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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.**

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The establishment and maintenance of an adequate airway is often the single most important initial therapy provided to a victim of severe injury.[1] This may be accomplished by simple techniques such as placement of an oral or nasopharyngeal airway that prevents the tongue from occluding the oropharynx, and bag-mask ventilation techniques. More advanced techniques such as endotracheal intubation or cricothyroidotomy require a higher level of training and expertise for both prehospital and hospital providers.

Although endotracheal intubation in the field is routinely practiced by paramedics, recent data highlight that many potential risks are associated with these procedures.[2] In a series of 314 patients, Sloane and colleagues reported that patients intubated in the field using rapid sequence techniques had a greater than fourfold increase in pneumonia.[3] Murray et al. demonstrated that patients with severe head injury (Glasgow Coma Scale [GCS] score ≤ 8 and head Abbreviated Injury Scale [HAIS] score ≥ 3) who were intubated in the field had a significantly greater risk of mortality compared with nonintubated patients.[2] In a large registry review (31,464 pediatric patients) with severe head injury, prehospital endotracheal intubation offered no increase in survival compared with bag-valve-mask ventilation only.[4] The weakness of all three of these studies was that they were all retrospective.

However, a recent prospective, randomized trial compared endotracheal intubation to bag-valve-mask ventilation in pediatric patients.[5] No improvement in survival was demonstrated in the patients who had endotracheal intubation in the field. The objective of our study was to prospectively evaluate whether prehospital intubation improved outcome in adult trauma patients with nonlethal (death within 48 hours) traumatic brain injury.

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PATIENTS AND METHODS

Prospective data were collected on 191 consecutive adult trauma patients over a 12-month period (August 2000–August 2001) admitted to the R Adams Cowley Shock Trauma Center with a GCS score ≤ 8 and a HAIS Score ≥ 3. Shock

Table 1 State of Maryland Protocol for RSI in the Field

Indications
Inability to tolerate laryngoscopy, and:
GCS score ≤ 8 with respiratory rate ≤ 8 or ≥ 35 or
GCS score ≤ 8 with oxygen saturation ≤ 90% on nonrebreather face mask
Online medical direction for RSI may be requested in the following situations:
GCS score ≤ 8 with clenched jaw and inability to adequately suction airway
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
Rapid sequence intubation protocol (paramedic only)
Midazolam: administer 0.05 mg/kg IVP over 1–2 min
Hold for BP < 80 mm Hg
May omit for GCS score = 3–8
Lidocaine: administer 1.0 mg/kg IVP over 1–2 min
Inline cervical spine stabilization by second caregiver
Apply cricoid pressure
Succinylcholine: administer 1.5 mg/kg IVP
Intubate trachea and verify endotracheal tube position
Repeat succinylcholine if inadequate relaxation after 2–3 min
Vecuronium 0.05 mg/kg may be administered if significant resistance to ventilation occurs

RSI, rapid sequence intubation; IVP, intravenous push; BP, blood pressure.

Table 2 R Adams Cowley Shock Trauma Center Criteria for the Clinical Diagnosis of Pneumonia in Trauma Patients

Absolute criteria*
A new or increasing infiltrate on chest film
Purulent tracheobronchial secretions
Sputum Gram's stain with many PMNs, < 10 epithelial cells, and the predominance of one organism
Additional criteria
Fever with temperature > 100.4°F
Leukocytosis or leukopenia
Rales or dullness on percussion on chest physical examination
No improvement on chest film after two to three treatments of chest physiotherapy over a 6-h period

PMNs, polymorphonuclear neutrophils.

* Patients must meet all three of these criteria for the diagnosis of clinical pneumonia.

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.[6] 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 χ^2 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

Table 3 Characteristics of Study Population

	Field Intubation	Hospital Intubation	p Value
Age (yr)	35 ± 21	40 ± 15	NS
ISS	20.1 ± 8	19.2 ± 9	NS
HAIS score	4.9 ± 0.7	4.5 ± 0.9	NS
GCS score (field)	4.0 ± 0.8	4.4 ± 2.1	NS
GCS score (admission)	4.3 ± 1.9	4.9 ± 1.7	NS
O_2 saturation (field)#	89 ± 7	91 ± 6	NS
SBP (field)	105 ± 33	111 ± 39	NS
Ventilator days	14.7 ± 11*	10.4 ± 8.7	0.003
Hospital days	20.2 ± 12.6*	16.7 ± 10.9	0.04
ICU days	15.2 ± 9.3*	11.7 ± 7.8	0.005
Pneumonia (%)	49*	32	0.02
Mortality (%)	23*	12.4	0.05

NS, not significant; ISS, Injury Severity Score; HAIS, head Abbreviated Injury Scale; O_2, oxygen; SBP, systolic blood pressure.
Data are presented as mean ± SD.
* Statistics by Pearson's χ^2 analysis and t test.
# Prior to intubation.

