Endotracheal Intubation in the Field Does Not Improve Outcome in Trauma Patients Who Present without an Acutely Lethal Traumatic Brain Injury

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Objectives: There is an absence of prospective data evaluating the impact of prehospital intubation in adult trauma patients. Our objectives were to determine the outcome of trauma patients intubated in the field who did not have an acutely lethal traumatic brain injury (death within 48 hours) compared with patients who were intubated immediately on arrival to the hospital.

Methods: Prospective data were collected on 191 consecutive patients admitted to the trauma center with a field Glasgow Coma Scale score ≤ 8 and a head Abbreviated Injury Scale score ≥ 3 who were either intubated in the field or intubated immediately at admission to the hospital. Patients who died within 48 hours of admission and transfers were excluded from the study.

Results: Of the 191 patients, 176 (92%) sustained blunt trauma and 25 (8%) were victims of penetrating trauma. Seventy-eight (41%) of the 191 patients were intubated in the field and 113 (59%) were intubated immediately at admission. There was no significant difference in age, Glasgow Coma Scale score, head Abbreviated Injury Scale score, or Injury Severity Score between the two groups. Patients who were intubated in the field had a significantly higher morbidity (ventilator days, 14.7 vs. 10.4; hospital days, 20.2 vs. 16.7; and intensive care unit days, 15.2 vs. 11.7) compared with patients intubated on immediate arrival to the hospital and nearly double the mortality (23% vs. 12.4). Field-intubated patients had a 1.5 times greater risk of nosocomial pneumonia compared with hospital-intubated patients.

Conclusion: Prehospital intubation is associated with a significant increase in morbidity and mortality in trauma patients with traumatic brain injury who are admitted to the hospital without an acutely lethal injury. A randomized, prospective study is warranted to confirm these results.

Key Words: Endotracheal intubation, Traumatic brain injury, Acute lethal injury, Outcome.

Table 1 State of Maryland Protocol for RSI in the Field

<table>
<thead>
<tr>
<th>Indications</th>
<th>RSI, rapid sequence intubation; IVP, intravenous push; BP, blood pressure.</th>
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<tbody>
<tr>
<td>Inability to tolerate laryngoscopy, and:</td>
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<tr>
<td>GCS score ≤ 8 with respiratory rate ≤ 8 or ≥ 35 or</td>
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<tr>
<td>GCS score ≤ 8 with oxygen saturation ≤ 90% on nonrebreather face mask</td>
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<td>Online medical direction for RSI may be requested in the following situations:</td>
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<tr>
<td>GCS score ≤ 8 with clenched jaw and inability to adequately suction airway</td>
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<tr>
<td>Respiratory extremis with contraindications to nasotracheal intubation (respiratory rate ≥ 35 with air hunger, use of accessory muscles, and oxygen saturation ≤ 90% on nonrebreather face mask)</td>
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<td>Rapid sequence intubation protocol (paramedic only)</td>
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<tr>
<td>Midazolam: administer 0.05 mg/kg IVP over 1–2 min</td>
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<tr>
<td>Hold for BP &lt; 80 mm Hg</td>
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<tr>
<td>May omit for GCS score = 3–8</td>
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<tr>
<td>Lidocaine: administer 1.0 mg/kg IVP over 1–2 min</td>
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</tr>
<tr>
<td>Suxcinylcholine: administer 1.5 mg/kg IVP</td>
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<tr>
<td>Intubate trachea and verify endotracheal tube position</td>
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<tr>
<td>Repeat suxcinylcholine if inadequate relaxation after 2–3 min</td>
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<tr>
<td>Vecuronium 0.05 mg/kg may be administered if significant resistance to ventilation occurs</td>
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Trauma serves as the principal adult resource center for trauma in the state of Maryland and as the designated neurotrauma center. Triage protocols govern patient flow in the field (i.e., whether patients with traumatic brain injury come directly to Shock Trauma or go to a regional trauma center). Local field providers have variable levels of training ranging from Emergency Medical Technician-Basic to Emergency Medical Technician-Paramedic. Lower skill providers will transport directly to the trauma center without calling for advanced providers only if transportation time is deemed faster than waiting for a helicopter transport or the arrival of another ground Advanced Life Support unit. The helicopters are manned by Maryland State Police officers trained at the highest level of paramedic. Airway instruction to paramedics is provided at Shock Trauma by the anesthesiologists.

