Early Intubation in the Management of Trauma Patients: Indications and Outcomes in 1,000 Consecutive Patients

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Background: **The Eastern Association for the Surgery of Trauma Practice Management Guidelines identify indications (EI) for early intubation. However, EI have not been clinically validated. Many intubations are performed for other discretionary indications (DI). We evaluated early intubation to assess the incidence and outcomes of those performed for both EI and DI.**

Methods: **One thousand consecutive intubations performed in the first 2 hours after arrival at our Level I trauma center were reviewed. Indications, outcomes, and trauma surgeon (TS) intubation rates were evaluated.**

Results: **During a 56-month period, 1,000 (9.9%) of 10,137 trauma patients were intubated within 2 hours of arrival. DI were present in 444 (44.4%) and EI in 556 (55.6%). DI were combativeness or altered mental status in 375 (84.5%), airway or respiratory problems in 21 (4.7%), and preoperative management in 48 (10.8%). Injury Severity Score was 14.6 in DI patients and 22.7 in EI patients ($p < 0.001$). Predicted versus observed survival was 96.6% versus 95.9% in DI patients and 75.2% versus 75.0% in EI patients ($p < 0.001$). Head Abbreviated Injury Scale score of ≥3 occurred in 32.7% with DI and 52.0% with EI ($p < 0.001$). Seven (0.7%) surgical airways were performed; two for DI (0.2%). Eleven (1.1%) patients aspirated during intubation and five (0.5%) suffered oral trauma. There were no other significant complications of intubation for either DI or EI and complication rates were similar in the two groups. Delayed intubation (early intubation after leaving the trauma bay) was required in 67 (6.7%) patients and 59 (88.1%) were for combativeness, neurologic deterioration, or respiratory distress or airway problems. Intubation rates varied among TS from 7.6% to 15.3% ($p < 0.001$) and rates for DI ranged from 3.3% to 7.4% ($p < 0.001$). There was a statistically insignificant trend among TS with higher intubation rates to perform fewer delayed intubations.**

Conclusions: **Early intubation for EI as well as DI was safe and effective. One third of the DI patients had significant head injury. Surgical airways were rarely needed and delayed intubations were uncommon. The intubation rates for EI and DI varied significantly among TSs. The Eastern Association for the Surgery of Trauma Guidelines may not identify all patients who would benefit from early intubation after injury.**

Key Words: **Airway, Cricothyroidotomy, EAST Practice Management Guidelines, Intubation.**

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Airway control is the first priority in the management of the injured patient. Those at particular risk should have the airway protected by an endotracheal tube to provide oxygen, maintain ventilation, and reduce the risk of aspiration.[1] Failure to secure a proper airway remains a major cause of preventable death after injury, even at Level I trauma centers.[2–4] Recognizing the importance of airway control, in 2002 the Eastern Association for the Surgery of Trauma (EAST) published indications for early intubation in trauma patients.[5,6] The EAST indications (EI) include airway obstruction, hypoventilation, severe hypoxemia, severe cognitive impairment (Glasgow Coma Scale, GCS score of ≤8), cardiac arrest, and severe hemorrhagic shock. Although evidence-based, EI have not been clinically validated. Many intubations during the early period after injury are done at the discretion of the trauma surgeon (TS) for a variety of other patient conditions that indicate airway control may be at risk. These discretionary indications (DI) include facial injury, altered mental status, combativeness, respiratory distress, intoxication, and preoperative management. We evaluated the practice of early intubation at our Level I trauma center to assess the incidence and outcomes of those performed for both EI and DI.

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MATERIALS AND METHODS

The trauma registry, medical records, and hospital Picture Archiving and Communications System were retrospectively reviewed from October 20, 2001 through June 30, 2006 for 1,000 consecutive trauma patients who underwent early intubation at our adult Level I trauma center. Early intubation was defined as endotracheal intubation or surgical airway performed for any reason in any hospital location within the first 2 hours after arrival. Patients intubated in the field or at

another hospital were excluded from the study unless they required reintubation within 2 hours of arrival at our trauma center.

The decision for early intubation at our center was made by the TS. An emergency medicine physician (EMMD) responded to all trauma activations, with orotracheal intubation usually performed during resuscitation in the trauma bay by the EMMD or a resident (RES) (postgraduate year 2–4) under direct EMMD supervision. The intubating RES was restricted to one or two attempts, depending on the stability of the patient, before the EMMD took over. EMMDs encountering especially difficult airways called for the assistance of an anesthesiologist (AN). Uncommonly, the TS either performed or supervised a RES in performing the intubation. Intubations for general anesthesia in the operating room (OR) were performed by the AN. In patients who could not be intubated, the TS performed cricothyroidotomy by open technique.

