# Positive Signs on Physical Examination Are Not Always Indications for Endotracheal Tube Intubation in Patients with Facial Burn

**Ruo-Yi Huang**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Szu-Jen Chen**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Yen-Chang Hsiao**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Ling-Wei Kuo**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Chien-Hung Liao**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Chi-Hsun Hsieh**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Francesco Bajani**
Chang Gung Memorial Hospital Linkou Main Branch: Chang Gung Memorial Hospital
**Chih-Yuan Fu** ( drfu5564@gmail.com )
Chang Gung University

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# Abstract

### Background

After clinical evaluation in the emergency department (ED), facial burn patients are usually intubated to protect their airways. However, the possibility of unnecessary intubation or delayed intubation after admission exists. Objective criteria for the evaluation of inhalation injury and the need for airway protection in facial burn patients are needed.

### Methods

Facial burn patients between January 2013 and May 2016 were reviewed. Patients who were and were not intubated in the ED were compared. All intubated patients received routine bronchoscopy to evaluate whether they had inhalation injuries. Patients with and without confirmed inhalation injuries were compared. Multivariate logistic regression analysis was used to identify the independent risk factors for inhalation injuries in facial burn patients. The reasons for intubation in patients without inhalation injuries were also investigated.

### Results

During the study period, 121 patients were intubated in the ED among a total of 335 facial burn patients. Only 73 (60.3%) patients were later confirmed to have inhalation injuries on bronchoscopy. The comparison between patients with and without inhalation injuries showed that shortness of breath (odds ratio=3.376, $p$=0.027) and high total body surface area (TBSA) (odds ratio=1.038, $p$=0.001) were independent risk factors for inhalation injury. Other physical signs (e.g., hoarseness, burned nostril hair, etc.), laboratory examinations and chest X-ray findings were not predictive of inhalation injury in facial burn patients. All patients with a TBSA over 60% were intubated in the ED even if they did not have inhalation injuries.

### Conclusion

In the management of facial burn patients, positive signs on conventional physical examinations may not always be predictive of inhalation injury and the need for endotracheal tube intubation in the ED. More attention should be paid to facial burn patients with shortness of breath and a high TBSA because they have an increased risk of inhalation injuries. Airway protection is needed in facial burn patients without inhalation injuries because of their associated injuries and treatment.


# Introduction

Inhalation injury is as a major cause of morbidity and mortality in patients with burn injury. [1] The immediately life-threatening consequence of inhalation injury is upper airway edema and further obstruction. It can be heralded by hoarseness, retraction, and stridor. [2] According to the current guidelines and treatment principles, endotracheal tube intubation is usually recommended in facial burn

patients for the prevention of inhalation injury-related airway obstruction. [3] Patients with specific burn sites or specific findings on physical examinations, such as burned nasal hairs or carbonaceous debris in the mouth or sputum, need early airway protection. In addition, intubation decisions in the emergency department (ED) for burn patients are made based on the type or site of burn. [4]

Practically, patients with positive findings on physical examination, which may indicate the need for airway protection, are not always intubated. [5] They may have signs of dyspnea or evidence of airway obstruction. On the other hand, some patients meet the current intubation criteria and undergo intubation in the ED; however, subsequent examinations confirm the absence of airway damage. These patients are soon extubated because there is no further need for airway protection. In other words, the diagnosis of inhalation injury remains a clinical judgment based on subjective evaluations. The probability of overresuscitation for airway injury exists in the management of burn patients. It is important to develop an objective evaluation rather than relying on subjective “clinical judgment” to determine the need for airway protection in burn patients. Burn patients who need airway protection should be identified in the ED on the basis of clearer and more precise criteria. Such criteria would allow the avoidance of unnecessary intubation.

In the current study, the characteristics of burn patients with inhalation injuries were studied. The role of conventional physical examinations in the decision regarding the need for airway protection was evaluated. We hypothesized that there are specific signs that can be evaluated in the ED to determine which burn patients need airway protection. With more precise intubation criteria, unnecessary intubation could be avoided, and delayed treatment could be minimized.

