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ORIGINAL

Does inhalation injury increase the mortality rate in burn patients? Investigation of relationship between inhalation injury and severity of burn surface

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ABSTRACT

Objective. Inhalation injury accounts for 20% to 80% of deaths in burn patients due to severe cardiopulmonary distress not seen in cutaneous injury alone. However, there are few comparative studies or retrospective analyses of the injury severity or deaths of patients with inhalation injury.

Methods. We evaluated 59 patients (31 with inhalation injury and 27 without inhalation injury) who had sustained a severe burn injury and were treated in the intensive care unit at our medical center from 2004 through 2006. Of the 31 patients with inhalation injury, 14 (45.2%) died, and of the 27 without inhalation injury, 4 (16.7%) died.

Results. We investigated specific aspects of the severity and mortality of burn patients. The median (mean) burn index in patients without and with inhalation injury were 45 and 50 points (17.9 and 34.4), and the median (mean) prognostic burn index scores between patients with and without inhalation injury were 88.5 and 55.5 points (86.8 and 69.4). The median (mean) prognostic burn index scores in surviving patients with and without inhalation injury were 49.5 and 67 points (60.0 and 70.0), which suggest that patients with inhalation injury sustained significantly more severe cutaneous burns than did patients without inhalation injury.

Conclusions. We conclude that inhalation injury alone may be fatal, but many patients with inhalation injury also sustain more severe cutaneous burns, which can further increase the mortality rate.

Key words: inhalation injury, burn, burn index, mortality, prognostic burn index

Introduction

The mortality rate in patients with burn injuries is affected as much by the presence of inhalation injury as by burn area or age. (1-3) Many investigators have reported that inhalation injuries are associated with a high mortality rate, because they cause cardiopulmonary distress not seen in patients with cutaneous injury alone. (3-7) However, there have been few comparative studies or retrospective analyses of the severity of burns or deaths of patients with inhalation injury. This retrospective study aimed to examine the epidemiological characteristics and tendencies of inhalation injury and to evaluate the risk of death in patients with inhalation injuries though analysis of the burn index (BI= body surface area [BSA] of deep burn + BSA of dermal burn × 1/2) and the prognostic burn index (PBI= BSA of deep burn + BSA of dermal burn × 1/2 + patient age).

Patients and methods

Fifty-nine patients who had sustained a severe burn injury and were treated in the intensive care unit (ICU) at our medical center from 2004 through 2006 were evaluated in this study. Of these patients, 31 with inhalation injuries and 27 without inhalation injuries were eligible for this retrospective study (the presence of inhalation injury in 1 patient was unclear). All inhalation injuries were diagnosed by immediate bronchoscopic examination revealing bronchomucosal abnormalities, including a large amount of soot, mucous exudates, and edema. (1) Patients with inhalation injury ranged in age from 15 to 92 years (mean age, 57.4 ± 20.3 years), and patients without inhalation injury ranged in age from 3

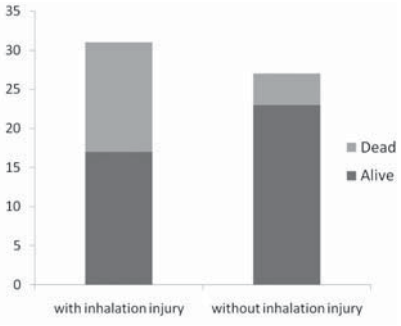

Figure 1. Inhalation injuries and deaths of patients treated in our intensive care unit (n=59).

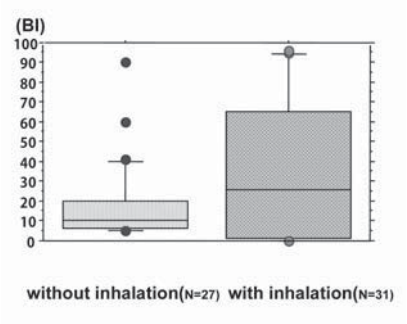

Figure 3. Differences in BI (burn index) between patients with or without inhalation injury who were treated in our ICU (n=58).