Our protocol for orotracheal intubation of awake patients employed a standard rapid sequence induction (RSI) technique. The protocol included preoxygenation with 100% oxygen and the administration of etomidate (0.3 mg/kg), succinylcholine (2.0 mg/kg), and lidocaine (1.5 mg/kg) for patients with suspected head injury. Bag-valve-mask ventilation was avoided before intubation unless the patient's ventilation was inadequate. During the procedure, cardiac rhythm, blood pressure, and oxygen saturation were monitored. Manual in-line cervical stabilization was maintained and cricoid pressure was continuously applied. Orotracheal tube passage was attempted only when the vocal cords were clearly visualized. Once the tube was placed, tracheal tube placement was confirmed with a colorimetric carbon dioxide (CO_2) detector, inspection and auscultation of the chest and epigastrium, and pulse oximetry. An oral gastric tube was then placed to aspirate as much of the gastric contents as possible. Tube position was checked by chest roentgenogram or promptly performed chest computed tomography (CT). A trauma nurse and a respiratory therapist remained with the patient until arrival at the intensive care unit or the OR.

The details of intubations were reviewed for the primary indication for intubation, location of procedure (trauma bay, OR, or other area), level and specialty of physician performing the procedure (EMMD, TS, AN, or RES), route used (orotracheal or other method), adherence to RSI protocol, number of intubation attempts, postintubation imaging to confirm tube placement, and complications directly related to the intubation procedure. An intubation attempt was defined as a single pass of a laryngoscope blade or an endotracheal tube. Minor complications were transient physiologic alterations or technical problems that were easily correctible, including hypoxemia (decrease in oxygen saturation by pulse oximetry to $\leq$95% during an intubation attempt); bradycardia (significant drop in heart during an intubation attempt); esophageal intubation (endotracheal tube in the esophagus immediately detected by physical examination and colorimetric CO_2 detector); and mainstem intubation (endotracheal tube in the mainstem bronchus detected by postintubation imaging). Major complications included aspiration pneumonia (witnessed aspiration followed by radiologic evidence of infiltrates in one or both lower lobes); undetected esophageal intubation; oral trauma (lip, dental, or oropharyngeal injury attributed to laryngoscopy); and cricothyroidotomy.

Patients were categorized by their primary indication for intubation according to a hierarchical list of 10 indications, beginning with five EI followed by five DI (described below). This allowed selection of the single most clinically significant reason for intubation in patients with multiple indications. In all cases, patient assignment to a category was based on clinical data available at the time of intubation and providers' rationale for performing the procedure.

The rank order and definition of EI included (1) airway obstruction (facial or neck trauma with apparent inability to move air, physical examination findings of "gurgling" or "sonorous" respirations, or significant blood or gastric contents in the airway); (2) hypoventilation or hypoxemia (respiratory rate $\leq$12, apnea, use of bag-valve-mask ventilation or Combitube, or sustained transcutaneous oxygen saturation [$TcPo_2$] $\leq$95% despite supplemental oxygen); (3) cardiac arrest (cardiopulmonary resuscitation in progress or pulseless ventricular arrhythmia); (4) severe cognitive impairment (GCS score of $\leq$8); and (5) severe hemorrhagic shock (systolic blood pressure $<$100 mm Hg or history of significant and persistent hypotension in the field).

DI, which included other indications for intubating trauma patients based on the literature and clinical experience, were rank ordered and defined as (1) facial or neck injury (significant injury to face or neck without airway obstruction); (2) altered mental status (GCS score of $>$8); (3) combativeness (uncooperative behavior impeding evaluation and management or physically dangerous behavior); (4) respiratory distress (significant dyspnea despite the presence of normal vital signs and $TcPo_2$ $>$95%); and (5) preoperative management (intubation before going to the OR, often to facilitate pain management). Another potential indication, intoxication, was not included in the final list of DI; instead, the altered mental status or combative behavior that resulted from the suspected intoxication was used as the primary indication.

All intubations were reviewed for patient age, gender, mechanism of injury, Injury Severity Score, head Abbreviated Injury Scale, GCS, length of hospital stay, and a delay in intubation. Delayed intubation was defined as early intubation performed after the patient exited the trauma bay for transport to another location in the hospital other than the OR, unless the delay to intubation in the OR was inappropriate. Finally, individual TS rates of intubation for EI and DI and rate of delayed intubation were determined and compared.

Statistical analysis was performed using standard (Mantel-Haenszel) χ^2 analysis (Epi Info version 3.3.2, Centers for Disease Control, Atlanta, GA) for dichotomous variables and

Table 1 Priority and Frequency of Indications for Intubation

EAST indications (n = 556)	
Airway obstruction	149 (14.9%)
Hypoventilation/hypoxemia	194 (19.4%)
Cardiac arrest	2 (0.2%)
Severe cognitive impairment (GCS score of ≤8)	127 (12.7%)
Severe hemorrhagic shock	84 (8.4%)
Discretionary indications (n = 444)	
Facial or neck injury	15 (1.5%)
Altered mental status (GCS score of >8)	248 (24.8%)
Combativeness	127 (12.7%)
Respiratory distress	6 (0.6%)
Preoperative management	48 (4.8%)
Total	1,000 (100%)

the Student's *t* test (Excel 2003, Microsoft Corp., Redmond, WA) for quantitative variables. The study was reviewed and approved by our trauma center's institutional review board.

