Emergency Endotracheal Intubation in Pediatric Trauma

DON K. NAKAYAMA, M.D., MARY J. GARDNER, R.N., and MARC I. ROWE, M.D.

The purpose of this study was to determine the effectiveness and associated problems of emergency intubation in 605 injured infants and children admitted to the Children's Hospital of Pittsburgh in 1987. We identified 63 patients (10.4%) undergoing endotracheal intubation at the scene of injury, at a referring hospital or in our emergency department. Injuries were to the head (90.5%), abdomen (12.7%), face (11.1%), chest (6.3%), neck (3.2%); or were orthopedic (19%) or multiple (39.7%). Indications for intubation included coma (74.6%), shock (28.6%), apnea (22.2%), and airway obstruction (3.2%). Of 16 complications (25.4%), 13 were immediately life threatening: right mainstem intubation (5), massive barotrauma (2), failure of adequate preoxygenation (2), esophageal intubation (1), attempt at nasotracheal intubation in an open facial fracture (1), and extubation during transport (1). Three were late complications: vocal cord paresis (2) and subglottic stenosis (1). Airway complications led to PO2 < 90 mm Hg in 7 of 12 on first ABG, compared to 9 of 44 in uncomplicated cases ($p < 0.05$). Intubation attempts at the scene of injury were more often multiple, unsuccessful, and associated with airway complications. All four complication-associated fatalities were life-threatening scene complications. Nearly one half (44.4%, 28 of 63) had one of the following problems in respiratory management: major airway complication, PaO2 less than 90, or PaCO2 greater than 45 on either the first or second ABG after arrival at our emergency department. Head injury with coma is the most common setting for emergency intubation. Airway complications are common, and are more frequent in treatment attempt at the scene. Despite endotracheal intubation, injured children in our series remain at high risk for hypoxemia, elevated arterial PCO2, and major airway complications, all of which contribute to secondary brain injury.

From the Department of Pediatric Surgery and the Benedum Pediatric Trauma Program, the Children's Hospital of Pittsburgh, and the Department of Surgery, the University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania

AN OPEN AIRWAY and adequate gas exchange are the central goals of trauma care. With the recognition and treatment of shock, they form the now-familiar mnemonic "ABC" (*a*irway, *b*reathing, and *c*irculation) that summarizes the basic priorities of injury management. Current guidelines for trauma care emphasize an aggressive approach to airway management.[1] Early endotracheal intubation is lifesaving in injuries that cause airway obstruction and allows assisted ventilation of the patient in apnea. Many authorities also recommend that patients with severe head injuries undergo early endotracheal intubation.[1,2] Airway obstruction, aspiration, and apnea are among the major hazards to respiratory function in the brain-injured patient. These factors increase the risk of hypoxemia and thus may result in ischemic brain damage, termed secondary injury, that adds to damage already suffered from the initial injury. Injury-induced brain swelling increases intracranial pressure and compromises cerebral perfusion, representing another cause of secondary brain injury. Endotracheal intubation assures optimal gas exchange and allows controlled hyperventilation to decrease intracranial pressure through cerebral vasoconstriction.[2,3]

Despite these compelling arguments that favor early endotracheal intubation under certain critical circumstances, the efficacy of early airway management protocols are unknown. Airway management in children is a particularly difficult task.[1] We therefore reviewed all cases of emergency endotracheal intubation in children admitted to a level I pediatric trauma center during a recent 12-month period.

Materials and Methods

A comprehensive trauma registry records relevant clinical data from all children with significant injuries requiring hospitalization at the Children's Hospital of Pitts-

Supported in part by grants from the Claude Worthington Benedum Foundation and the Health Research and Services Foundation, Pittsburgh, Pennsylvania.

Address correspondence and reprint requests to Don K. Nakayama, M.D., Department of Pediatric Surgery, Children's Hospital, One Children's Place, 3707 Fifth Ave. at DeSoto St., Pittsburgh, PA 15213-2583.

