflicts of interest.

Abstract: *Objective.* Inhalation injury is an acute respiratory tract insult caused by direct thermal injury, carbon monoxide poisoning, or toxic chemical inhalants, such as fumes, gases, and mist. The aim of this study is to review the authors' experiences in a regional burn unit in a developing country. *Methods.* The University College Hospital, Ibadan, Nigeria prospective burn unit database was retrospectively reviewed from January 2001 to December 2013 and analyzed using SPSS software, version 16 (SPSS Inc, Chicago, IL). *Results.* There were 840 patients in all, 63% (527) had cutaneous burns only, while 37% (313) had associated inhalation injury. There was a male preponderance in both groups. Those with cutaneous burns only and those with associated inhalation injury had a male to female ratio of 1.6:1 and 1.5:1, respectively. The mean ages were 26 years ± 18 years (inhalation injury) and 21 years ± 17 years (cutaneous burn only) ($P < 0.05$). The mean total body surface area (TBSA) of the burn injuries was 55% (inhalation injury) and 25% (cutaneous burn only) ($P < 0.05$). Burn injury occurred most frequently between 19.00 hours and 24.00 hours, and 56% of burn injuries that occurred during this time were associated with inhalation injury ($P < 0.05$). Major causes of burns were flames and scalding (86.2%). Mortality was 71% in patients with inhalation and 26% in patients with cutaneous burns only ($P < 0.05$). *Conclusion.* The association of inhalation injury with cutaneous burns portends a grave condition. An upgrade of expertise and infrastructure in the management of these patients is necessary in order to improve outcomes.

Key words: inhalation injury, cutaneous burn

Inhalation injury is an acute respiratory tract insult caused by direct thermal injury, carbon monoxide poisoning, or toxic chemical inhalants, such as fumes, gases, and mist. Inhalation injury usually occurs with cutaneous burns, however it may be seen without a burn injury. The presence of inhalation injury still remains a major cause of morbidity and mortality in patients with major burns.[1] It is one of the 3 most significant predictors of death after thermal injury, along with age and total body surface area (TBSA).[1] This is with the general decrease in mortality

and morbidity in patients with burns as due to improved management of shock and wound sepsis using intensive fluid and nutritional support as well as early wound cover by excision and grafting.[2] The outcomes of the management of patients with major burns in a less developed country tend to be different because of the constraints in the implementation of appropriate care for these patients. There is also a paucity of data in developing countries to assist in appropriate planning for care of patients with burns, especially those with major burns. The aim of this study is to review the authors' experiences in a regional burn unit in a developing country and demonstrate the influence of inhalation injury on the outcome of their patients with major burns.

Methods

The prospective database records of burn patients seen consecutively in the University College Hospital, Ibadan, Nigeria from January 2001 to December 2013 was reviewed retrospectively. The data was then entered into a proforma. The information obtained was analyzed using SPSS version 16 software (SPSS Inc, Chicago, IL). The retrospective study was done in line with the Helsinki declaration both in the collation and analysis of the data. The patients seen in the University College Hospital presented mainly at the emergency department, either pediatric or adult. Resuscitation and initial reviews are done there before admission to the burn unit if the burns occurred within 24 hours of presentation, or to the general wards if the burns occurred more than 24 hours before presentation. Patients with suspected inhalation injury were either admitted to the intensive care unit or the burn unit. The diagnosis of inhalation injury was mainly clinical, employing a patient's history of closed-space smoke exposure or loss of consciousness, or physical findings of hoarseness, facial burns, carbonaceous sputum, and/or singed nasal vibrissae. Other findings such as conjunctivitis, stridor, dyspnea, disorientation, obtundation and coma are also indicative of inhalation injury. Fiber optic bronchoscopy was done occasionally to confirm the diagnosis because of the inability of many patients to access the facilities due to insufficient funds. When fiber-optic bronchoscopy was used, bronchial lavage was done and specimens were taken for culture and sensitivity. The patients with suspected inhalation injury were prophylactically intubated and had humidified 100% oxygen administered to them to maintain $SaO_2 > 90$. Patients also had aerosolized 3 ml of 20% N-acetylcysteine every 4 hours with a bronchodilator such as racemic epinephrine alternated with aerosolized 5,000 units of heparin in 3 ml of normal saline every 4 hours. In addition, these patients had chest physiotherapy. Mechanical ventilation was done for patients whose $SaO_2 < 10$kpa.