# Materials And Methods

Burn patients who presented at our ED were retrospectively reviewed in our trauma registry and medical records from January 2013 to June 2016. Patients with facial burns (International Classification of Diseases-9: 940.xx and 941.xx) were studied. Inhalation injury was suspected in patients with positive signs on physical examination (coughing, hoarseness, sore throat, shortness of breath or burn marks on nostril hairs, eyebrows, eyelids and hair), poor $PaO_2$ or $SaO_2$ on arterial blood gas (ABG) analysis or positive findings on chest X-ray (CXR). Endotracheal tube intubation to ensure early airway protection was performed in these patients based on the clinical judgment of the ED physicians. The exclusion criteria of the current study included age < 16 years, patients without facial burns or patients who arrived at our ED more than 72 hours after the burn injury.

Our institution serves as a level I trauma center with 24/7 trauma surgeon and burn surgeon availability. Burn patients received timely and comprehensive evaluations and treatment in our ED and burn center (ten beds for intensive care and ten beds in the general ward). All burn patients sent to our ED were managed according to a protocol based on the Advanced Trauma Life Support (ATLS) guidelines. [6] After admission, bronchoscopy was routinely performed to obtain a definitive diagnosis of inhalation injury. The severity of inhalation injury was evaluated per the abbreviated injury scale based on the

bronchoscopy findings. (Supplementary Table). [7] Grade 0 indicates no inhalation injury, and grades 1 to 4 indicate inhalation injuries ranging from minor to severe, respectively. In the current study, general demographics (age, sex, type of burns), vital signs, Glasgow coma scale (GCS) scores, laboratory examinations (arterial blood gas analysis and HbCO) and physical examination findings in the ED were recorded and analyzed. The total body area surface (TBSA) estimation and burn degree were obtained from the initial assessment by the specialist burn surgery team. The revised trauma score (RTS) was calculated to evaluate the condition of the trauma patients upon arrival at the ED. [8]

First, patients who were and were not intubated were compared. Second, patients with and without definitive inhalation injury, as confirmed on subsequent bronchoscopy, were compared. Then, statistically significant variables in the bivariate analysis were included in a multivariate logistic regression (MLR) model. Independent risk factors and the associated odds ratios for inhalation injury in facial burn patients were analyzed. Third, patients who received delayed intubation after admission were studied in detail.

Statistical analysis was performed with Excel and SPSS™ (Statistical Package for the Social Sciences, Chicago, IL, USA). The numerical data are presented as the means ± standard deviations, and the nominal data are presented as numbers with percentages. Bivariate analyses were performed using Student's t test and the chi-square test. A value of $p < 0.05$ was considered statistically significant. In the MLR model, a confidence interval (CI) not including or crossing 1.000 was considered statistically significant.

# Results

The patient distribution and study protocol of the current study are shown in Fig. 1. This retrospective study took place from January 2013 to June 2016 (42 months) and included an initial total of 1,004 burn patients, 335 of whom ultimately fulfilled the inclusion criteria. The mean age of the patients was 40.9 years, and 258 (77.0%) were male. The mean TBSA of these patients was 16.0%. The mean length of stay in the intensive care unit was 18.2 days, and the mean hospitalization duration was 20.3 days.

There were 121 patients (36.1%, 121/335) who underwent endotracheal tube intubation in the ED. Seventy-three of those patients (60.3%, 73/121) had inhalation injuries that were confirmed on bronchoscopy after admission, whereas 39.7% of the intubated patients did not have inhalation injuries. Among the patients who were not intubated in the ED, 10 (4.7%, 10/214) patients underwent delayed intubation after admission. Only two of them had inhalation injuries. In patients without inhalation injuries who underwent intubation in the ED (N = 48), the endotracheal tubes were retained for longer than three days in 33 patients.

Table 1 compares the patients who were and were not intubated in the ED. Patients who were intubated in the ED had a significantly higher proportion of flame burns (77.7% vs. 46.7%, $p < 0.001$), lower GCSs (13.8 vs. 14.7, $p < 0.001$), higher TBSAs (27.9% vs. 9.8%, $p < 0.001$) and lower RTSs (7.6 vs. 7.8, $p < 0.001$) than patients who were not intubated. In addition, the group of intubated patients had significantly higher proportions of patients with burned nostril hair (42.1% vs. 12.6%, $p < 0.001$), eye injuries (28.9% vs. 14.5%,

$p = 0.001$), burned hair (25.6% vs. 11.5%, $p = 0.001$), hoarseness (7.4% vs. 0.9%, $p = 0.001$), shortness of breath (19.8% vs. 1.9%, $p < 0.001$) and positive CXR (52.1% vs. 22.9%, $p < 0.001$).