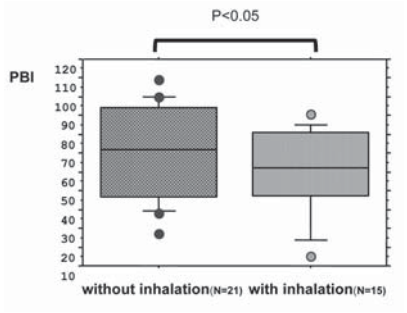

Figure 5. Differences in PBI (prognostic burn index) between patients with or without inhalation injury who survived (n=36).

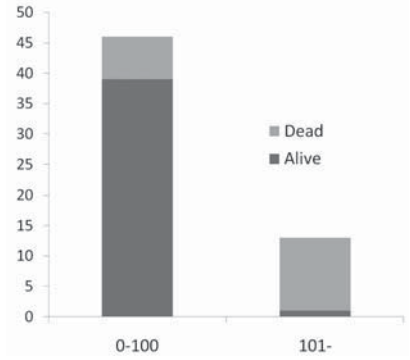

Figure 2. PBI (prognostic burn index) and mortality rate of patients treated in our ICU (n=59).

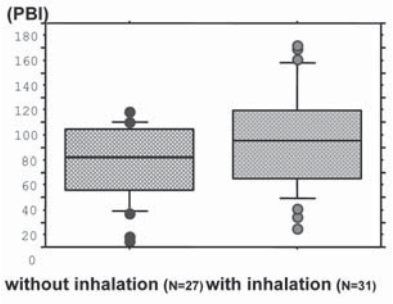

Figure 4. Differences in PBI (prognostic burn index) between patients with or without inhalation injury who were treated in our ICU (n=58).

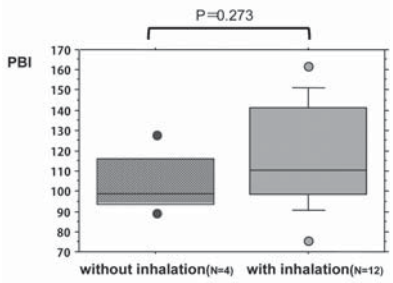

Figure 6. Differences in PBI (prognostic burn index) between patients with or without inhalation injury who died (n=16).

months to 102 years (mean age, 57.8 ± 32.4 years) (no significant difference, Wilcoxon signed rank test).

We investigated several aspects of the severity and mortality rate of burn patients including 1) differences in the BI and PBI scores in all patients with or without inhalation injury; 2) PBI differences between patients with or without inhalation injury who survived; 3) PBI differences between patients with or without inhalation injury in patients who died.

Results

Of the 31 patients with inhalation injury, 14 (45.2%) died, and of the 27 without inhalation injury, 4 (16.7%) died (figure 1). Patients with inhalation injury were more likely to have a fatal outcome than those without inhalation injury, however, the difference was not statistically significant ($p=0.09$, Chi-square test). Most burn injuries were caused by fire (71.1%) or hot liquids (18.6%). Burn injuries were also caused by explosion 3.4%, steam 3.4% and electricity 1.7%. The PBI scores and deaths are shown in figure 2. There were significant differences in mortality between the group with a PBI score is less than 100 points, and those with a PBI score greater than 101 points ($p<0.001$, Chi-square test). It was difficult to save the lives of patients with a PBI score of more than 101 points.

The ranges of PBI scores in patients who survived and died were 5 to 109 points (median 57) and 72 to 162 points (median 117). There was a significant difference between the groups (p 0.001, Wilcoxon rank sum test).

(1) PBI differences in patients with or without inhalation injury (figure 3): The ranges of BI scores in patients with and without inhalation injury were 0 to 90 points (median 45) and 5 to 95 points (median 50). There was a significant difference between the groups ($p<0.05$, Willcoxon rank sum test). PBI differences in patients with or without inhalation injury (figure 4). The ranges of PBI scores in patients with or without inhalation injury were 15 to 162 points (median 88.5) and 5 to 110 points (median 55.5). There was a significant difference between the groups ($p<0.05$, Willcoxon rank sum test).