Results

There were 840 patients, approximately 63% (527), who had cutaneous burns only, while 37% (313) had associated inhalation injuries (Table 1). There was a male preponderance in both groups, which was not statistically significant ($P = 0.57$). For those with cutaneous burns only and those with associated inhalation injury, the male to female ratio was 1.6:1 and 1.5:1, respectively. The mean ages were 26 years ± 18 years (inhalation injury) and 21 years ± 17 years (cutaneous burns

Table 1. Gender distribution of patients with and without inhalation injury.

	Male	Female	
Inhalation injury	186 (59.6%)	127 (40.4%)	313 (37.3%)
Cutaneous burns	324 (61.5%)	203 (38.5%)	527 (62.7%)
Total	510 (60.8%)	330 (39.2%)	840 (100%)

Table 2. Comparison of age groups and inhalation injury/cutaneous burn.

	Age groups							
	0-9	10-19	20-29	30-39	40-49	50-59	>60	**Total**
Inhalation injury	24.5% (77)	13.1% (41)	24.5% (77)	16.8% (52)	9.1% (28)	6.6% (21)	5.4% (17)	100% (313)
Cutaneous burns	36.4% (192)	11.4% (60)	19% (100)	17.1% (90)	7.9% (42)	4.5% (23)	3.8% (20)	100% (527)
Total	31.9% (268)	12% (100)	21.1% (177)	17% (143)	8.4% (70)	5.3% (45)	4.4% (37)	100% (840)

only) (Table 2). The mean TBSA of the burn injuries was 55% (inhalation injury) and 25% (cutaneous burn only) ($P < 0.05$). Burn injuries occurred most frequently between 19.00 hours and 24.00 hours of the day, 56% of burn injuries during this time were associated with inhalation injury ($P < 0.05$). The most common place of occurrence was the home in both groups. Major causes of burns in patients with inhalation injury were flames (93.7%), contact (1.6%), and chemical (1.3%); major causes for those with cutaneous burns alone were flame (52.7%) and scald (28.3%). Mortality was 71% in patients with inhalation and 26% in patients with cutaneous burns only ($P < 0.05$) (Tables 3, 4). The LA-50 for patients with inhalation injury was 53%, while the LA-50 for patients with cutaneous burns was 64%.

Discussion

Inhalation injury is an acute respiratory tract insult caused by steam or toxic inhalants such as fumes, gases, and mists. Inhalation injury may occur independent of cutaneous burn injuries although they usually occur concurrently. There have been significant improvements in the management of patients with major burns of burn shock and wound sepsis using intensive fluid and nutritional support. The aggressive policy of early excision and grafting has also resulted in a significant decrease in mortality.[2] Incidence of smoke inhalation injury varies from 5%-30% of patients hospitalized with thermal injuries,[3] with an incidence of 46.3% reported in Egypt.[4]

This picture of burn management, however, is not the same in many developing countries because of the limited resources in the care of major burns. The presence of inhalation injury further compounds the problems of the care of major burns. Inhalation injury remains a major cause of morbidity and mortality of patients with major burns.[1] Reported mortality rate among patients with inhalation injury was 41.5% compared with 7.2% among patients without inhalation injury.[4] In a study in the authors' center that was published in 2001, there was inhalation injury in 16% of 164 burn patients who were treated at the University College Hospital in Ibadan, Nigeria, and the mortality rate was 78%.[5] In this 13-year review of 840 burn patients managed in the same institution, 37% had inhalation injury and the mortality was 71%. This suggests the incidence of inhalation injury has almost doubled, while mortality remained largely the same. It also suggests patients are presenting with more severe burn injuries, in relation to inhalation injury, than in the past. This review also shows 2 peaks in the number of patients with inhalation injuries in 2003 and 2012. These occurred in 2003 when a group of traders who were illegally transporting petrol were involved in an automobile accident and were trapped in the burning vehicle. The incident involved 28 people. The second peak occurred in 2012 when some primary school pupils were trapped in a school bus that caught on fire. Nineteen children were involved (Figure 1). The LA-50 for patients with inhalation injury was 53%, while for those with cutaneous burns only was 64%.