Table 1
Comparisons between facial burn patients who did and did not undergo intubation in the ED.

| Variables | Facial burn patients (N = 335) | | *p*-value |
|---|---|---|---|
| | Intubation in the ED (+) (N = 121) | Intubation in the ED (-) (N = 214) | |
| Demographics | | | |
| Age | 38.0 ± 16.1 | 42.2 ± 18.9 | 0.064† |
| Male | 91 (75.2%) | 167 (78.0%) | 0.648‡ |
| Types of burn (N, %) | | | < 0.001‡ |
| Flame burn | 94 (77.7%) | 100 (46.7%) | |
| Scald burn | 1 (0.8%) | 49 (22.9%) | |
| Chemical burn | 16 (13.2%) | 47 (22.0%) | |
| Electrical burn | 10 (8.3%) | 18 (8.4%) | |
| TBSA (%) | 27.9 ± 23.1 | 9.8 ± 5.5 | < 0.001† |
| Condition upon ED arrival | | | |
| SBP (mmHg) | 154.1 ± 31.1 | 155.6 ± 28.6 | 0.652† |
| Pulse (/minute) | 99.8 ± 20.2 | 93.2 ± 64.4 | 0.219† |
| RR (/minute) | 20.9 ± 4.1 | 19.9 ± 8.6 | 0.516† |
| Temperature (°C) | 36.3 ± 0.7 | 36.4 ± 0.7 | 0.694† |
| GCS | 13.8 ± 2.6 | 14.7 ± 1.1 | < 0.001† |
| RTS | 7.6 ± 0.6 | 7.8 ± 0.1 | < 0.001† |
| Laboratory examinations and imaging studies | | | |

Values are reported as the means ± SDs

ED = emergency department, SBP = systolic blood pressure, RR = respiratory rate,

CXR = chest X-ray, TBSA = total body surface area, RTS = Revised Trauma Score

† Student's t-test, ‡ chi-squared test

| Variables | Facial burn patients (N = 335) | | *p*-value |
|---|---|---|---|
| | Intubation in the ED (+) (N = 121) | Intubation in the ED (-) (N = 214) | |
| pH | 7.3 ± 0.1 | 7.4 ± 0.1 | < 0.001† |
| $PaCO_2$ (mmHg) | 38.2 ± 13.0 | 36.5 ± 6.1 | 0.175† |
| $HCO_3^-$ (mmol/L) | 21.2 ± 3.8 | 23.4 ± 4.6 | < 0.001† |
| $SaO_2$ (%) | 90.5 ± 16.1 | 96.4 ± 61.5 | 0.315† |
| HbCO (%) | 3.4 ± 4.2 | 2.2 ± 1.7 | 0.008† |
| Positive CXR (N, %) | 63 (52.1%) | 49 (22.9%) | < 0.001‡ |
| Positive physical examination | | | |
| Nostril hair (N, %) | 51 (42.1%) | 27 (12.6%) | < 0.001‡ |
| Eye (N, %) | 35 (28.9%) | 31 (14.5%) | 0.001‡ |
| Hair (N, %) | 31 (25.6%) | 25 (11.7%) | 0.001‡ |
| Cough (N, %) | 6 (5.0%) | 3 (1.4%) | 0.053‡ |
| Sore throat (N, %) | 6 (5.0%) | 3 (1.4%) | 0.053‡ |
| Hoarseness (N, %) | 9 (7.4%) | 2 (0.9%) | 0.001‡ |
| Dysphagia (N, %) | 1 (0.8%) | 0 (0.0%) | 0.183‡ |
| Shortness of breath (N, %) | 24 (19.8%) | 4 (1.9%) | < 0.001‡ |
| Values are reported as the means ± SDs | | | |
| ED = emergency department, SBP = systolic blood pressure, RR = respiratory rate, | | | |
| CXR = chest X-ray, TBSA = total body surface area, RTS = Revised Trauma Score | | | |
| † Student's t-test, ‡ chi-squared test | | | |