RESULTS

Of the 10,137 trauma patients evaluated during the 56-month study period, 1,078 (10.6%) were intubated. Seventy-eight patients were excluded: 77 patients intubated in the field or another institution and one stillbirth delivered by emergency C-section. The remaining 1,000 (9.9%) patients who were intubated within 2 hours postadmission consisted of 556 (55.6%) patients intubated for EI and 444 (44.4%) patients intubated for DI (Table 1). The age and gender of the two groups did not differ significantly. EI patients were more severely injured than DI patients, as defined by a higher Injury Severity Score and lower admission GCS, and had a longer hospital length of stay and a higher mortality rate (Table 2).

Overall, the most common indication for intubation was altered mental status (GCS score of >8), a DI, accounting for 248 (24.8%) patients (Table 1). The second most common was hypoventilation or hypoxemia, an EI, in 194 (19.4%) patients. Third was airway obstruction, an EI, in 149 (14.9%) patients. Severe cognitive impairment (GCS score of ≤8), an EI, was present in 127 (12.7%) patients and was fourth along with combativeness, a DI, in 127 (12.7%) patients. Fifth was severe hemorrhagic shock, an EI, present in 84 (8.4%) patients. Preoperative management, a DI, was sixth as the indication in 48 (4.8%) patients.

Analysis of those indications related to altered mental status and behavior revealed both the role of intoxication (blood alcohol concentration ≥80 mg/dL or positive toxicology test) and the presence of head injury (head Abbreviated Injury Scale score of ≥3). Of those intubated for the DI of combativeness, 90.3% were intoxicated and 12.6% had significant head injury. Patients intubated for the DI of altered mental status (GCS score of >8) had a 69.6% rate of intoxication and a 49.8% rate of head injury. Of those intubated for the EI of severe cognitive impairment (GCS score of ≤8), 68.9% were intoxicated and 66.1% had a head injury.

Table 2 Demographic Data, Mechanism, and Severity of Injury, Length of Hospital Stay, and Survival in 1,000 Consecutively Intubated Trauma Patients

	EI (n = 556)	DI (n = 444)	*p*
Male (%)	77.2	79.3	NS
Female (%)	22.8	20.7	
Mean age (±SD)	38.8 ± 19.3	38.1 ± 16.8	NS
Mechanism of injury			
Blunt (%)	72.7	86.0	<0.001
Penetrating (%)	27.3	14.0	
Alcohol or drug intoxication (%)	66.9	75.4	<0.01
Mean ISS (±SD)	22.7 ± 15.3	14.6 ± 10.6	<0.001
Mean GCS (±SD)	9.1 ± 4.9	13.3 ± 2.3	<0.001
Mean AIS (±SD)			
Head	2.7 ± 1.9	2.3 ± 1.5	<0.001
Face	0.5 ± 0.9	0.4 ± 0.8	NS
Chest	1.4 ± 1.7	0.8 ± 1.3	<0.001
Abdomen/pelvis	1.0 ± 1.4	0.6 ± 1.1	<0.001
Extremity	0.9 ± 1.3	0.8 ± 1.2	NS
Integument	0.9 ± 0.7	1.0 ± 0.6	<0.05
Mean LOS (d ± SD)	12.1 ± 19.0	8.7 ± 15.2	<0.01
Survived	417 (75.0%)	426 (95.9%)	<0.001

Alcohol and drug testing available in 898 (89.8%) of patients; 487 (87.6%) EI; and 411 (92.6%) DI.

EI, EAST indications; DI, discretionary indications; NS, not significant; SD, standard deviation; ISS, Injury Severity Score; GCS, Glasgow Coma Scale; AIS, Abbreviated Injury Scale; LOS, length of stay; d, days.

Table 3 Type, Attempts, and Location of Intubation for East Indications (EI) and Discretionary Indications (DI)

Type of Intubation	EI (%)	DI (%)	Total (%)
Total intubations	556 (100)	444 (100)	1,000 (100)
Standard orotracheal intubations	544 (97.8)	432 (97.3)	976 (97.6)
Orotracheal in operating room	6 (1.1)	10 (2.3)	16 (1.6)
Nasotracheal	1 (0.2)	0 (0.0)	1 (0.1)
Cricothyroidotomy	5 (0.9)	2 (0.5)	7 (0.7)
Standard orotracheal intubations (Attempts)			
Total	544 (100)	432 (100)	976 (100)
Attempts known	531 (97.6)	418 (96.7)	949 (97.2)
Intubated on first attempt	459 (86.4)	353 (84.4)	812 (85.6)
Intubated on ≤3 attempts	528 (99.4)	411 (98.3)	939 (98.9)
Intubated on >3 attempts	3 (0.6)	7 (1.7)	10 (1.1)
Standard orotracheal intubations (Location)			
Total	544 (100)	432 (100)	976 (100)
Location known	537 (98.7)	420 (97.2)	957 (98.1)
Trauma bay	521 (97.0)	407 (96.9)	928 (97.0)
ED	8 (1.5)	9 (2.1)	17 (1.8)
Radiology	4 (0.7)	1 (0.2)	5 (0.5)
ICU	4 (0.7)	2 (0.5)	6 (0.6)
Medical/surgical floor	0 (0.0)	1 (0.2)	1 (0.1)

ED, emergency department; ICU, intensive care unit.