Mortality from smoke inhalation alone is low (0%-11%), the combination of cutaneous burns and inhalation injury is fatal in 30%-90% of patients (Figure 2). The presence of inhalation injury increases burn mortality by 20% and inhalation injury further predisposes the

Table 3. Etiology and inhalation injury.

	Flames	Scald	Contact	Chemical	Electric	Miscellaneous	Total
Inhalation injury	93.7% (293)	0.9% (3)	1.6% (5)	1.3% (4)	-	2.5% (8)	100% (313)
Cutaneous burns	52.7% (278)	28.3% (149)	7.3% (38)	3.1% (16)	6.4% (34)	2.2% (12)	100% (527)
Total	68% (571)	18.2% (152)	5.1% (43)	2.3% (20)	4.1% (34)	2.3% (20)	100% (840)

Table 4. Total burn surface area and inhalation injury.

	% Total body surface area				
	0-14%	15-29%	30-59%	60+%	Total
Inhalation injury	2.9% (9)	16.9% (53)	44.8% (140)	35.5% (111)	313
Cutaneous burns	29.1% (153)	32% (169)	35% (184)	3.9% (21)	527
Total	19.2% (162)	26.2% (222)	38.7% (324)	15.9% (132)	840

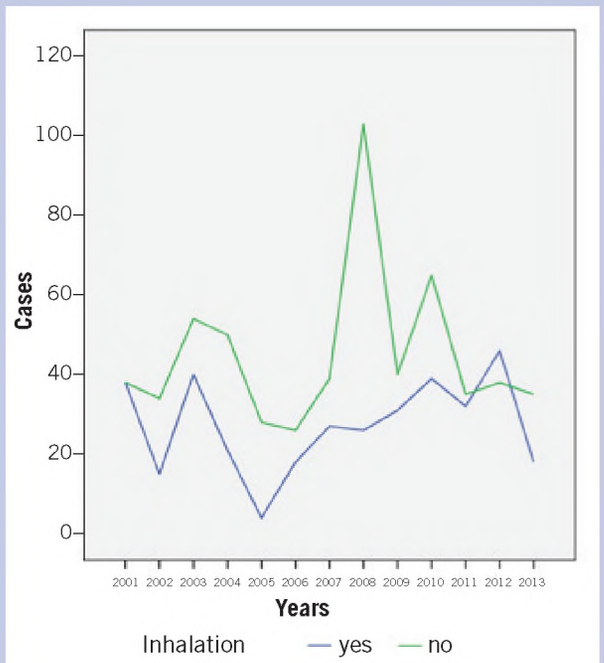

Figure 1. Comparison of patients with and without inhalation injury during the study period.

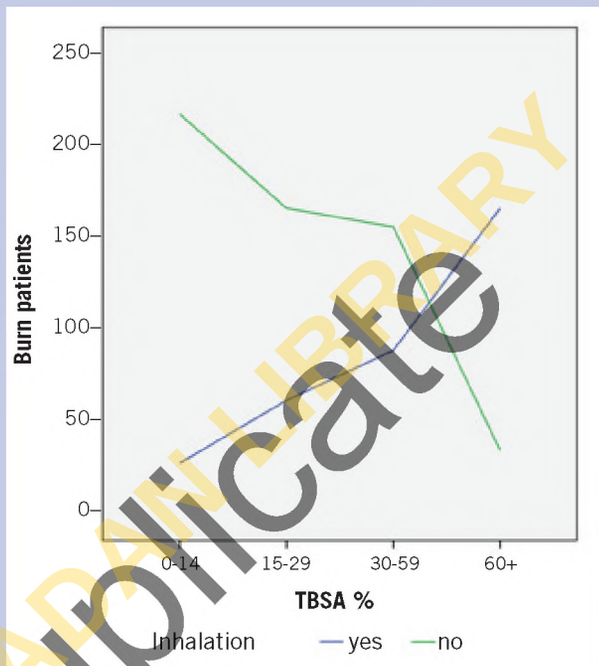

Figure 2. Total body surface area and inhalation injury. TBSA: total body surface area