Table 2 compares patients with and without inhalation injuries as confirmed on bronchoscopy after admission. Compared with the group of patients without inhalation injuries, the group of patients with

inhalation injuries had a significantly lower GCS (13.8 vs. 14.5, $p < 0.001$), lower pH value (7.3 vs. 7.4, $p < 0.001$) and lower $HCO_3$- level (20.5 vs. 23.1 mmol/L, $p < 0.001$) on arterial blood gas analysis, higher HbCO value (3.6% vs. 2.5%, $p = 0.023$), higher TBSA (31.5% vs. 12.1%, $p < 0.001$), lower RTS (7.5 vs. 7.8, $p < 0.001$) and larger percentages of patients with burned nostril hair (39.7% vs. 18.7%, $p < 0.001$), hoarseness (9.6% vs. 1.5%, $p = 0.010$), and positive CXR (53.4% vs. 27.9%, $p < 0.001$). However, the MLR analysis showed that only TBSA (odds ratio = 1.038, $p = 0.001$) and shortness of breath (odds ratio = 3.376, $p = 0.027$) were independent risk factors for inhalation injuries in facial burn patients (Table 3).

Table 2
Comparisons between facial burn patients with and without inhalation injuries.

| Variables | Facial burn patients (N = 335) | | *p*-value |
|---|---|---|---|
| | Inhalation injury (+) (N = 73) | Inhalation injury (-) (N = 262) | |
| Demographics | | | |
| Age | 37.4 ± 13.4 | 41.6 ± 20.1 | 0.071† |
| Male | 51 (69.9%) | 207 (79.0%) | 0.841‡ |
| Types of burn (N, %) | | | 0.099‡ |
| Flame burn 194 | 40 (54.8%) | 154 (58.8%) | |
| Scald burn 50 | 11 (15.1%) | 39 (14.9%) | |
| Chemical burn 63 | 14 (19.2%) | 49 (18.7%) | |
| Electrical burn 28 | 6 (8.2%) | 22 (8.4%) | |
| TBSA (%) | 31.5 ± 18.1 | 12.1 ± 6.4 | < 0.001† |
| Condition upon ED arrival | | | |
| SBP (mmHg) | 150.8 ± 39.6 | 156.2 ± 31.4 | 0.094† |
| Pulse (/minute) | 98.4 ± 19.5 | 94.8 ± 23.4 | 0.777† |
| RR (/minute) | 20.0 ± 1.4 | 20.3 ± 2.5 | 0.308† |
| Temperature (°C) | 36.4 ± 0.5 | 36.4 ± 0.6 | 1.000† |
| GCS | 13.8 ± 4.8 | 14.5 ± 2.6 | < 0.001† |
| RTS | 7.5 ± 0.8 | 7.8 ± 0.2 | < 0.001† |
| Laboratory examinations and imaging studies | | | |
| pH | 7.3 ± 0.4 | 7.4 ± 0.4 | < 0.001† |
| $PaCO_2$ (mmHg) | 39.2 ± 12.7 | 36.5 ± 7.0 | 0.047† |

Values are reported as the means ± SDs

ED = emergency department, SBP = systolic blood pressure, RR = respiratory rate,

CXR = chest X-ray, TBSA = total body surface area, RTS = Revised Trauma Score

† Student's t-test, ‡ chi-squared test

| Variables | Facial burn patients (N = 335) | | *p*-value |
|---|---|---|---|
| | Inhalation injury (+) (N = 73) | Inhalation injury (-) (N = 262) | |
| $HCO_3^-$ (mmol/L) | 20.5 ± 4.4 | 23.1 ± 4.2 | < 0.001† |
| $SaO_2$ (%) | 88.8 ± 12.5 | 95.5 ± 39.8 | 0.290† |
| HbCO (%) | 3.6 ± 2.1 | 2.5 ± 1.9 | 0.023† |
| Positive physical examination | | | |
| Nostril hair (N, %) | 29 (39.7%) | 49 (18.7%) | < 0.001‡ |
| Eye (N, %) | 17 (23.3%) | 49 (18.7%) | 0.384‡ |
| Hair (N, %) | 17 (23.3%) | 39 (14.9%) | 0.089‡ |
| Cough (N, %) | 3 (4.1%) | 6 (2.3%) | 0.395‡ |
| Sore throat (N, %) | 2 (2.7%) | 7 (2.7%) | 0.975‡ |
| Hoarseness (N, %) | 7 (9.6%) | 4 (1.5%) | 0.010‡ |
| Dysphagia (N, %) | 0 (0.0%) | 1 (0.4%) | 1.000‡ |
| Shortness of breath (N, %) | 16 (21.9%) | 12 (4.6%) | < 0.001‡ |
| Positive CXR (N, %) | 39 (53.4%) | 73 (27.9%) | < 0.001‡ |
| Values are reported as the means ± SDs | | | |
| ED = emergency department, SBP = systolic blood pressure, RR = respiratory rate, | | | |
| CXR = chest X-ray, TBSA = total body surface area, RTS = Revised Trauma Score | | | |
| † Student's t-test, ‡ chi-squared test | | | |