Accepted for publication: June 22, 1989.

burgh. The trauma service registrar and clinical coordinators collect data concurrently with the child's admission, with the intent to insure complete and accurate capture of all patients and information. Source materials for the registry include prehospital trip records (trip sheets), trauma flow sheets in the emergency room and critical care areas of the hospital, progress notes, laboratory and radiology reports, and other material collected on the child's impatient record. All information are entered on a computer with standard database software.

The data contained on the registry allowed the identification of all acutely injured children who underwent emergency intubation during the 1987 calendar year. The following criteria defined emergency intubation: (1) arrival with an endotracheal tube in place after transfer from the scene of the injury; (2) arrival with an endotracheal tube placed at a referring hospital within 12 hours of transfer to our trauma service; and (3) endotracheal intubation in the Children's Hospital of Pittsburgh emergency department (ED).

The trauma service coordinators and physicians identified all deaths and complications during 1987 using a system of review described at length elsewhere.[4] In brief, a prehospital coordinator (an experienced paramedic) and a trauma nurse coordinator identify prehospital and in-hospital complications on all admitted patients on the basis of their experience and trauma service treatment guidelines. We use a system of audit screens to spot undesired occurances, such as an unexpected return to the operating room or intensive care unit. Attending physicians on the trauma service identify problem cases for review on a weekly basis. These procedures to maximize capture of all trauma service deaths and complications for quality review pinpoint cases that posed difficulties in initial airway management.

The first arterial blood gas (ABG) measurements after arrival in our ED determined the efficacy of airway management. For patients arriving with an endotracheal tube in place, we recorded the initial ABG after arrival; for those intubated in our ED, the first ABG obtained after endotracheal intubation was recorded. Many patients had a second ABG in the ED. We reasoned that procedures for airway control should provide a PaO2 that was sufficiently high to provide a margin of safety should untoward events occur without warning. Therefore we chose values of less than 90 mm Hg to represent suboptimal oxygenation in the absence of chest injuries. In addition, because so many of our patients had head injuries, we believed that inadequate ventilation, PaCO2 greater than 45 mm Hg, represented deficient care. We also noted cases characterized by extreme hyperventilation to PaCO2 $\leq$ 25 mm Hg, because of experimental evidence that cerebral ischemia may complicate hypocarbia-induced vasoconstriction when these low levels are reached.[3]

We reviewed hospital records of the identified cases to cross-check data yielded by the registry. We used data from the hospital record when discrepancies occurred. During the year we submitted data from the registry and discharge diagnoses to the Pennsylvania Trauma Systems Foundation, a nonprofit organization responsible for overseeing trauma care in the state. A private firm, Tri-Analytics, Inc. (Rockville MD), coordinated a statewide registry for the Foundation, including computation of the Glasgow Coma Score (GCS), Trauma Score (TS), Abbreviated Injury Score (AIS), and Injury Severity Score (ISS) for each eligible patient with sufficient data. In the few that did not satisfy Foundation inclusion data, we computed GCS and TS using standard procedures,[1,5] and AIS and ISS according to American Association for Automotive Medicine guidelines.[6]

Chi square, Students' t test, and analysis of variance were used for statistical analysis. Yates' correction for chi square analysis was used when degrees of freedom equalled one.

Results

From January 1987 through December 1987, 605 children were admitted to the Children's Hospital of Pittsburgh Trauma Service. Sixty-three patients (10.4%) arrived with an endotracheal tube placed at the scene of injury (9 patients), or at the referring hospital (37 patients), or underwent endotracheal intubation at the Children's Hospital emergency department (17 patients; Table 1). Although children aged 0 to 4 years were intubated more often (28 of 200 patients; 14%) than older children (35 of 405 patients; 8.6%), the difference was not statistically significant. Head injuries were present in all but 5 of the 63 patients (Table 2), and coma was present in nearly three fourths of patients (Table 3). Of the 16 patients with apnea or airway obstruction, 15 were in coma because of head injuries.