Patients were stratified by whether or not they were intubated in the field or immediately on arrival to the trauma center (see Table 1 for protocol for field intubation). Patients who died within 48 hours of admission (because of nonsalvageable traumatic brain injury diagnosed at admission and/or kept alive for transplant purposes), failed intubation in the field, long field extrications (presence of “Go Team” physicians or greater than 30-minute extrication from vehicle), and transfers from outside institutions were excluded from the study. The incidence of pneumonia was defined as the number of patients diagnosed with infection as the numerator and the population at risk as the denominator. Outcome was assessed by hospital length of stay, intensive care unit length of stay, ventilator days, and mortality.

The criteria for the diagnosis of pneumonia are listed in Table 2. Invasive procedures for procurement of quantitative sputum cultures, including bronchoscopy with bronchoalveolar lavage or protected specimen brush sampling, were not routinely practiced but reserved for patients with progression of pulmonary infiltrates or clinical deterioration.

The relative risk of pneumonia and mortality was defined as the rate of pneumonia in patients intubated in the field divided by the rate of pneumonia in patients intubated on arrival to the hospital. The relative risk of mortality was defined as the rate of mortality of patients intubated in the field divided by the rate of mortality of patients intubated on arrival to the hospital. The statistical significance of data in tabular analysis was based on χ² and t test. Multiple logistic regression analysis was used to determine the significance of multiple variables.

RESULTS

Of the 191 patients in the study cohort, 78 (41%) were intubated in the field (3 during transport) and 113 (59%) were intubated immediately at admission by a dedicated trauma anesthesiologist. One hundred seventy-six patients (92%) sustained blunt trauma and 25 (8%) were victims of penetrating trauma. The majority (67%) of these patients came to the trauma center by air transport. Male patients (n = 155) constituted 81% of the study population, and female patients constituted 19% (n = 46). The mean age of the study cohort was 37.5 ± 21 years, with a mean Injury Severity Score of 19.7 ± 12. The mean GCS score was 4.6 ± 2.1, with a mean HAIS score of 4.73 ± 0.7. There were no significant differences in age, ISS, GCS score (prehospital and at admission), and HAIS between the two groups (Table 3). When stratified by Abbreviated Injury Scale score, there was no significant difference in the incidence of specific injuries associated with clot (Fig. 1). There was also no significant difference in the
incidence of diffuse axonal injury (field intubation, 6.4%; hospital intubation, 4.4%). However, a significant increase in dispatch/arrival time (ground and air) was found in the field intubation group ($p < 0.05$) (Fig. 2).

Sixty-eight patients (36%) were found to have isolated head injuries. Orthopedic injuries (22%) and pulmonary injuries (22%) (i.e., hemothorax, pneumothorax, contusion) accounted for the majority of associated injuries. Other associated injuries included facial fractures (9%), spine fractures (7%), and intra-abdominal injuries (4%). There was no significant difference in frequency or distribution of noncranial operations between the two groups.

A total of 49 of the 191 patients (26%) went to the operating room for neurosurgical intervention. Patients who were intubated on arrival to the hospital (34%) were more likely to have urgent neurosurgical operative intervention ($p < 0.01$) compared with patients intubated in the field (14%) (Fig. 3). Subdural evacuation was the most common procedure in both groups (Fig. 4). We further evaluated the time differential in terms of time of prehospital dispatch to arrival in the operating room (Fig. 5). Field-intubated patients were found to have a significantly longer time interval compared with the hospital-intubated group ($p < 0.05$).

Patients who were intubated in the field had significantly longer intensive care unit ($p < 0.005$) and hospital lengths of stay ($p < 0.04$) (Table 2). In addition, mean ventilator days (14.7 vs. 10.4) and the incidence of pneumonia (49% vs. 32%) were both significantly higher in the field intubation group. Thus, the relative risk of pneumonia was 1.53 times greater in the field intubation group.

Field-intubated patients also had a significantly greater mortality (23% vs. 12.4%, $p < 0.05$). This equals a 1.85 times greater risk of mortality in the field-intubated group compared with patients intubated on arrival to the hospital. Field-intubated patients were more likely to have died with respiratory failure–related complications (61% vs. 29%, $p < 0.05$).