Successful orotracheal intubation was performed in 992 (99.2%) patients. The vast majority (97.0%) were performed in the trauma bay. Sixteen (1.6%) were performed in the OR

under general anesthesia. Intubation with RSI was confirmed in 952 (96.7%) of the 984 patients whose data were available (Table 3). Information regarding the physician performing the orotracheal intubation and the number of attempts was available in 949 (97.2%) patients (Table 3). Orotracheal intubation was accomplished at the first attempt in 85.6% of patients overall, including 86.4% in the EI group (459/531) and 84.4% in the DI group (353/418), with a success rate within three attempts of 98.9% (939/949). RES physicians performed 373 (38.2%) of the intubations and were significantly less successful at their first attempts at intubation compared with attending physicians (78.0% vs. 92.2%, $p < 0.001$). Radiologic imaging was obtained in 968 (99.3%) of the 975 patients who did not die from their injuries shortly after intubation or who were intubated in the OR. Seven (0.7%) patients did not have chest imaging after intubation.

Of the eight (0.8%) airways not secured by orotracheal technique, one (0.1%) involved a cooperative patient with an isolated severe open mandible fracture who underwent awake nasotracheal intubation with topical anesthetic administered by an AN in the trauma bay. Seven patients (0.7%) required cricothyroidotomy, five for EI, and two for DI, after failed attempts at orotracheal intubation in the trauma bay (Table 4).

Complications related to intubation occurred in 116 (11.6%) patients, including 65 (11.7%) intubated for EI and 51 (11.5%) intubated for DI (Table 5). Complications were more common when RESs were involved in the intubation than when they were not (14.2% vs. 9.7%; $p < 0.05$), and the rate of complications increased with the number of intubation attempts ($p < 0.001$). In addition to cricothyroidotomy, major complications consisted of aspiration pneumonia in 5 (0.9%) EI and 6 (1.4%) DI, and oral trauma in 2 (0.4%) EI and 3 (0.7%) DI. Minor complications in both EI and DI patients included hypoxemia, bradycardia, immediately detected esophageal intubation, and mainstem bronchus intubation. All mainstem intubations were promptly identified and remedied by tube repositioning. Major and minor complication rates were similar in EI and DI.

Fifty-seven (5.7%) patients overall had cervical spine injuries, but suffered no new or worsening neurologic deficit from intubation. One hundred fifty-seven (15.7%) patients, including 139 (25.0%) EI and 18 (4.1%) DI, died as a result of their injuries. Failure or delay in obtaining an airway within 2 hours postadmission did not contribute to any of these deaths.

Delayed intubation after leaving the trauma bay was performed in 67 patients. The most common indication was altered mental status in patients with a GCS score of >8, a DI (Table 6). The overall rate of complications was similar in the delayed group compared with those intubated earlier (11.9% vs. 11.6%, $p =$ not significant). The rate of major complications was higher but not significantly different in the delayed

Table 4 Indications for Cricothyroidotomy in 7 of 1,000 Intubations in Trauma Patients

Patient No.	Age (yr)	Sex	MOI	Indication for Cricothyroidotomy	GCS	ISS	EI/DI	Outcome
1	49	M	Fall	Profuse vomitus; occluded airway	3	16	EI	Died/h. 19
2	35	M	SW	Anterior airway	14	16	EI	Survived
3	23	M	GSW	Penetrating wound to neck	15	17	EI	Survived
4	29	M	GSW	Airway deviated to right	10	13	EI	Survived
5	30	F	GSW	Penetrating wound to face	3	30	EI	Died/h. 3
6	45	M	Fall	Micrognathia, difficult airway	15	14	DI	Survived
7	48	M	Assault	Micrognathia	13	5	DI	Survived

No., number; MOI, mechanism of injury; GCS, Glasgow Coma Scale; ISS, Injury Severity Score; EI, EAST indications; DI, discretionary indications; M, male; F, female; h, hour; SW, stab wound; GSW, gunshot wound.

Table 5 Complications of Intubation in 1,000 Consecutive Patients

	EI Patients (556)	DI Patients (444)	Total (1,000)	*p*
Major complications				
Aspiration pneumonia*	5 (0.9%)	6 (1.4%)	11 (1.1%)	NS
Cricothyroidotomy	5 (0.9%)	2 (0.5%)	7 (0.7%)	NS
Oral trauma	2 (0.4%)	3 (0.7%)	5 (0.5%)	NS
Undetected esophageal intubation	0 (0.0%)	0 (0.0%)	0 (0.0%)	NS
Total	12 (2.2%)	11 (2.6%)	23 (2.3%)	NS
Minor complications				
Hypoxemia	21 (3.8%)	19 (4.3%)	40 (4.0%)	NS
Bradycardia	2 (0.4%)	1 (0.2%)	3 (0.3%)	NS
Detected esophageal intubation	16 (2.9%)	13 (2.9%)	29 (2.9%)	NS
Mainstem intubation	27 (4.9%)	19 (4.3%)	46 (4.6%)	NS
Patients with at least one complication	65 (11.7%)	51 (11.5%)	116 (11.6%)	NS

*Pneumonia related to aspiration at intubation—prehospital aspirations excluded.
EI, EAST indications; DI, discretionary indications; NS, not significant.