patient to pneumonia. Pneumonia independently increases burn mortality by 40%, and the combination of inhalation injury and pneumonia leads to a 60% increase in death.[6] The LA-50 figures in this study are due to a combination of factors, such as large surface area burns, flame burns resulting in inhalation injury, and a lack of resources including an inadequate physical building, appropriate personnel, treatment materials for management of major burns, and a poorly funded health care system.

The policy for patients with inhalation injuries at the authors' center is to prophylactically intubate rather than watch and wait. Diagnoses are made based on clinical evidence due to the high cost of confirmatory investigations and availability of equipment for diagnosis and investigation. This may result in an over diagnosis of inhalation injuries, but the authors prefer to be overly cautious in these cases than to wait for ill effects to present themselves, at which point it may be too late to properly treat the patient.

Indication for endotracheal intubation in burn patients with inhalation injuries fall into 3 broad categories[7] which include altered mental status, imminent threat of acute airway obstruction, and respiratory failure in spite of maximum noninvasive supportive therapy. Acute airway obstruction may result from proximal airway edema which will result in a situation that may quickly evolve to the requirement of a surgical airway or an airway that is unsalvageable. Rather than waiting until severe obstruction occurs, the most experienced available manager of airways onsite should perform a semi-urgent intubation.[6] Benefits of endotracheal intubation include protection of the airway against acute airway obstruction, facilitation of airway toileting, and oxygen delivery to reverse carbon monoxide and cyanide inhalation effects. Though the rate of pulmonary injury is higher with intubation, this complication is certainly preferable to death, which can follow sudden acute airway obstruction.[7] In this review, the patients with inhalation injuries tended to have burns covering a larger surface area, a mean of 55% compared to 25% with cutaneous burns only. It was also significant that flame burns were significantly more often the cause of inhalation injury than other causes. Based on the authors' clinical experience, flame burns occur from mishandling of petrochemicals such as refueling a lit kerosene lantern or a lit kerosene stove, refueling a generator without turning it off, and bringing an open flame too close to stored petrochemicals. In this review, inhalation injuries were also observed in rare

cases of scald, with the cause of the injury usually being facial scald from the steam of an automobile's radiator following a road traffic accident. There was also documented evidence of inhalation in chemical burns from assault in which chemicals were splashed on the patient's face. Contact burns occurred when patients fell face down on a hot object such as burning coal. The highest cases of inhalation injury occurred at night, following increased use of petrochemical energy sources after power outages and, therefore, patients were asleep in an enclosed enivroment at the onset of the fire.

The results of this study underscore the need for early diagnosis of inhalation injuries and prevention or treatment of associated life-threatening complications. It is also important to recognize that the morbidity and mortality associated with inhalation injuries can be reduced with a well-organized, protocol-driven approach to the respiratory management of burn care.[6]

The authors' experience in their treatment center is, however, not the absence of a protocol for the respiratory management of patients but the inability to implement the protocol due to resource constraints. These include patient-centered concerns such as financial constraints and social issues; hospital system inadequacies such as a lack of availability of instruments for respiratory management such as bronchoscopes, monitors, and ventilators; and the clinical presentation of burn patients due to inadequate burn preventive measures in Nigeria (Figure 3). The payment for health services in the authors' clinical setting is largely out-of-pocket, which is grossly inadequate bearing in mind the huge expenses for appropriate management of patients with burn injuries and the usual associated damages to property and life that may have occurred during the incident. The earner of the family may have been injured in the fire, or property damaged that could have been sold to pay for the patient's care. The inadequacies in the hospital system, which can be mostly blamed on budgetary contraints, manifest in lack of respiratory equipment such as bronchoscopes, monitors, and ventilators. When the equipment is available, it is not accessible because of a lack of funds (ie, payment for equipment must be made prior to use, and some patients cannot afford this) and a high demand on limited resources. Most major burn centers regard the fiber-optic bronchoscope as the current standard for diagnosis of inhalation injury.[8] Inhalation injuries are a dynamic condition[9] and the more severe the injury, the more frequently fiber-optic bronchoscopy may be necessary.[10] In the authors' experience, fiber-optic bronchoscopy is rarely done because of the bureaucracy of accessing the equipment from the hospital because of hospital policy, and the inability of patients to afford the service.

