

Pneumonia Risk in Urgently Intubated Burn Patients

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ABSTRACT: **Background:** Pneumonia is a major cause of morbidity and mortality in burn patients with inhalation injuries. An increased risk of pneumonia has been demonstrated in trauma and burn patients urgently intubated in the field vs. emergency departments (EDs).

Objectives: To compare intubation setting (field vs. ED) and subsequent development of pneumonia in burn patients and to evaluate the indication for urgent intubation outside the hospital setting.

Methods: A retrospective medical records review was conducted on all intubated patients presenting with thermal (study group, 118 patients) or trauma (control group A, 74 patients) injuries and admitted to the intensive care unit of a level I trauma and burn center at a single institution during a 15 year period. Control group B (50 patients) included non-intubated facial burn patients hospitalized in the plastic surgery department.

Results: Field intubation was less frequent (37% field vs. 63% ED), although it was more frequent in larger burns (total body surface area > 50%; 43% field vs. 27% ED). More field intubated patients developed pneumonia during hospitalization (65% field vs. 36% ED [burns]; 81% field vs. 45% ED [multi-trauma]; 2% non-intubated, $P < 0.05$), with a significantly higher all-cause mortality (49% field vs. 24% ED, $P < 0.05$) and dramatically lower rates of extubation within 3 days (7% field vs. 27% ED, $P < 0.05$).

Conclusions: Field intubation is associated with a higher risk of subsequent development of pneumonia in burn and multi-trauma patients and should be applied with caution, only when airway patency is at immediate risk.

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common infectious complication, with high reported mortality rates [10]. An increased risk of pneumonia has previously been demonstrated in trauma and burn patients who were urgently intubated in field settings or in the emergency department (ED) [11–14]. Given the high rates of morbidity and mortality, and the significant cost associated with this complication, it is important to identify risk factors for development of pneumonia to facilitate early diagnosis and treatment. To the best of our knowledge, no study in Israel has compared urgent field intubation to ED intubation in an effort to further stratify the risk of developing pneumonia. We investigated the association of the setting where intubation was performed in burn patients to the subsequent development of pneumonia and evaluated the indication of urgent intubation outside of the hospital setting.

PATIENTS AND METHODS

Following approval of the Helsinki Committee and the institutional review board of the Rambam Health Care Campus, medical records were retrospectively reviewed for 192 urgently intubated patients presenting with thermal or other trauma injuries (trauma patients served as the control group) who were admitted to the intensive care unit (ICU) of the burn center and the level I trauma center at the medical facility. The study group consisted of all intubated burn patients (field or ED intubation) during a 15 year period, which ended in July 2016, and control group A that included intubated trauma patients hospitalized during a 10 month period (October 2015 to July 2016). The records of a third group included in the review (control group B) included 50 patients with facial burn injuries who were not intubated and were hospitalized in the plastic surgery department.

Urgent airway acquisition was defined as the need for endotracheal intubation or a surgical airway conducted in the field or in the ED. Pneumonia was defined by a medical diagnosis in the patient records or by standard clinical criteria including chest radiograph, vital signs, and microbiology results. We analyzed the following criteria: patient demographics, co-morbidities, burn mechanism, presence of inhalation injury, carboxyhemoglobin (COHb) blood levels, setting at the time of intubation, presence of associated injury, burn percentage of the total body surface area (TBSA), hospital and ICU length of stay, hospitalization day of pneumonia diagnosis, all-cause mortality, and microbiology results.

Burns are common forms of trauma and affect about 1% of the population each year [1]. Although most burn patients survive their hospitalization, many die every year as a result of their injuries [2]. In the past few years, advances in burn treatment have reduced mortality and modified its causes [3–8]. However, pneumonia remains a major cause of morbidity and mortality in burn patients, particularly those with inhalation injuries [9]. In addition, pneumonia is one of the leading complications among trauma patients and remains the most

Data were examined for normal distribution, and parameters were compared by independent groups using the chi-square test, where $P < 0.05$ was considered statistically significant. Absence of data regarding pneumonia occurrence or the setting where the intubation was performed were exclusion criteria. Based on these criteria, five burn patients from the study group were excluded.