Table 6 Delayed Intubations: Indications, Complications, and Location

	No.	%
Indications (n = 67)		
Airway obstruction	8	(11.9)
Hypoventilation/hypoxemia	10	(14.9)
Cardiac arrest	1	(1.5)
Severe cognitive impairment (GCS score of <8)	2	(3.0)
Severe hemorrhagic shock	2	(3.0)
Facial or neck injury	1	(1.5)
Altered mental status (GCS score of >8)	28	(41.8)
Combativeness	9	(13.4)
Respiratory distress	1	(1.5)
Preoperative management	5	(7.5)
Complications (n = 67)		
Major complications		
Aspiration pneumonia	2	(3.0)
Oral trauma	1	(1.5)
Minor complications		
Hypoxemia	1	(1.5)
Bradycardia	1	(1.5)
Detected esophageal intubation	2	(3.0)
Mainstem intubation	1	(1.5)
Any complication	8	(11.9)
Where Intubation was Performed (n = 64)		
Trauma bay	45	(70.3)
ED	5	(7.8)
Radiology	3	(4.7)
ICU	6	(9.4)
Operating room	4	(6.3)
Medical/surgical floor	1	(1.6)

GCS, Glasgow Coma Scale; ED, emergency department; ICU, intensive care unit.

group (4.5% vs. 1.9%, $p = 0.16$). No surgical airways were required. More than two thirds of the delayed intubations were performed after returning the patient to the trauma bay specifically for the intubation procedure. Five (7.5%) were performed in the emergency department after CT scan findings of major intracranial hemorrhage in patients who became trauma consults.

The individual TS intubation rate varied significantly from 7.6% to 15.3% ($p < 0.001$). These differences were also reflected in the range of EI rates (3.8–7.9%, $p < 0.001$) and the range of DI rates (3.3–7.4%, $p < 0.001$). The rates of delayed intubation also varied from 0.26% to 0.87% (not significant). Although there was a trend toward fewer delayed intubations for surgeons with a higher overall intubation rate, this was not statistically significant.

DISCUSSION

We found that our overall intubation rate was 10% and that a significant proportion (44%) of the 1,000 consecutive intubations were performed for DI, usually combativeness or altered mental status, not identified by the EAST Practice Management Guidelines.[5,6] One in three DI patients had significant head injury, the majority (62.7%) of whom were intoxicated. There were few major complications associated with the intubation procedure and the surgical airway rate was only 0.7%. Delayed intubation during the first 2 hours of care was infrequent (6.7%) and was not significantly more complicated than earlier intubations. Individual TS rates of EI and DI varied widely and there was a slight trend toward performing more delayed intubations in those whose overall intubation rate was lower.

Our study appears to be the first to evaluate the practice of early intubation against the guidelines recommended for the procedure by EAST.[5,6] Recent studies on the inhospital practice of trauma intubation have generally focused on the safety of emergency medicine-managed intubations, evidencing positive intubation outcomes under an airway management protocol and similar success rates compared with anesthesia-managed intubations.[7–10]

More pertinent to the present discussion are the earlier studies on trauma intubation that focused on the safety and efficacy of the RSI technique. For example, in 1988 Talucci et al. reported 260 successful emergency oral endotracheal intubations using the RSI technique with no hemodynamic or neurologic complications secondary to RSI or intubation.[11] In 1989, Dunham et al. reported a series of 1,461 patients with blunt injuries undergoing intubation within the first postadmission hour, virtually all via orotracheal route with RSI.[12] Of the 81 patients with cervical spine injury who were intubated immediately upon admission, none had neural function deterioration related to intubation. In 1993, Rotondo et al. reported a series of 204 patients undergoing orotracheal intubation with RSI within 8 hours of admission.[13] They found an intubation mishap rate of 12% and a concurrent pulmonary complication rate of 8%. Likewise, in 1994 Norwood et al. reported a series of 299 emergency orotracheal intubations, including 175 (76.4%) with RSI.[14] They identified a 97% overall intubation success rate, with only one (0.4%) complication related to intubation and six (2.6%) cricothyroidotomies.

Many of these early studies give the reasons for intubation, but they predate the EAST Guidelines[5,6] and the varying indications reported make a comparison difficult. Intubation to control the patient who is combative, however, does recur with some consistency. Thus, Norwood et al. observed fully 33% of their trauma intubations were to control combative behavior;[14] Rotondo et al. reported a rate of 12%.[13] Yet another review by Kuchinski et al. revealed that of 563 trauma patients undergoing emergency paralysis with intubation, 57 (10%) were paralyzed expressly for agitation and combativeness, 50% of whom were found to be legally intoxicated.[15] Our 12.6% rate of intubation for combativeness, a DI, was either similar to or low compared with these reports. The patients we intubated for combativeness were very likely (90%) to be intoxicated.