TABLE 1. *Patients Undergoing Endotracheal Intubation at the Scene, at the Referring Hospital, or on Admission to the Emergency Room*

	Intubation		Tracheotomy or Needle
Location (N = 63)	Successful	Unsuccessful	Cricothyroidotomy
At scene (9)	8	6*	2
Referring hospital (37)	36	0	1
Children's Hospital (17)	17	0	0

* Of the unsuccessful scene intubations, 3 were successfully intubated at Children's Hospital, 1 was intubated at the referring hospital, and 2 underwent attempts at cricothyroidotomy. One patient with an unsuccessful cricothyroidotomy later underwent successful intubation at the referring hospital. No adequate airway control was possible in the second unsuccessful cricothyroidotomy, which is included in the total of nine scene intubations.

TABLE 2. *Body Region Injured*

Region	N = 63*	%
Head	57	90.4
Neck	2	3.2
Chest	4	6.3
Abdomen	8	12.7
Orthopedic	12	19.0
Facial	7	11.1

* More than one body region was injured in 25 patients (39.7%).

When scene intubations were successful, they more frequently required more than one attempt (6 of 8 cases, $p < 0.05$), compared to those done at the referring hospital (5 of 37 cases) and in our ED (4 of 17 cases). The only unsuccessful attempts at intubation were at the scene of injury, where prehospital personnel were unable to place ETT in 6 of 14 (42.8%) children (Table 1). Of these six, three were subsequently intubated at Children's Hospital and one at the referring hospital. Two others underwent unsuccessful attempts at needle cricothyroidotomy. Both suffered barotrauma with massive subcutaneous emphysema. One of the two, a 14-year-old boy, was later orally intubated at the referring institution before transfer, but he later died of head injuries. The second, an 11-year-old boy, also with head injuries, died during transfer from the scene without adequate airway control.

Airway-related complications occurred in 16 patients (6 scene, 6 referring hospital, and 4 Children's Hospital; 25.4%), summarized in Table 4. Thirteen were immediately life threatening: right mainstem intubation (5), massive barotrauma (2), failure of adequate preoxygenation (2), massive aspiration(1), esophageal intubation (1), attempt at nasotracheal intubation in an open facial fracture (1), and extubation during transport (1). Three were late complications: vocal cord paresis (2) and subglottic stenosis (1).

FIO2, recorded in 35 cases, was 1.0 in 24 (68.8%), 0.8 in 1; 0.5 in 5; and less than 0.4 in 5. The 28 without a recorded FIO2 were ventilated by a bag apparatus supplied by an oxygen tank or a wall oxygen source, and no FIO2 was specifically recorded. In two patients, however, the wall source was not turned on so that the child received room air during bag and mask ventilation that preceded intubation. We considered these airway management complications, even though arterial oxygen levels were 122 and 313 mm Hg on the first ABG after intubation.

TABLE 3. *Associated Conditions*

Condition	N = 63*	%
Coma/unstable neurologic	47	74.6
Shock	18	28.6
Apnea	14	22.2
Airway obstruction	2	3.2
Other	2	3.2
Stable	8	12.7

* More than one condition was present in 19 patients (30.2%).

Table 5 summarizes the incidence of suboptimal oxygenation ($PaO2 < 90$ mm Hg), hypercarbia ($PaCO2 > 45$ mm Hg), and extreme hypocarbia ($PaCO2 < 25$) in 56 cases (four with chest injuries are listed separately, and no ABGs were obtained in three fatalities). Because our goal of oxygen administration is to provide a margin of safety in addition to adequate oxygenation, we decided that airway procedures that did not provide $PaO2 \geq 90$ mm Hg represented suboptimal oxygenation. One in four had a PaO2 less than 90 mm Hg, with significantly more cases with airway complications having low PaO2 than noncomplicated cases ($p < 0.05$). Suboptimal oxygenation occurred more frequently in fatalities and children with apnea but failed to reach statistical significance. Site of intubation (Children's Hospital, transferring hospital, or scene of injury) and age did not significantly influence the occurrance of suboptimal oxygenation or hypercarbia. Hypoventilation ($PaCO2 > 45$) occurred in four children (7.1%). Extreme hyperventilation ($PaCO2 < 25$) was present in 39.3% (15 of 56 cases).