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 had 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%, $p < 0.05$).

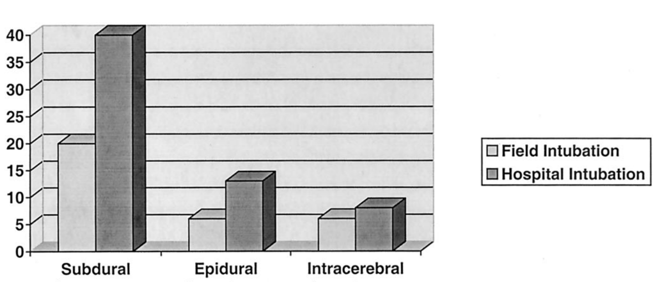

Fig. 1. *Incidence of clot-related injuries by group.*

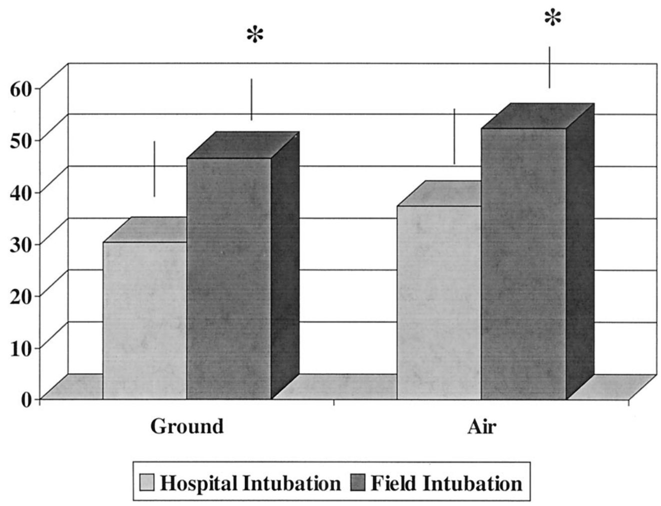

Fig. 2. *Average time from dispatch to hospital arrival by mode of transport (minutes).*

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-

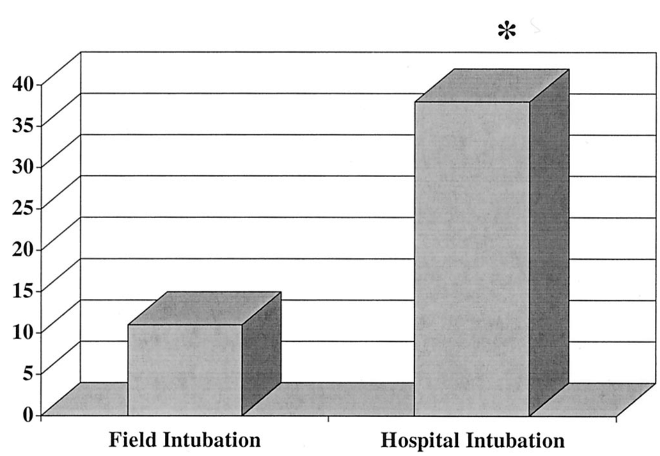

Fig. 3. *Number of immediate neurosurgical procedures comparing the field intubation group with the hospital intubation group (n = 49) (*p < 0.05).*