More than a few of our patients were intubated for preoperative management to facilitate pain relief, a DI. Early intubation of patients destined for the OR to provide relief from pain caused by trauma is important because timely analgesia is associated with improved patient outcomes.[16]

Unfortunately, the need for analgesia can be missed during trauma resuscitations, particularly in intubated patients. In 2006, Chao et al. reported analgesic use in a series of 120 patients undergoing intubation during the acute trauma resuscitation.[17] Only half (51%) received analgesia during their stay in the trauma bay; intubation was performed specifically to control severe pain in only four (3%). Our 4.8% rate of intubation for preoperative management to facilitate pain relief is consistent with their report.

That nearly half of the early intubations at our center were for DI is surprising. One possible explanation for this finding is that we are intubating too many of our trauma patients. However, a variety of trauma centers have reported a wide range (8.7–27%) of trauma patients undergoing emergency tracheal intubation, with an average of 19.4%.[11–13,15,18,19] Our overall rate of intubation of 10% is at the lower end of the spectrum. Another possibility is that with the implementation of prehospital (paramedic) RSI protocols,[20] the trauma center patient intubation pool experiences a decrease in the number of patients evidencing "hard" intubation indications (i.e. EI) and a relative increase in the number of intubations for discretionary reasons. Yet a review of our data over time does not bear this out (Fig. 1). During the study interval, the number of prehospital intubations remained low and the rates of EI and DI intubations did not significantly change. A third possibility is that the EAST Guidelines[5,6] do not adequately address the trauma patients who need airway control that are identified all or in part by DI. This explanation is not without merit. Although the patients we intubated for DI tended to be less injured than EI patients overall, one third of DI patients had significant head injury. Moreover, less than 7% of DI patients were deemed appropriate for discharge within 24 hours.

One of the concerns of an aggressive intubation policy is the risk of airway failure, precipitating the need for cricothyroidotomy. Although rare, failed laryngoscopy after RSI can pose catastrophic consequences when combined with an inability to ventilate.[21] However, in our study only two patients with DI and five patients with EI required cricothyroidotomy, at an overall rate of 0.7%. This compares favorably with the cricothyroidotomy rates in trauma patients reported in the literature, which vary in the range of 0.3% to 4.1% (mean 1.4%).[7–10,13,14,18,19,22]

We achieved a successful intubation in 86% of patients after the first attempt and more than 98% after the third attempt. Other similar studies involving trauma patients have reported success rates after the first attempt from 73.7% to 86.4% and from 91.6% to 97% after the third attempt.[7–10] Our success rate is equal to or better than previously published studies.

We experienced a major complication rate of 2.3%, including the need for cricothyroidotomy, and an overall 11.9% of patients suffered at least one complication. The rate of complications rose with the number of attempts; RES involved intubations incurred more complications. There were no intubation related deaths or spinal cord injuries. Given the inclusion of transient physiologic alterations and cricothyroidotomy among our reported complications, these rates appear similar to those encountered by other authors reporting retrospective series of intubations in trauma patients.[13,14] The rate of complications we observed with delayed intubations was similarly low.

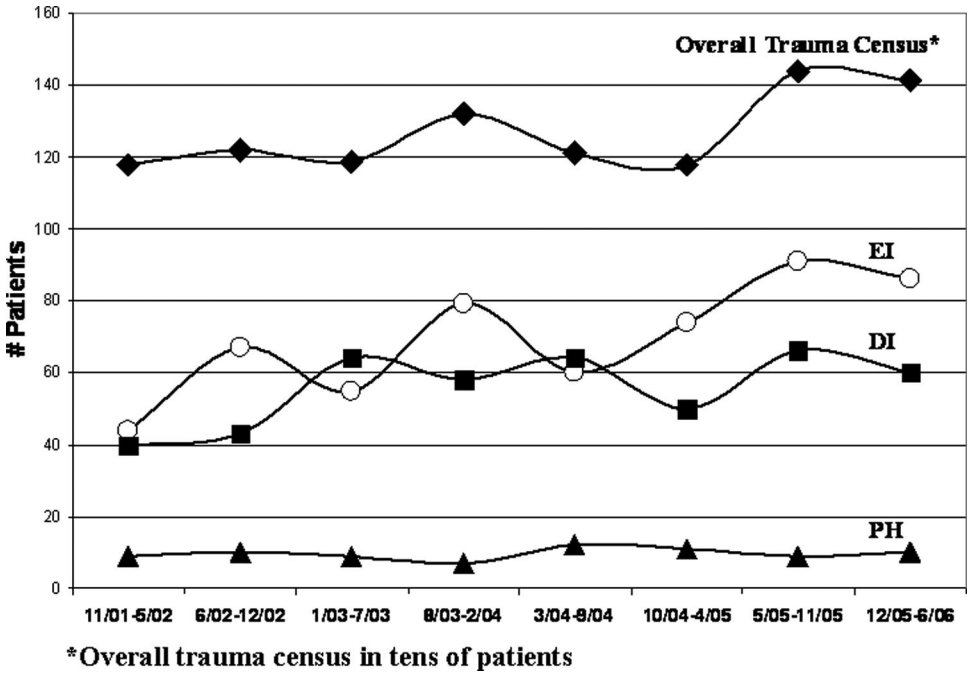

Fig. 1. *Prehospital (PH), EAST indication (EI), and discretionary indications (DI) intubations in comparison with trauma patient volume.*