(2) PBI differences in surviving patients with or without inhalation injury (figure 5): The ranges of PBI scores in patients with and without inhalation injury were 5 to 94 points (median 49.5) and 25 to 109 points (median 67). There was a significant difference between the groups ($p<0.05$, Wilcoxon rank sum test).

(3) PBI differences in patients who died with or without inhalation injury (figure 6): The ranges of PBI scores in patients with or without inhalation injury were 73 to 162 points (median 67) and 88 to 129 points (median 67). There was no significant difference between the groups ($p=0.27$, Wilcoxon rank sum test).

Discussion

Many investigators have reported that inhalation injuries are associated with high mortality rates. (1-6) Rue et al. studied 330 patients with inhalation injuries and concluded that they had a higher mortality rate (29.4%) than did patients without inhalation injury. (8) Klosova et al. performed a retrospective analysis of 67 elderly patients with burns and found that only 6% of patients had inhalation injuries; however patients with inhalation injuries had a high mortality rate of 75%. (6) Our study showed that patients with inhalation injuries have a mortality rate three times that of patients without inhalation injury. Reasons for the increased mortality rate of patients with inhalation injury have been examined with pathophysiological studies. Acute responses to inhalation injury cause a release of inflammatory mediators, the effects of which are not limited to the lung and bronchus but also affect systemic vascular resistance. (1) Furthermore, intravascular volume deficiency, which frequently leads to decreases in cardiac output and stroke volume, occurs due to increased permeability of the capillary bed and substantial interstitial fluid accumulation. This hypovolemic condition requires excessive fluid resuscitation, which could cause an overload of cardiopulmonary function during the refilling phase. Our study supports these findings. The PBI score for surviving patients with inhalation injuries was 10 points lower than that for surviving patients without inhalation injuries, indicating that inhalation injuries could cause death with less-severe cutaneous burns (figure 5). That is to say, inhalation injuries are likely to cause a patient's condition to weaken and to result in an increased mortality rate.

However, this assumption may not take into account the severity of cutaneous burns; patients with inhalation injury may also receive more severe cutaneous burns. Usually, inhalation injuries occur as a complication of flame burns, which will also cause severe and deep burns to large cutaneous areas. Our study revealed that patients with inhalation injury were likely to have more severe cutaneous burns, reflected by both BI and PBI scores (figures 3 and 4). On the other hand, patients with inhalation injury with died tended to have higher PBI scores than did patients without inhalation injury, although, the difference was not significant (figure 6). This result also suggests that patients with inhalation injury will have burns to a larger area of the body surface. This could be another reason for the increased mortality rate of patients with inhalation injury.

Conclusion

We conclude that inhalation injuries alone may increase the mortality rate, but many patients with inhalation injury are also likely to sustain more severe cutaneous burns, which can also cause death.

REFERENCES

1. Latenser BA, Iteld L. Smoke inhalation injury. Semin Respir Crit Care Med 2001;22:13-22.
2. Shin SD, Suh GJ, Sung J, Kim J. Epidemiologic characteristics of death by burn injury from 1991 to 2001 in Korea. Burns 2004;30:820-8.
3. Wang Y, Tang HT, Xia ZF, Zhu SH, Ma B, Wei W, et al. Factors affecting survival in adult patients with massive burns. Burns 2009 May 30. [Epub ahead of print]
4. Belgian Outcome in Burn Injury Study Group. Development and validation of a model for prediction of mortality in patients with acute burn injury. Br J Surg 2009 Jan;96(1):111-7.
5. Quinn DA, Moufarrej R, Volokhov A, Syrkina O, Hales CA. Combined smoke inhalation and scald burn in the rat. J Burn Care Rehabil 2003;24:208-16.
6. Klosova H, Tymonova J, Adamkova M. Burn injury in senior citizens over 75 years of age. Acta Chir Plast 2005;47:21-3.
7. Fujioka M, Tasaki I, Isihara Hiroshi M, Houbara S, Sasaki E. A case of severe smoke inhalation injury without cutaneous burn required massive fluid for resuscitation. Burns 2007;11:670-1.
8. Rue LW 3rd, Cioffi WG, Mason AD, McManus WF, Pruitt BA Jr. Improved survival of burned patients with inhalation injury. Arch Surg 1993;128:772-8.