Figure 3. Photo of the burn unit.

There is also the challenge of keeping the burn unit staff up-to-date with the management of patients with inhalation injuries and major burns while there is frequent turnover of staff. An essential component of a burn center's multidisciplinary approach is the presence of an on-site, dedicated respiratory therapy team.[10] Frequent rotation of nursing staff and residents to other sections of the hospital prevents the consistent availability of such a team, as retraining has to be constantly done to maintain a standard of care.

The clinical presentation of the patients as can be observed from this review is, of patients with large surface area burns and inhalation injuries, the inadequacy of passive and active burn prevention measures in the authors' city is evident with the doubling in the ratio of patients with inhalation injuries seen in the same institution.

These patients with inhalation injuries tend to present with large surface area burns. These burns tend to occur in the night and are caused by the use of petrochemical products because there are incessant power outages in Ibadan. The patient-centered concerns, hospital system constraints, and the patients' clinical presentations are major factors that have left the mortality rate in patients with inhalation injuries very high and largely unchanged.

Conclusion

The association of inhalation injury with cutaneous burns portends a grave condition. Developing countries face specific challenges to providing appropriate care to patients with burn injuries, such as patient-centered concerns, inefficient hospital service delivery, and patients' clinical presentations with severe injury largely due to inadequate burn prevention measures in the community. Addressing these challenges and an upgrade of expertise and infrastructure in the care management of these patients is necessary to improve patient outcomes.

References

1. Hassan Z, Wong JK, Bush J, Bayat A, Dunn KW. Assessing the severity of inhalation injuries in adults. *Burns*. 2010;36(2):212-216.
2. Oluwatosin OM. Overview of Inhalation injury. In: Iyun AO, ed. Advanced Airway Support For Patients With Inhalation Injury. 1st ed. Ibadan, Nigeria: OmniCraft Enterprises; 2011:2-8.
3. Chan KY, Hairol O, Imtiaz H, et al. A review of burns patients admitted to the Burns Unit of Hospital Universiti Kebangsaan Malaysia. *Med J Malaysia*. 2002;57(4):418-425.
4. El-Helbawy RH, Ghareeb FM. Inhalation injury as a prognostic factor for mortality in burn patients. *Ann Burns Fire Disasters*. 2011;24(2):82-88.
5. Adigun IO, Oluwatosin OM, Amanor-Boadu SD, Oluwole OA. Inhalation injury in burns patients in Ibadan. *Nigerian J Surgical Research*. 2001;3(2):50-55.
6. Mlcak RP, Suman OE, Herndon DN. Respiratory management of inhalation injury. *Burns*. 2007;33(1):2-13.
7. Cochran A. Inhalation injury and endotracheal intubation. *J Burn Care Res*. 2009;30(1):190-195.
8. Yeung JK, Leung LT, Papp A. A survey of current practices in the diagnosis of and interventions for inhalational injuries in Canadian burn centres. *Can J Plast Surg*. 2013;21(4):221-225.
9. Cancio LC. Current concepts in the pathophysiology and treatment of inhalation injury. *Trauma*. 2005;7(1):19-35.
10. Cancio LC, Batchinsky AI, Park MS, et al Inhalation injury: pathophysiology and clinical care proceedings of a symposium conducted at the Trauma Institute of San Antonio, San Antonio, TX, USA on 28 March 2006. *Burns*. 2007;33(6): 681-692.