RESULTS

Our study was comprised of 118 intubated burn patients (study group), 50 facial burn non-intubated patients (control group A), and 74 intubated multi-trauma patients (control group B). About 63% had their airways established in the ED (65 burn patients, 46 multi-trauma patients), while 37% were intubated in the field. Most of the intubated burn patients were male (about 75%), with a similar mean age in both burn subgroups (~42 years), and no major differences in co-morbidities. The study group comprised 33 multi-trauma patients, 18 smokers, 3 patients with lung disease, 9 with diabetes, and 6 with ischemic heart disease. The different burn mechanisms were fire (64 patients), blast (39), hot water (3), chemical burn (4), and electrical burn (8). In total, 23 cases were admitted with COHb levels above 5%, and 55 patients had COHb levels lower than 5% [Table 1].

In the field intubation subgroup, more patients had large burns (43% had TBSA > 50%, compared to 27% in the ED intubation group), and fewer presented with small burns (TBSA < 20%, 23% field vs. 36% ED). Thirty-six percent of ED intubated burn patients and 45% of multi-trauma patients developed pneumonia during hospitalization, compared to 81% in the field intubated control group, 65% in the field intubated burn group, and 2% in the non-intubated burn group. Field intubated patients had higher chances of developing pneumonia than did ED intubated patients, $P < 0.05$ [Figure 1A].

Analysis of a group consisting of all of the intubated trauma and burn patients together (118 study group patients and 74 control group B patients) showed that even after 1 week, there was a statistically significant difference between ED intubation compared to field intubation regarding pneumonia occurrence ($P < 0.05$), as shown in Figure 1B.

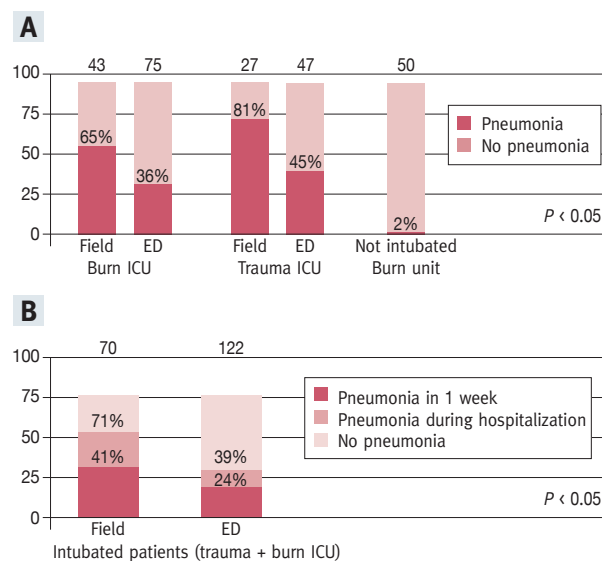
Regarding TBSA burn percentage in the study group, 41 patients had burns of TBSA < 20%, 38 had burns of TBSA 20–50%, and 34 presented TBSA > 50%. Analysis of patients with burns of TBSA < 20% showed that field intubated patients had higher percentages of pneumonia than did ED intubated patients, $P < 0.05$ [Figure 2A]. In addition, intubated patients with relatively small burns presented with higher rates of pneumonia than did non-intubated patients, $P < 0.05$ [Figure 2B]. Even when comparing patients who were intubated for only a short period (less than 3 days), there was still a statistically significant difference in pneumonia occurrence compared to the non-intubated group, (7% vs. 2%, $P < 0.05$).

Table 1. General information on the patients and their injuries. Data are presented as numbers (percentage). Data were missing for some of the parameters