Fifteen children died (23.8%). One died from uncontrolled hemorrhage from avulsion of the hepatic veins. Fourteen died with head injuries, of which three suffered gunshot wounds to the head. The other 11 deaths involved major head injuries with AIS of 3 to 6. Nine of the eleven had no other injuries. One of the two remaining fatalities also had a small bowel laceration and the other had an acetabular fracture. The four deaths involving scene intubations were complicated in each case by a major airway mishap (Table 4). Deaths were not associated with age or site of intubation. Deaths were associated with a higher ISS and Head AIS, as expected (Table 6).

Airway complications, hypoxemia, and hypercarbia reflect difficulties in respiratory management and are summarized in Table 6. At least one of these factors was present in 44.4% of cases (28 of 63 cases) and were significantly more common in scene intubations (77.8%; 7 of 9 cases). Table 7 attempts to show the possible effect of secondary injury due to respiratory management problems (*i.e.*, airway complications, hypoxemia, and hypercarbia) on mortality for head injuries of an equivalent AIS level. No statistically significant differences were found between the mortality rates among children who experienced airway or respiratory difficulties and those free from airway complications when stratified for AIS. However, cases with an airway complication, PaO2 less than 90, or PaCO2 more than 45 had a mortality rate more than twice that of cases free from respiratory problems ($p < 0.05$).

TABLE 4. *Airway Complications in Pediatric Trauma*

Complication	Number	Site*	Age (Years)	Death(s)
Right mainstem intubation	5	1S, 3R, 1C	1, 4, 4, 7, 8	0
Massive subcutaneous emphysema from cricothyroidotomy needle	2	2S	12, 15	2
Esophageal intubation	1	S	1.5 months	1
Failed nasotracheal intubation in a open LeFort III	1	S	4.5	1
Massive aspiration	1	R	15	0
Bilateral vocal cord paralysis	1	R	6	0
Subglottic stenosis	1	R	4	0
Failure of adequate preoxygenation	2	2C	4, 10	0
Extubation during transport	1	S	8	0
Left vocal cord paralysis	1	C	5 months	0
Total	16	6S, 6R, 4C	mean 6.45	4

* Site refers to where the child was intubated: S, scene of injury; R, referring hospital; C, Children's Hospital.

We defined unnecessary intubations as those occurring in survivors who did not have apnea or airway obstruction, had a GCS of more than 10, and were intubated for less than two days. Of our study group, 30.2% (19 of 63 cases) satisfied these criteria. All but one had head injuries. Mean GCS was 14.5, with a range of 10 to 15. Scene personnel intubated 2; referring hospital physicians, 13; and Children's Hospital physicians, 4. Eighteen had ABG determinations, which are summarized in Table 5. Of note is that 26.3% (5 of 19 cases) had PaO2 less than 90 mm Hg. Six of the 19 (31.6%) suffered airway complications (3 right mainstem intubations, 2 cases of vocal cord paralysis, and 1 massive aspiration).

TABLE 5. *Arterial Blood Gas Measurements in Injured Children Undergoing Endotracheal Intubation (Excluding Chest Injuries)*

Category	N	PaO2 <90	PaCO2 >45	PaCO2 <25
Total	56	16 (29)	4 (7)	22 (39)
Site of intubation				
Children's Hospital	16	2 (13)	0 (0)	6 (38)
Transfer Hospital	32	10 (31)	3 (9)	15 (47)
Scene	8	4 (50)	1 (13)	1 (13)
Age				
Less than 1 year	10	1 (10)	1 (10)	5 (50)
1 to 4 years	16	5 (31)	1 (6)	5 (25)
5 to 9 years	18	5 (28)	1 (6)	8 (39)
10 to 19 years	12	5 (42)	1 (8)	4 (33)
Airway complication				
Present	12	7 (58)*	2 (17)	1 (8)
Absent	44	9 (20)	2 (5)	21 (48)
Deaths				
Fatalities	13	6 (46)	2 (15)	5 (38)
Survivors	43	10 (23)	2 (5)	17 (40)
Apnea				
Present	13	5 (38)	1 (8)	6 (46)
Absent	43	11 (26)	3 (7)	16 (37)
Chest injury	4	2	0	2
Unnecessary intubations	19	5 (26)	1 (6)	6 (33)

Total excludes four children with chest injuries and three who did not have arterial blood gas measurements (two fatal cases and one survivor intubated because of apnea). Unnecessary intubations are described as those occurring in surviving patients without apnea or airway obstruction, who have a GCS of more than 8, and remained intubated for less than two days.