The small number of patients comprising the delayed group experienced slightly more complications, raising the question whether they should have been intubated earlier. By far the most common indication for intubation in this group was altered mental status (GCS score of >8). These patients appeared to suffer neurologic decline after the attending TS decided it was safe for them to leave the trauma bay unintubated. In many cases, a subsequent CT scan revealed significant intracranial injury. Whether these patients' mental status changes and need for intubation should have been anticipated is difficult to assess retrospectively.

We think that our high rate of successful intubation and few complications resulted from a consistently applied intubation protocol which emphasized preoxygenation, manual in-line stabilization to protect the cervical spine, cricoid pressure to prevent aspiration, and postintubation clinical tests and imaging to confirm tube placement. The vast majority of our intubations were performed with RSI, which has been associated with high intubation success rates and low complication rates in critically ill and injured patients.[10,13,23,24] In addition, all intubations performed by RES physicians were conducted under the direct supervision of attending physicians. When intubation was required after leaving the trauma bay, we returned the patient to the trauma bay whenever possible and reassembled the necessary personnel for the procedure. These measures may well have facilitated intubation and kept complications to a minimum. Similar observations have been made by other authors in their analysis of emergency intubation techniques.[8,10,12]

Individual TSs rates of DI in our study varied widely. Although there was a trend for surgeons with lower intubation rates to perform more delayed intubations after leaving the trauma bay, the small number of these intubations (6.7%) precluded statistical inference. Loss of the airway in an environment without immediate access to advanced airway devices and key support members of the trauma team, e.g. the CT scan suite, is less than optimal and may precipitate a series of catastrophic events. Indeed, in all inhospital emergency airway procedures performed outside of the OR, the incidence of severe hypoxia preceding cardiac arrest has been reported to be as high as 90%.[25]

The identification of trauma patients who require early intubation in the trauma bay is frequently difficult. Airway management of patients with isolated injuries may differ from that of the patients with multiple injuries and be further complicated by intoxication or combativeness. Screening tests to predict difficult airways in emergency patient intubations are of limited value.[21] In the absence of more comprehensive, evidence-based guidelines for early intubation, variability will exist in the practice of early intubation with institutional or individual surgeon preferences, rather than evidence-based patient indications, guiding care.

We did not analyze the cost of hospitalization in this study. Trauma patients with low injury severity who require restraint for agitation and combativeness have been reported to have significantly higher costs if they are paralyzed and intubated than if they are not.[15] Presumably, many of our DI patients would likewise incur extra costs. However, this assumption does not account for potential expenses associated with avoidable delays in diagnosis or an inability to treat because of a loss of airway control or patient control.

The results and conclusions of this study at a single Level I trauma center with a strictly enforced intubation protocol may not be relevant to other centers. Although complete data were available in more than 95% of our patients, we are limited by the retrospective nature of our study. We did not have access to long-term outcomes and, in the absence of a randomized controlled trial, certain patient characteristics could confound comparisons between the DI and EI groups.

Our findings nonetheless demonstrate that early intubation of trauma patients for both EI and DI is safe and effective. Surgical airways were rarely needed and delayed intubations were uncommon. Consistent adherence to our intubation protocol may have kept complications to a minimum. DI appear to be important reasons for intubation given that one third of these patients had significant head injury. The EAST Practice Management Guidelines[5,6] may therefore not identify all patients who would benefit from early intubation after injury.

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DISCUSSION

Dr. Satoshi Ishihara (Japan): The authors retrospectively reviewed their patients that required intubation within two hours after arrival and analyzed indication and the complications of intubation.

A thousand seventy-eight patients were intubated during a four-and-a-half-year period from over 10,000 trauma patients. Compared with former studies this ratio is low.

My first question is, what is entry criteria of total trauma victims in your study? If former studies exclude patients who had mild injury and if your study includes those this might lead to the low incidence ratio of intubation.

And Dr. Sise has shown that 556 patients intubated for EAST Guideline indication, which is abbreviated as EI, 444 patients intubated for other discretionary indications also abbreviated as DI. These results revealed a relatively high ratio of DI compared with former studies.

The authors suggested that the reason this may be is that the EI does not identify all primary and necessary indications for early intubation. I totally agree with your conclusion.

Our domestic guideline of initial treatment for trauma, similar to ATLS, recommends to consider severe head injury and other serious situations such as circulatory shock or intoxication, not only when GCS is below nine but when score is significantly decreased.

Therefore, the most of experienced emergency physicians or trauma surgeon will intubate those patients in Japan regardless the indication criterion depending on evidence-based guidelines.