**DISCUSSION**

The establishment and maintenance of the airway in the field is the first and main priority of prehospital personnel. Maintaining oxygenation and preventing hypercarbia are crit-
ical in managing the trauma patient, especially if the patient has sustained traumatic brain injury. Endotracheal intubation is a mechanical skill that well-trained prehospital providers should be able to perform in most cases. Thus, any discussion of the disadvantages of prehospital intubation would seem counterintuitive, because there are many reports on the advantages of prehospital endotracheal intubation. However, many recent reports have suggested an adverse outcome in patients who were intubated in the field instead of prehospital bag-valve-mask ventilation followed by intubation immediately on arrival to the hospital.

In a retrospective review of 314 adult trauma patients with brain injury, Sloane and colleagues compared patients that were intubated by aeromedical crews (n = 47) to patients who arrived by ground transportation and were intubated immediately in the trauma suite (n = 267). Although there was no difference in hospital and intensive care unit length of stay and mortality, patients who were intubated in the field were greater than four times as likely to develop pneumonia. Karch et al. demonstrated similar findings in a study of 94 patients.

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Field Intubation and Outcome

two attempts) failed prehospital intubations from the study, because skill level and circumstance may have impacted on the outcome in these patients. This may be particularly true in patients with brain injury if they develop even transient hypoxia. A significant difference in the skill of ground providers to the Shock Trauma Center exists and may very well be a confounding factor in this study. However, lower level skilled providers in our system only transport directly to the trauma center in situations in which transport time to the hospital is significantly less than waiting for further assistance by ground or air paramedics.

The increased rate of morbidity and mortality in the field-intubated patient population in our study may be attributed to several factors. First, the higher incidence of pneumonia and the increased ventilator days may well be a consequence of aspiration in the field during airway manipulation. These data are in agreement with previous data reported by Sloane et al. and Karch et al.3,9 In addition, there was a greater incidence of respiratory-related mortality in the field intubation group. It is important to mention, however, that in the majority of these patients neurologic outcome had already declared itself, and their respiratory failure and subsequent pneumonia was a consequence of this. These results would also partially explain the greater intensive care unit and hospital lengths of stay.

More importantly, however, was the significantly greater rate of mortality in the field intubation group. In our analysis, there was no significant difference in the number of clot-related injuries between both groups. However, there was a significant difference in the number of emergent craniotomies in the hospital intubation group, which obviously means that these patients had traumatic brain injuries that were amenable to surgery. It is possible that this difference influenced our results. One could theorize that patients able to be decompressed would fare better. Alternatively, one could argue that injuries not requiring surgery might be less severe.

Another important matter is that of the difference in dispatch to hospital arrival time. The hospital intubation group had a significant decrease in transport time. In addition, dispatch to operation time was significantly less in the hospital intubation group. Outcome from traumatic brain injury is time sensitive. The time differences we observe, although statistically significant, may not be sufficient to explain the large differences in mortality. Alternatively, although the HAIS was not different between the two groups, it is possible that those patients with a brain injury amenable to surgery would do better, because evacuation of the clot offers near definitive therapy. This proposed benefit may be counterbalanced by the underlying brain injury that commonly accompanies subdural hematomas, the most common indication for surgery in our patients. Only a large, randomized, prospective study could truly answer these questions.

There were several limitations to this study. First, a certain amount of individual paramedic bias exists in the determination of whether or not patients are intubated before helicopter departure. For example, if a paramedic determines that the return flight time is too long and thus unsafe not to have definitive airway control, he or she may choose to subjectively intubate the patient. Second, there is a significant difference between level of training in prehospital airway management between ground paramedics and state patrol flight paramedics. Third, although there was no statistical difference in the incidence of injuries with clots, certain biases may have existed in the practice of the individual neurosurgeon who was on call on any given night that we were not able to more clearly define. Finally, there is a lack of long-term outcome data, as these patients were not followed postdischarge.

CONCLUSION

Although there is clearly a subset of traumatic brain injury patients that benefit from the placement of a field airway, this population has to be more clearly defined. In our study, field intubation in patients without an acutely lethal traumatic brain injury was associated with a greater incidence of morbidity and mortality in adult trauma patients. Patients intubated at admission were more likely to go on to surgery. Differences in field time may have contributed to this. Thus, there may be a subset of brain-injured patients that are better served by more rapid transportation to the hospital with bag-valve-mask ventilation. It is still possible, however, that there was some difference in the nature of these described injuries, but we were unable to discover them. A large, randomized, prospective study to more clearly define which patients would most benefit from either field or hospital intubation is warranted.

REFERENCES