$p < 0.05$ by chi square test.

* Percentages are shown in parentheses.

Discussion

Timely endotracheal intubation is among the basic interventions in trauma care that provide a therapeutic margin that may ensure survival under critical circumstances. Although its role in the management of apnea and the obstructed airway is obvious, the most frequent indication for endotracheal intubation in our series was in the management of head injury. Ninety per cent had head injuries and three fourths were in coma. Of the 25% noted to be in apnea or to have an obstructed airway, all but one had a coexisting head injury.

The rationale for endotracheal intubation in the management of the head-injured patient, outlined above, justifies current recommendations for early endotracheal intubation and assisted ventilation.[1,7,8] Achieving these goals in children is difficult. In our study we encountered major airway complications with disturbing frequency in nearly one fourth of intubated injured patients. Two thirds of patients intubated at the scene of injury experienced major complications. All four complication-related deaths occurred during scene intubation attempts. We judged that more than 80% (13 of 16) of complications were life threatening, requiring immediate corrective action to avoid death or severe hypoxia.

It is not surprising that airway complications were associated with ABG with low PaO2 (< 90 mm Hg; 58%, 7 of 12 cases). But we still encountered suboptimal ABG (defined as PaO2 < 90 and PaCO2 > 45) in noncomplicated cases. In all an airway complication or suboptimal ABG was present in 44.4% of cases (28 of 63; Table 6). Despite endotracheal intubation, head-injured children remain at considerable risk for secondary brain injury from hypoxia and intracranial hypertension.

TABLE 6. *Deaths, Airway Complications, Arterial Blood Gas (ABG) Results in Relation to Survival, Site of Intubation, Head Abbreviated Injury Score (AIS), and Injury Severity Score (ISS)*

Factor	N	ISS (Mean ± S.D.)	Head AIS ≥ 4 (%)	Deaths (%)	Compl't'ns (%)	Initial ABG		Second ABG		Complication
						Lo PO2	Hi PCO2	Lo PO2	Hi PCO2	Lo PO2 or Hi PCO2
Total	63	20.7 ± 16.5	44 (69.8)	15 (23.8)	16 (25.4)	16	4	3	4	28 (44.4)
Survival										
Death	15	32.4 ± 22.7*	12 (80.0)*	—	4 (26.7)	6	2	2	2	10 (66.7)
Alive	48	17.0 ± 12.2	22 (45.8)	—	11 (22.9)	10	2	1	2	18 (37.5)
Site of Intubation										
CHP	17	17.6 ± 7.5	10 (58.8)	3 (17.6)	4 (23.5)	2	0	0	1	7 (41.2)
Refer	37	20.0 ± 18.8	17 (45.9)	8 (21.6)	6 (16.2)	10	3	2	1	14 (37.8)
Scene	9	29.3 ± 18.2	7 (77.8)	4 (44.4)	6 (66.7)*	4	1	1	2	7 (77.8)†
Head AIS (N = 56)										
≥4	34	27.9 ± 18.3*	—	12 (35.3)†	10 (29.4)	8	3	1	4	17 (50.0)
<4	22	12.0 ± 8.2	—	2 (9.1)	5 (22.7)	7	1	2	0	9 (40.1)
ISS										
≥10	44	—	34 (77.3)*	14 (31.8)*	12 (27.3)	12	3	1	4	21 (47.7)
<10	19	—	0 (0.0)	1 (5.3)	4 (21.0)	4	1	2	0	7 (36.8)
Complication, lo PO2 or hi PCO2										
Present	28	24.3 ± 17.1	17 (60.7)	9 (33.3)	—	—	—	—	—	—
Absent	35	17.9 ± 15.9	18 (50.0)	6 (16.7)	—	—	—	—	—	—

Head AIS includes only the 56 head-injured patients. All ABG are in mmHg. "Lo PO2" indicates PaO2 < 90; "hi PCO2" indicates PaCO2 > 45.

* $p \leq 0.05$.
† $p = 0.06$.