Table 3
Multivariate logistic regression analysis identifying independent risk factors for inhalation injury in patients with facial burn.

| Variables | *p*-value* | Odds of inhalation injury | 95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| GCS in ED | 0.394 | - | - | - |
| TBSA (%) | 0.001 | 1.038 | 1.022 | 1.049 |
| RTS | 0.594 | - | - | - |
| Nostril hair | 0.208 | - | - | - |
| Hoarseness | 0.185 | - | - | - |
| Shortness of breath | 0.027 | 3.376 | 3.133 | 3.601 |
| Positive CXR | 0.351 | - | - | - |
| PH | 0.555 | - | - | - |
| $PaCO_2$ (mmHg) | 0.862 | - | - | - |
| $HCO_3^-$ (mmol/L) | 0.456 | - | - | - |
| HbCO (%) | 0.588 | - | - | - |
| *Multivariate logistic regression | | | | |
| GCS = Glasgow coma scale, ED = emergency department, TBSA = total body surface area, | | | | |
| RTS = Revised Trauma Score, CXR = chest X-ray, CI = confidence interval | | | | |

Figure 2 shows the relationships between the TBSA and the proportion of patients intubated in the ED and the proportion of patients with inhalation injuries. With increasing TBSA, the proportions of both patients intubated in the ED and patients with inhalation injuries increased. In addition, the proportion of patients intubated in the ED was substantially higher than the proportion of patients with inhalation injuries in all categories of TBSA. All patients with a TBSA over 60% were intubated in the ED regardless of whether they had inhalation injuries. The details of the patients who received delayed endotracheal tube intubation after admission are listed in Table 4.

Table 4
Characteristics of patients who received delayed intubation after admission

| Patient | Age | Sex | Reason for intubation | TBSA (%) | Intubation duration (days) |
|---|---|---|---|---|---|
| Patient 1 | 22 | M | Surgery | 18 | 2 |
| Patient 2 | 37 | M | Surgery | 20 | 3 |
| Patient 3 | 18 | M | Surgery | 27 | 5 |
| Patient 4 | 25 | M | Surgery | 12 | 2 |
| Patient 5 | 55 | M | Pneumonia | 50 | 19 |
| Patient 6 | 31 | F | Pneumonia | 55 | 31 |
| Patient 7 | 59 | M | Shock | 60 | 26 |
| Patient 8 | 24 | M | ARDS | 60 | 28 |
| Patient 9 | 65 | M | Inhalation injury (Gr. 2) | 35 | 15 |
| Patient 10 | 42 | M | Inhalation injury (Gr. 1) | 20 | 11 |
| TBSA = total body surface area | | | | | |
| ARDS = acute respiratory distress syndrome | | | | | |

# Discussion

Facial burns expose patients to a higher risk of respiratory problems, and early prophylactic intubation might be life-saving. Therefore, the early detection of the need for intubation in those with facial burns is important. [9] Several sets of criteria (e.g., the American Burn Association guidelines or Denver criteria) have been established and suggest early intubation in burn patients. [10, 11]

Traditionally, the diagnosis of inhalation injury has usually been based on a combination of clinical evaluations, such as patient history or physical examinations. Some physical findings have been considered indicators of a higher likelihood of laryngeal edema or inhalation injuries above the glottis and thus a greater need for intubation. A previous study (Vivó, C et al) demonstrated that stridor, shortness of breath, facial burns, singed nasal hairs, cough, soot in the oral cavity and history of being in an enclosed space with the fire should be strongly considered indicators for early intubation. [12] However, physical examinations are usually subjective evaluations. Diagnostic modalities such as laboratory examinations or chest X-ray may objectively contribute to the evaluation of inhalation injury. Arterial blood gas analysis was described as a good tool for the early detection of inhalation injury, while (Onishi, S. et al) carboxyhemoglobin levels (HbCO) were considered a useful predictor of inhalation injury below the glottis. [13, 14] In addition, the utility of chest X-rays (increased perihilar or peribronchial infiltration, ground glass haziness of the lung, or other signs that may indicate pulmonary edema or

respiratory distress) or even computed tomographic scans (bronchial wall thickness) for the detection of significant inhalation injuries have also been reported. [14]

Similar to the findings of previous studies and current guidelines for facial burn management, in the current study, patients who were intubated in the ED had significantly more positive signs on physical examinations or abnormal blood gas analysis results (Table 1). However, after undergoing bronchoscopy as a definitive evaluation, 39.7% of the intubated patients were not found to have airway injuries (Fig. 1). This fact indicates that some airway protection procedures might be considered overresuscitation, and more objective evaluations of the indication for early intubation are needed. Positive signs on physical examination may be indicators for intubation in the ED but may not correlate with the presence of inhalation injury.