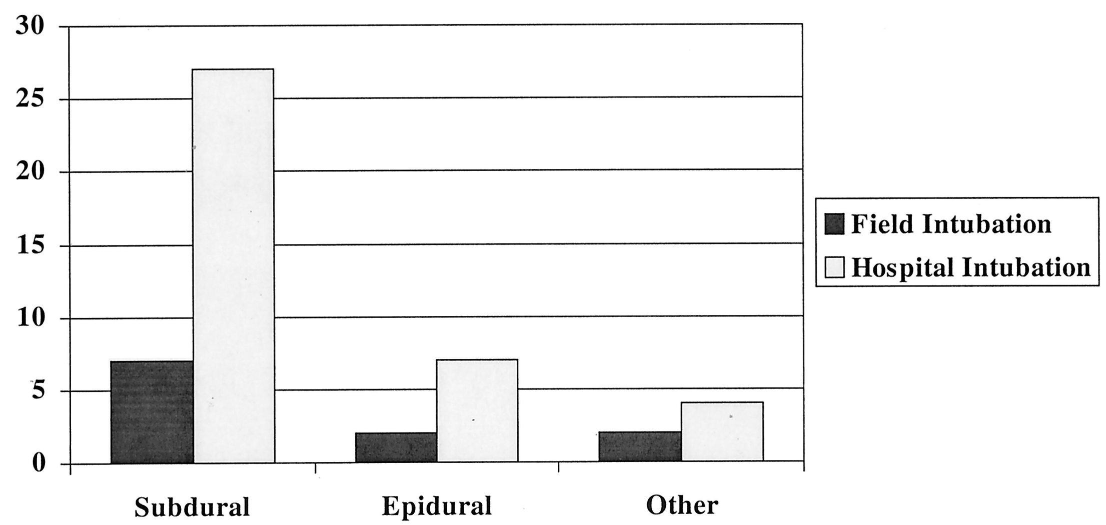

Fig. 4. *Neurosurgical procedures stratified by airway placement.*

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.[7,8] 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).[3] 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.[9]

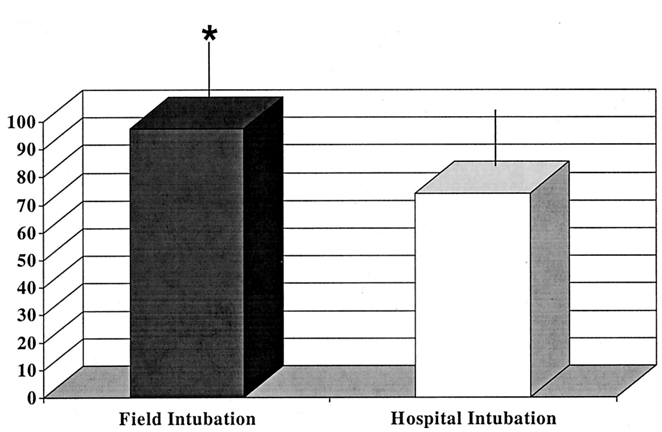

Fig. 5. *Average time from dispatch to operating room (minutes) (*p < 0.05).*

In a retrospective review of 852 patients in 13 trauma centers in Los Angeles County, Murray et al. compared brain-injured prehospital-intubated patients with hospital-intubated patients.[2] The authors concluded that prehospital-intubated patients had a 1.74 times greater risk of mortality. This study did not report data on pneumonia rates or hospital length of stay.

The National Pediatric Trauma Registry was queried to examine 31,464 pediatric patients with severe brain injury comparing prehospital-intubated patients to bag-valve-mask–ventilated patients.[4] Prehospital endotracheal intubation offered no demonstrable survival or functional advantage when compared with prehospital bag-valve-mask ventilation.

In a randomized, prospective trial of 830 consecutive patients aged 12 years or younger, patients were assigned to receive either bag-valve-mask ventilation (n = 410) or endotracheal intubation (n = 420).[5] There was no significant difference in survival or neurologic outcome between the bag-valve-mask ventilation group and the endotracheal intubation group. These results demonstrated that the addition of out-of-hospital endotracheal intubation to a paramedic scope of practice that already includes bag-valve-mask ventilation did not improve overall or neurologic outcome of pediatric patients treated in an urban Emergency Medical Services system.

The goal of our study was to prospectively evaluate the morbidity and mortality in patients with non–acutely lethal traumatic brain injury in a statewide trauma system, because this is a distinct population that has not been previously studied. The Maryland Emergency Medical System has highly trained paramedics staffing the Maryland aeromedical system. Each of these paramedics is trained in oral endotracheal intubation in a proscribed course by Shock Trauma Center anesthesiologists and adhere to strict protocols as listed in Table 1. The state protocol allows only for two attempts at endotracheal intubation unless further directed by a physician. It was decided to exclude multiple (more than 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.

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