Although we could not find a significantly higher mortality rate with airway or gas exchange difficulties for a given degree of head injury severity (Table 7), other authors have found that airway and respiratory problems have an adverse effect on head injury. Gentleman and Jennett[9] found that many head-injured patients suffer from inadequate respiratory management. Of 150 patients (21% were children), 40 (27%) had evidence of airway obstruction. Eighteen progressed to respiratory arrest, and 34 (23%) had documented hypoxemia. Only 28% of their patients had an endotracheal tube in place, 44% had an oral airway, and 28% had neither. The authors found a higher mortality rate among those who suffered hypoxia, hypotension, or both, than among those who did not have those complications. Their findings substantiated the secondary injury effect of airway-related and circulatory complications in head injury.

TABLE 7. *Head AIS, Respiratory Difficulty, and Mortality Rates in 56 Children with Head Injuries*

AIS	Airway Complication, Lo PO2 or Hi PCO2	N	Survived	Died
1–2	Yes	1	1	0
	No	5	5	0
3	Yes	8	6	2
	No	8	8	0
4	Yes	10	7	3
	No	13	10	3
5–6	Yes	7	3	4
	No	4	2	2
Total	Yes	26	17	9 (34.6%)*
	No	30	25	5 (16.7%)

One child with head injury did not have a defined Abbreviated Injury Score (AIS). Lo PO2 indicates PaO2 < 90; hi PCO2 indicates PaCO2 > 45.

* $p < 0.05$.

The high death rate (23.8%) may be a reflection of the severity of injury and extremity of conditions in these children. Mean ISS among all patients was 20.7, reflecting serious multisystem injuries. But the severity of injury did not fully explain the high frequency of airway difficulties. The mean ISSs of scene-intubated and complicated groups were high (Table 6), but differences did not reach statistical significance. When patients with high ISSs (≥ 10) were compared to those with low ISSs (< 10), complication rates and suboptimal ABGs were not statistically different.

Scene intubation proved to be difficult, reflected by the high proportion that required multiple attempts before successful intubation and the number of failures. Two attempts at cricothyroidotomy ended in disaster. This reflects the confusion that surrounds the scene of injury, which includes environmental conditions, inadequate light, limited personnel, and a multitude of distracting influences. What may be an easy airway in the operating room may be an impossible one in the field. Still, complications occurred at the referring hospital and our ED where conditions are more favorable to successful airway control.

Gauging the depth and rate of assisted breaths in small subjects to achieve recommended PaCO2 levels of 25 to 30[2] is difficult until ABGs are obtained. We encountered both hypo- and hyperventilation, although the latter was more common. We found that one in four (27%, 15 of 56 cases) had PaCO2 less than 20, levels that in theory risk cerebral ischemia from excessive hypocarbia-induced

cerebral vasoconstriction.[3] We expected that problems in ventilation would be a particular problem in the very young, and in community hospitals not experienced in pediatric-assisted ventilation. This was not the case, because unacceptable PaCO2 values were encountered in all age groups and within all settings.

A troubling group is the 19 surviving patients who arrived with relatively high GCSs (≥ 10) and were extubated soon after admission (within two days), indicating that endotracheal intubation and assisted ventilation were not necessary. Nearly one third suffered airway complications and more than one fourth (Table 5) had PaO2 less than 90. Because the risks of pediatric intubation are considerable, the clinical challenge is to identify those children who will not require intubation. None of the 19 had airway obstruction, all were breathing spontaneously, and none were in deep coma (GCSs in all were 10 to 15, with a mean of 14.5). Thus it appears that injured children who are breathing and who have GCSs ≥ 10 require only supplemental oxygen and simple manual maneuvers to keep an open airway (such as a chin-lift or jaw-thrust maneuver), unless neurologic or respiratory deterioration occurs. The data suggests that these patients can be identified and spared the risks of emergency intubation in the field or before transfer. Should airway control be necessary for computed tomography (CT) or surgery, the procedure can be performed at the trauma center where the procedures will take place, avoiding the hazards associated with interhospital transfer. Patients in coma will require airway control before transfer.