In addition to the evaluation of patients who underwent intubation in the ED, patients with inhalation injuries who truly needed airway protection were analyzed. Compared with patients without inhalation injuries, patients with inhalation injuries were significantly more likely to have some positive signs on physical examination, abnormal laboratory examinations and positive findings on CXR in univariate analyses (Table 2). However, further MLR analysis in the current study revealed that most positive signs on physical examinations, laboratory examinations and CXR results could not significantly predict inhalation injury. However, shortness of breath is an easy-to-identify sign that was an independent risk factor for inhalation injury in facial burn patients. The presence of shortness of breath in facial burn patients was associated with a 3.376-fold higher odds of inhalation injury ($p = 0.027$, odds ratio = 3.376, 95% CI.=3.133–3.601). In addition, a high TBSA may also be independently predictive of inhalation injury. Every one percent increase in the TBSA was associated with a 1.038-fold increase in the odds of inhalation injury ($p = 0.001$, odds ratio = 1.038, 95% CI.=1.022–1.049)

In the current study, positive correlations between TBSA and the odds of inhalation injury and intubation were both observed. It is noteworthy that the proportion of intubated patients was higher than the proportion with inhalation injuries, regardless of the TBSA (Fig. 2). All patients with a high TBSA (> 60%) were intubated in the ED, even if they had no sign of inhalation injury. This implied that for severe burn patients (with a higher TBSA), inhalation injury is not the only indication for intubation. Steinvall, I and Liffner, G et al reported that acute respiratory distress syndrome can develop in burn patients without inhalation injury due to an inflammatory process mediated by the effect of the burn, and this physiopathological process is not associated with inhalation injury. [15, 16] Dries et al also reported that critical burn patients may develop several lung injuries, such as sepsis, ventilator-induced lung injury or systemic inflammation, in addition to inhalation injury. [17]

In the current study, ten patients (8.3%, 10/121) underwent delayed intubation after admission. They were not intubated on admission to the ED. Most of these patients (80%, 8/10) were intubated because they needed to undergo surgery under general anesthesia (four patients) or they had complications of severe burn injuries (TBSA > 50%) (four patients). Only two patients had delayed symptoms of inhalation injury (shortness of breath or hoarseness) (Table 4). Among the patients who underwent intubation, there were

33 (27.3%, 33/121) patients without inhalation injuries (bronchoscopy grade = 0), although they remained intubated for longer than 3 days. Upper airway edema usually resolves within 2–3 days. These prolonged intubations implied that these patients were not intubated only due to airway edema, a common complication of inhalation injury, but also other reasons. Therefore, in addition to the management of inhalation injury, intubation still plays a significant role in stabilizing and treating other associated injuries. Airway management, as a part of resuscitation, should be considered for all burn-associated injuries not only inhalation injuries.

The major limitations of this study are its retrospective nature and the small patient sample, which was obtained from a single institution. In addition, there were some patients with missing records of physical examinations and reasons for intubation. The aforementioned limitations notwithstanding, the results provide important information about the role of airway protection in the management of facial burn patients. A prospective study with a larger patient sample size should be designed to determine the accurate indications for endotracheal tube intubation in the ED.

# Conclusion

In the management of facial burn patients, conventional physical examinations may not always be predictive of inhalation injury and the need for endotracheal tube intubation in the ED. More attention should be paid to facial burn patients with shortness of breath and a high TBSA because they have an increased risk of inhalation injury. Airway protection may be needed in facial burn patients without inhalation injury because of their associated injuries and treatment.

