Introduction

Inhalation burn injury (IBI) is a significant risk factor for in-hospital mortality of burn patients.\(^1\)\(^2\) Bronchoscopy is one of the main methods used for the specific diagnosis of IBI. Because it is difficult to diagnose IBI without a bronchoscope, especially in prehospital settings, the suspicion of IBI is generally based on factors common to burns in a closed space. These include cutaneous burns around the face, singed nasal hair, stridor and hoarseness.

IBI is also commonly associated with carbon monoxide (CO) inhalation. However, there are insufficient prehospitalization factors for predicting CO inhalation. Because patients with CO inhalation usually require additional therapy (e.g., hyperbaric oxygen therapy or intubation with 100% oxygen therapy), it would be useful to be able to predict CO inhalation before hospitalization.

In general, the injury type in blunt trauma patients is associated with the cause of injury. Therefore, there may be an association between the type of burn injury and the underlying cause of heat injury. In the present study, we tried to identify factors taken from fire site information that might predict IBI in facial burn patients.

Methods

Study design

This single-centre study involved retrospective collection and analysis of medical records. The study was approved by the Institutional Review Board of the National Hospital Organization Kumamoto Medical Centre (Kumamoto City, Japan).

Patients

We retrieved the medical records of burn patients admitted to the National Hospital Organization Kumamoto Medical Centre between January 2013 and December 2016. The clas-
Fig. 1 - Classification of patients in this study. Of 107 burn patients admitted between 2013 and 2016, 27 had facial burns and 13 were diagnosed with inhalation burn injury by bronchoscopy. IBI = inhalation burn injury.

sification of burn patients is shown in Fig. 1. Of 107 patients with burns, IBI was suspected in 27. These patients were suspected of having IBI in the prehospital setting because the ambulance staff noted burns around the face (e.g. facial skin and hair). The other 80 patients were not suspected of having IBI.

IBI was subsequently diagnosed at admission by bronchoscopy performed via an endotracheal tube or the nasal cavity. The 27 patients with suspected IBI were divided into two groups (IBI, n = 13; non-IBI, n = 14) based on the bronchoscopy findings.

CO inhalation was evaluated by measuring arterial blood gases on admission. Patients with carboxyhemoglobin (COHb) ≥10% were suspected of having CO inhalation poisoning and were treated accordingly.

Patient data was collected from medical records: this comprised age, sex, total burn surface area (TBSA), COHb, hospital survival, and fire site information (domestic fire, outdoor fire, clothing fire and explosion).

Statistical analysis
Statistical analyses were performed using SPSS software version 23.0 (IBM, Armonk, NY, USA). The IBI and non-IBI groups were compared using the Mann–Whitney U test or the χ² test, as appropriate. All statistical analyses were considered significant at P < 0.05.

Results
The characteristics of the IBI and non-IBI groups are shown in Table I. There were 27 patients, 13 in the IBI group and 14 in the non-IBI group. The median age (65 vs. 53 years), proportion of males (77% vs. 57%), median TBSA (10% vs. 9%), and median COHb (3.0% vs. 2.2%) were not significantly different between the IBI and non-IBI groups. Hospital survival was not significantly different between the IBI and non-IBI groups (77% vs. 86%). Table I also shows the comparison of fire site information between the IBI and non-IBI groups. The proportion of domestic fires was significantly greater in the IBI group than in the non-IBI group, whereas other causes of burns were similar in both groups. One patient in the IBI group who experienced a domestic fire had a COHb level of >10% (the patient’s COHb level was 23.5%).

Fire site information for the IBI group showed that 69% (9/13) were domestic fires, including clothing fires (15%, 2/13), and an outdoor fire and explosion (8%, 1/13).