| Intubation setting | | Field N (%) | Hospital ED N (%) |
|-------------------------------------------------------|----------------------------|-------------|-------------------|
| Mean age, years | | 42.3 (39) | 41.8 (38) |
| Gender | Male | 32 (76.2) | 56 (74.7) |
| | Female | 10 (23.8) | 19 (25.3) |
| Known conditions | Lung | 1 | 2 |
| | Diabetes mellitus | 4 | 5 |
| | Ischemic heart disease | 3 | 3 |
| | Immunosuppression | 1 | 0 |
| | Smoker | 6 | 12 |
| | Other major co-morbidities | 9 | 18 |
| Burn mechanism | Fire | 25 (60) | 39 (51) |
| | Blast | 14 (33) | 25 (33) |
| | Hot water | 0 | 3 (4) |
| | Chemical burn | 0 | 4 (5) |
| | Electrical burn | 3 (7) | 5 (7) |
| %TBSA burns | < 20% | 8 (22) | 24 (36) |
| | 20–50 | 13 (35) | 25 (37) |
| | > 50% | 16 (43) | 18 (27) |
| Multi-trauma | | 13 (30) | 20 (27) |
| % COHb > 5 (percentage of patients with known values) | | 6 (19) | 17 (37) |
| Extubation within 3 days | | 3 (7) | 20 (27) |
| Death within 48 hours | | 1 (2.3) | 1 (1.3) |
| All-cause mortality | | 22 (51) | 18 (24) |

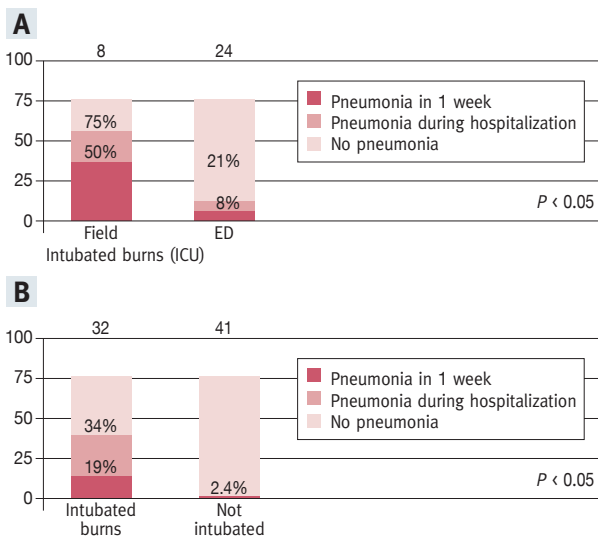
COHb = carboxyhemoglobin, ED = emergency department, TBSA = total body surface area

Figure 1. Percentage of pneumonia during hospitalization [A] Percentage of pneumonia during hospitalization in the study and control groups [B] Percentage of pneumonia in all intubated patients (study group and control group B, combined)



ED = emergency department, ICU = intensive care unit

Figure 2. Percentage of pneumonia during hospitalization for patients with small burns (total body surface area < 20%) **[A]** Intubated burn patients (field vs. ED intubation) **[B]** Intubated vs. non-intubated patients



ED = emergency department, ICU = intensive care unit

Sixty-seven patients were hospitalized in the ICU for more than 1 week, 52 were hospitalized more than 30 days, 2 died within 48 hours, and 38 patients died after more than 48 hours of hospitalization. All-cause mortality was significantly higher in the field intubation group: 49% field vs. 24% ED ($P < 0.05$), as presented in Figure 3.

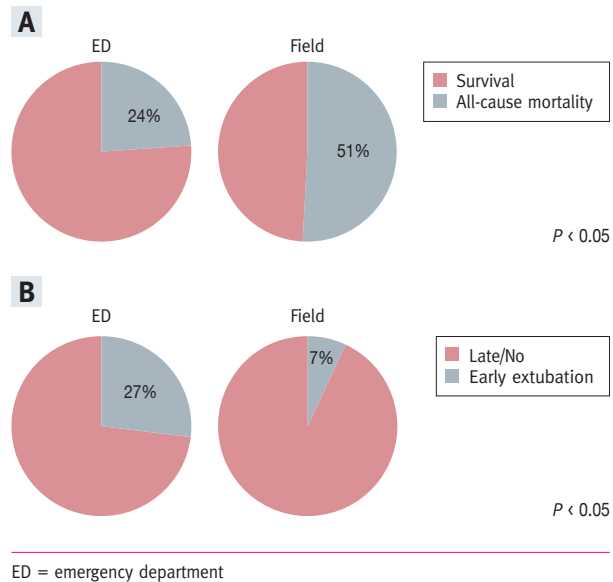
Twenty-three burn patients were extubated within 3 days, of whom 20 were intubated in the ED. Hence, the percentage of mortality for this relatively early extubation was dramatically lower in the ED group compared to the field intubation group (7% field vs. 27% ED, $P < 0.05$), as presented in Figure 3.