# Abbreviations

ED = emergency department

ABG = arterial blood gas

CXR = chest X-ray

ATLS = Advanced Trauma Life Support

GCS = Glasgow coma scale

TBSA = total body surface area

RTS = revised trauma score

MLR = multivariate logistic regression

SPSS = Statistical Package for the Social Sciences

CI = confidence interval

# Declarations

**Ethical Approval and Consent to participate:**

This retrospective study was approved by the Institutional of Review Board of Chang Gung Memorial Hospital

**Consent for publication:**

All authors agree with the publication of this article

**Availability of supporting data:**

Not applicable

**Competing interests:**

No competing interests

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**Authors' contributions:**

Study conception and design: Huang and Fu

Acquisition of the data: Huang, Kuo, Liao and Hsieh

Analysis and interpretation of the data: Huang, Hsiao and Fu

Drafting of the manuscript: Huang and Chen

Critical revision: Fu and Bajani

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# Figures

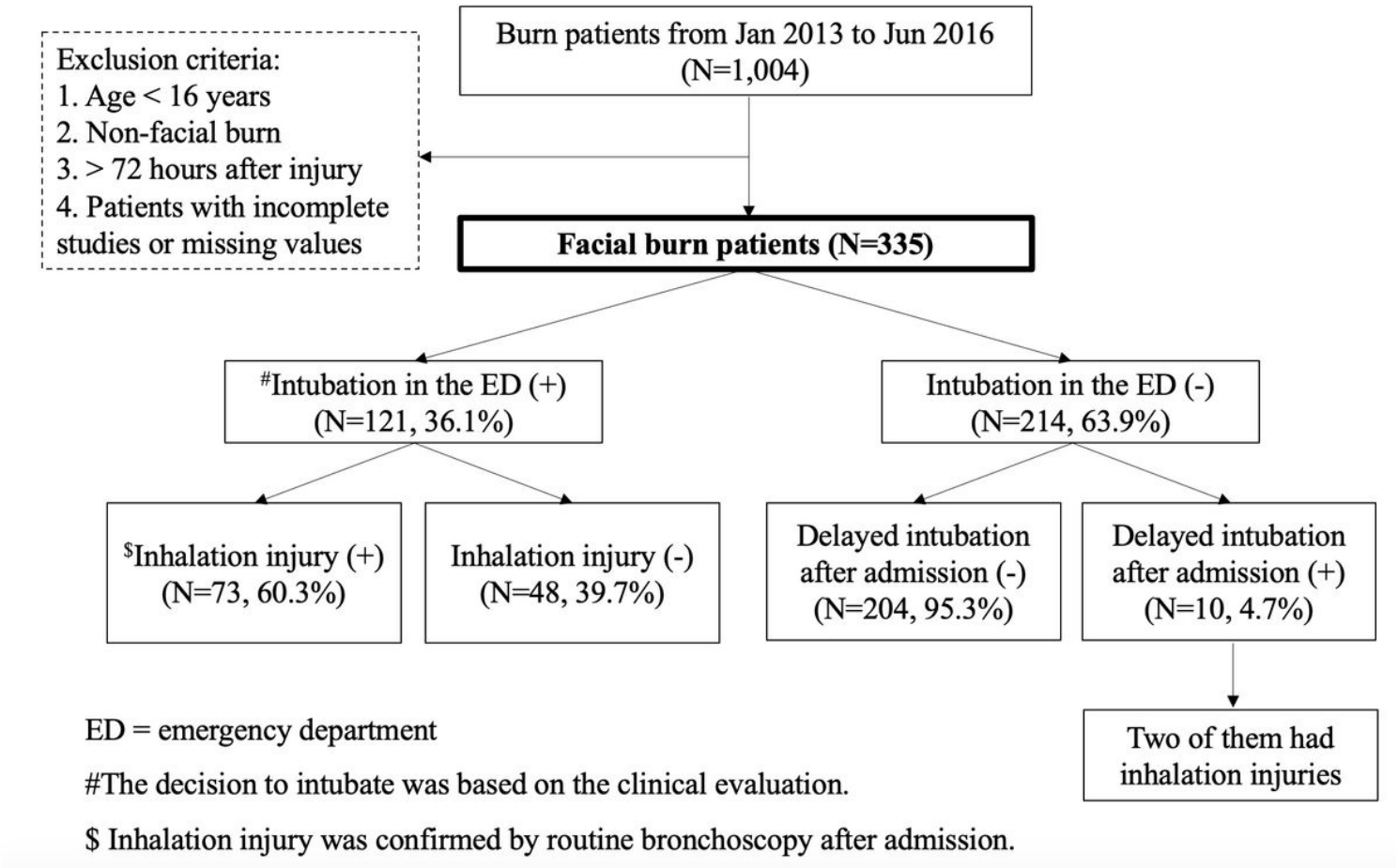


**Figure 1**

Study population, protocol and key numbers in the current study.