Discussion
Although the overall mortality rate of burn patients is improving with modern therapies, the current study showed that IBI has an impact on mortality. Sheppard et al. developed a prognostic scoring system for burns and reported that IBI increased the mortality rate by 10%–20% in moderate to severe cases. Shannon et al. reported that the presence of IBI increased mortality to 27.6%, from 13.9% in patients without IBI, based on a review of IBI studies. Moreover, multivariable analysis showed that IBI was one of the strongest risk factors for mortality.

Even though IBI is a significant risk factor for burn mortality, the current diagnostic tools are not sufficient for identifying all patients with IBI, especially in prehospital settings. Therefore, in this study, we assessed fire site information for the prediction of IBI. We found that patients burned in a domestic fire presenting with signs of facial burns have a significantly greater risk of IBI (69%), and one patient with IBI had elevated COHb after a domestic fire. These results suggest that a fire in an enclosed space (e.g., domestic fire) is an important risk factor for IBI.

Costa Santos et al. performed a retrospective study of a tertiary burn unit, in which 136 facial burn patients were treated over a period of 4.5 years. A total of 52 patients underwent tracheal intubation, but lesions indicative of IBI were found by bronchoscopy in only 12 patients (23%). These findings suggest that the presence of facial burns alone is not a strong predictor of IBI. The combination of these findings and fire site information might improve our ability to predict IBI in prehospital settings. However, our data did not justify prehospital tracheal intubation, although it did indicate that bronchoscopy should be an utmost priority for patients presenting with facial burns following a domestic fire, as soon as they are admitted to the emergency department.

Table I - Patient characteristics and fire site information

<table>
<thead>
<tr>
<th>Variable</th>
<th>IBI group (n = 13)</th>
<th>Non-IBI group (n = 14)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>65 (45–76)</td>
<td>53 (44–68)</td>
<td>0.185</td>
</tr>
<tr>
<td>Male</td>
<td>10 (77%)</td>
<td>8 (57%)</td>
<td>0.276</td>
</tr>
<tr>
<td>TBSA (%)</td>
<td>10 (3.5–32.5)</td>
<td>9 (3.5–31.3)</td>
<td>0.793</td>
</tr>
<tr>
<td>COHb (%)</td>
<td>3.0 (1.8–5.6)</td>
<td>2.2 (1.1–3.5)</td>
<td>0.302</td>
</tr>
<tr>
<td>COHb &gt; 10%</td>
<td>1 (8%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Hospital survival rate</td>
<td>10 (77%)</td>
<td>12 (86%)</td>
<td>0.557</td>
</tr>
<tr>
<td>Domestic fire</td>
<td>9 (69%)</td>
<td>4 (29%)</td>
<td>0.035</td>
</tr>
<tr>
<td>Outdoor fire</td>
<td>1 (8%)</td>
<td>3 (21%)</td>
<td>0.315</td>
</tr>
<tr>
<td>Clothing fire</td>
<td>2 (15%)</td>
<td>2 (14%)</td>
<td>0.936</td>
</tr>
<tr>
<td>Explosion</td>
<td>1 (8%)</td>
<td>5 (36%)</td>
<td>0.080</td>
</tr>
</tbody>
</table>

Results are presented as the median (range) or n (%) of patients. IBI = inhalation burn injury; TBSA = total burn surface area; COHb = carboxyhemoglobin.
Our study has some limitations. First, it was retrospective and performed at a single centre, so the sample size is not big enough for some statistical analyses (such as multivariate analysis). Second, because the median TBSA was 10% and the hospital survival rate was 81%, few of the patients in our study had severe facial burns. Third, COHb was measured on admission, not at the fire site, and may have improved with oxygenation therapy in the ambulance.

Conclusion

In conclusion, the results of this retrospective study suggest that a domestic fire is a remarkable predictor of IBI in facial burn patients. In other words, fire in an enclosed space might be an important factor for prospectively identifying patients with IBI before admission to hospital. Further studies are needed to confirm our results.

BIBLIOGRAPHY


Competing interests. The authors have no conflict of interest to declare.