DISCUSSION

The mortality risk among burn patients increases with age and burn size, as well as in the presence of inhalation injury [15]. Patients presenting with severe burn injuries caused by fire are at risk for an additional inhalation injury (up to 43% of burn patients) and incur an additional eightfold to tenfold risk for mortality [16].

Specialized burn centers and advances in burn therapy have led to improved survival rates for burn patients. Many attempts have been made to identify the risk factors that would predict whether a patient will develop pneumonia [9-14]. Despite the advances in antimicrobial therapy, management of pneumonia for burn and trauma patients continues to be a major source of morbidity and mortality, with significant associated costs [17].

Figure 3. **[A]** All-cause mortality in burn patients, **[B]** Early extubation in burn patients



ED = emergency department

Multiple risk factors for the development of pneumonia after trauma have been reported in the literature [12,13]. Urgent airway acquisition following trauma injury was previously identified as a risk factor for the development of pneumonia [10]. We aimed to examine the role of field intubation vs. ED intubation among burn patients in subsequent pneumonia development.

With regard to burn patients and multi-trauma patients who were ED intubated, 36% and 45%, respectively, developed pneumonia during hospitalization, compared to 65% of burn patients and 81% of multi-trauma patients who were intubated in the field ($P < 0.05$). Only 2% of the non-intubated burn group developed pneumonia. It should be emphasized that injuries of patients who were intubated in the field tended to be more complicated. Field intubated patients had higher chance of developing pneumonia than did ED intubated patients, even after 1 week of hospitalization. Moreover, subgroup analysis of patients with burns of TBSA < 20% showed that field intubated patients had a higher percentage of pneumonia compared to non-field intubated patients. All-cause mortality was significantly higher (49% field vs. 24% ED) and extubation within 3 days was dramatically lower (7% field vs. 27% ED) when comparing ED versus field intubation in burn patients.

Our findings show that significantly more intubated patients presented with pneumonia after field intubation, compared to ED intubation. Prior studies support these findings [17,18], and others contradict them [19,20]. However, after analyzing the experience of patients at our medical center, the largest trauma center in northern Israel, the results are clear. Our study showed a higher rate of pneumonia among

field intubated patients as well as significantly higher mortality rates and fewer early extubations.

It is yet to be decided whether the current practice should change. There is no place for hesitation when considering intubation since mistakes in airway treatment may increase the overall rate of death. However, the time from evacuation to treatment in Israel is very short, so there are occasions in which the decision for intubation can be delayed until arrival to the ED, thus preventing increased chance of developing pneumonia or death. One possible weakness of our study could be an inherent bias in the findings based on the fact that the injuries of patients who were intubated in the field tended to be more complicated. Nevertheless, subgroup analyses show a statistically significant finding in smaller burns (TBSA < 20%) that support our claim, in addition to an unequivocal trend (of the other TBSA subgroups). Finally, our findings concur with other reports that identify early intubation as an independent risk factor for the development of post-traumatic pneumonia [17,21-24] and associated morbidity and mortality [10-14]. Even the most remote regions of northern Israel are within an hour's drive of a hospital. Considering the physiology of a burn injury and the time needed to develop clinically evident laryngeal edema (up to 12–18 hours) [25], the challenge of field intubation, and the findings of this study, postponing intubation until ED arrival may be the prudent decision.

CONCLUSIONS

Field intubation (compared to ED intubation) in burn and multi-trauma patients is associated with a higher risk of subsequent development of pneumonia and higher morbidity and mortality rates; therefore, it should be applied with caution and only when airway patency is at immediate risk.

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“To cultivate kindness is a valuable part of the business of life”

Samuel Johnson, (1709–1784), lexicographer

“The life of every man is a diary in which he means to write one story, and writes another, and his humblest hour is when he compares the volume as it is with what he vowed to make it”

Sir James Matthew Barrie, 1st Baronet, (1860–1937), Scottish novelist and playwright, best remembered as the creator of Peter Pan