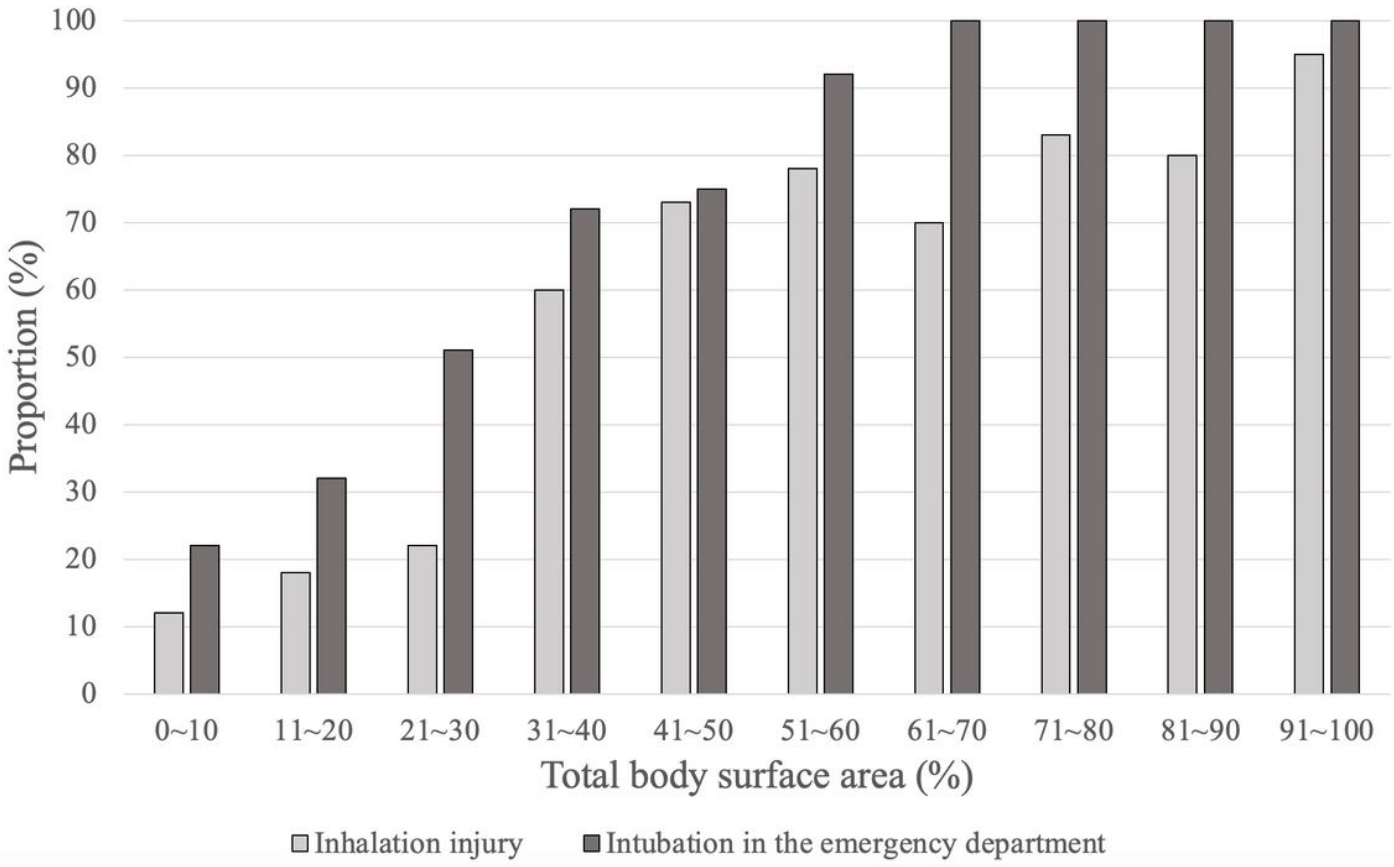


**Figure 2**

The relationship between the TBSA and proportion of patients with inhalation injuries and the relationship between the TBSA and the proportion of patients who were intubated in the ED.

# Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable.docx