My second question is whether combativeness or mild but worsening altered mental status is thought to be an optional indication for intubation in the U.S.

If general consensus does not reached that it is essential, I think your emergency physicians, especially trauma surgeons who are trained very well and doing a very good job. They should be applauded.

Third, although overall rates of complication was similar in the delayed group compared to those intubated earlier, the rate of major complication was higher in the delayed group.

I think this is clinically significant, even though it is not statistically significant. Furthermore, I have a concern about no intubation related deaths or spinal cord injuries.

In patients who lost consciousness it is so difficult that the intubation did not contribute to mortality or morbidity, especially in delayed intubated group.

Please describe the detail about how you identified that.

Dr. Michael F. Rotondo (East Carolina, North Carolina): I want to thank Dr. Sise for sending me this manuscript in advance so I can comment from the floor.

First I should say it's superbly written. It's a very well executed retrospective review and it was extremely well presented. When it comes out I would ask all of you to take a look at it. It's going to be aγÇôit's a wonderful manuscript.

Second, just a comment. These conclusions here are virtually identical to the paper that we presented at EAST in 1993, 204 patients of the over 500 patients we presented in '96. This is an excellent punctuation to the conclusions of that study. And here are my questions.

First, Mike, you did not include the revised trauma score or any physiologic data to stratify the patients. Maybe you could explain why or if you think that would change your results.

The second is the variability and practice pattern among surgeons is very interesting, even though the protocol is "strictly enforced." Maybe you could comment on that.

The third is how would you actually change the EAST Guidelines? Would you just include combativeness on the basis of this and the other paper that have gone before?

And my last question is in '93 when I presented this at EAST and declared it to be safe and efficacious, Past Presi-

dent Shackford rose to the microphone and he said, "Well, how is it that you do define safety and efficacy?"

I couldn't explain it then. I don't think I can explain it now. Mike, maybe you can explain what you definitions of "safety and efficacy" were.

Dr. Scott R. Peterson (Phoenix, Arizona): Mike, this was a very nicely presented work. One of the discretionary indications that you didn't include is the 2F word rule a two a.m. by a tired trauma surgeon.

Let me ask you two questions. I've certainly intubated my share of drunks and when they wake up they often self-extubate. Did you look at the self-extubation rate because I notice most of these patients, or a good portion, were extubated within 48 hours?

And, second, do you see any difference with your VAP rates?

Dr. Richard Dutton (Baltimore, Maryland): How often did you invite anesthesiology to the party? And did you have criteria for that, criteria for using bougie, LNA, Glidescope,or other technology?

Dr. Basil A. Pruitt, Jr. (San Antonio, Texas): I enjoyed your paper, Dr. Sise. I noticed that you said one of the discretionary indications was for pain control. Is that to keep the patient from shouting? Or is that to be prepared in case the analgesic dose suppresses ventilation?

Dr. Michael J. Sise (San Diego, California): Thank you all very much for your comments. First of all, thank you Dr. Ishihara for discussing your questions with me ahead of time.

First of all, our criteria for trauma activation are well established guidelines of the San Diego County Trauma System which include a field triage criteria which is determined by severity of injury, comorbidity factors and active communication with the base station and are pretty much competitive with and representative of the way things are done throughout the country.

I must admit, you know, one of the things when you talk about provider-specific rates is confidentiality. And it is an important part of how we report on our results. And I must say there was a trend towards older trauma surgeons intubating more often. And that's—I'll leave it at that.

In terms of mental status, I think the task for us is to look at that 80 percent of the discretionary group who had a GCS greater than eight or who were combative and to try to come up with some reasonable guidelines that reflect what we're doing because truly all around the country we are doing a lot of discretionary intubations. And that's the one area where I think our guidelines can be made more inclusive.

Dr. Rotondo, thank you very much for your comments. You basically were our go-by. We looked at your paper as we were designing our study and identified it as an excellent paper and really tried to use your techniques an the way you looked at things as how we would do things.

We used the prospective of the trauma surgeon in the trauma room and the available data. So, for instance, we didn't look at blood alcohol until we had stratified things later because that's not available to the trauma surgeon.

We looked at the vital signs, the results of tests like x-ray, FAST scan, everything available. We did not reinterpret the outcome. Because the complications were low we did not use revised trauma score or other physiologic data. That may be an important area of future examination.

The safety and efficacy, I think it's a tough issue to define. I think one clear indication is did we harm anybody by intubating them? And that was a very important question to answer.

We have advanced practice trauma nurses who escort the patient dedicated to the trauma service throughout the resuscitative phase of care until they are delivered to the ICU, to the operating room, or to the Med Surg floor. And in this group, obviously, it was the operating room or the ICU.

Scott, you had a question about anesthesia. Anesthesia came when requested. And if we had a very difficult time with an airway we would ask them to come down.

Dr. Pruitt, you asked an important question. There are some injuries which are so severe and require so much in the way of pain medication and who are patients definitely going to the operating room I think it's both compassionate but also a safety issue that they be promptly intubated and that's the group that we're talking about, severe orthopedic trauma in particular in an otherwise hemodynamically stable patient.