Our study may suffer selection bias from the transfer of patients presenting with difficult management problems: very young patients; those with severe head trauma; and those with difficult airway problems. This is reflected in our data: more of our patients who were less than 4 years of age arrived intubated; head injuries were present in nearly all patients reviewed; and the frequent occurrence of life-threatening airway problems.

Our findings underscore the necessity of education and training of those who care for acutely injured children in the field, in community hospitals, and in pediatric trauma centers. They confirm the difficulties in pediatric airway management that arise from the unique anatomic features of the pediatric airway, and inexperience in technique that arises from lack of exposure and practice.

Airway management is a difficult skill. De la Roche[10] documented the difficulties in achieving adequate ventilation in adult-sized mannequins among trainees. Pepe, Stewart, and Copass,[7] recognizing these problems, suggest that a small but completely trained cadre of life support specialists handle the bulk of emergency and trauma care that require advanced resuscitative skills, such as endotracheal intubation. However, Tsai and coworkers[11] in Fresno County, California, note that the opportunity to attain and maintain proficient pediatric emergency skills is limited. Children accounted for only 10% of all ambulance runs, although they comprise 32% of the population; none underwent endotracheal intubation during the 12 months of review. Pediatric emergencies comprised only 5% of the prehospital emergency caseload in Jerusalem, and only 2.6% of children (8 of 307) received endotracheal intubation in 18 months.[12]

Although none can argue that endotracheal intubation is the technique of choice for airway management in the obstructed or apneic patient,[1,7,8,13] there are few studies that document the effectiveness of advanced life support techniques, including endotracheal intubation, in the prehospital treatment of trauma. Jacobs and Sinclair[8] documented that resuscitative techniques in the field improved TS in patients with an initial TS of 4 to 13. However, only the most severely injured patients with TS 1 to 3 failed to show an improvement in TS, and were the only ones to undergo endotracheal intubation. Their status may have been so compromised that improvement in response to any therapeutic measure may have been impossible.

Airway control and endotracheal intubation are difficult tasks in pediatric trauma. Complications and inadequate gas exchange are unfortunately common, even with an endotracheal tube in place, and put the child at risk for secondary cerebral injury from hypoxemia and intracranial hypertension. Indications for emergency endotracheal intubation require careful review, particularly in children with head injury who are breathing without obstruction.

References

1. Advanced Trauma Life Support. Chicago: American College of Surgeons, 1989. pp. 216–234.
2. Bruce DA, Schuit L, Bruno LA, et al. Outcome following severe head injury in children. J Neurosurg 1978; 48:679–88.
3. Obrist WD, Langfitt TW, Jaggi JL, et al. Cerebral blood flow and metabolism in comatose patients with acute head injury. J Neurosurg 1984; 61:241–253.
4. Nakayama DK, Saitz EW, Gardner MJ, et al. Quality assessment in the pediatric trauma care system. J Pediatr Surg 1989; 24:159–162.
5. Champion HR, Sacco WJ, Carnazzo AJ, et al. Trauma score. Crit Care Med 1981; 9:672–676.
6. Joint Committee on Injury Scaling. The Abbreviated Injury Scale, 1985 Revision. Des Plaines, IL: American Association for Automotive Medicine, 1985.
7. Pepe PE, Stewart RD, Copass MK. Prehospital management of trauma: A tale of three cities. Ann Emerg Med 1986; 15:1484–1490.
8. Jacobs LM, Sinclair A, Beiser A, et al. Prehospital advanced life support: Benefits in trauma. J Trauma 1984; 24:8–13.
9. Gentleman D and Jennett B. Hazards of inter-hospital transfer of comatose head-injured patients. Lancet 1981; ii:853–855.
10. de la Roche MRP. Is prehospital advanced life support really necessary? Can Med Assoc J 1987; 137:995–999.
11. Tsai A and Kallsen G. Epidemiology of pediatric prehospital care. Ann Emerg Med 1987; 16:284–292.
12. Applebaum D. Advanced prehospital care for pediatric emergencies. Ann Emerg Med 1985; 14:656–659.
13. Cales RH. Advanced life support in prehospital trauma care: An intervention in search of an indication? Ann Emerg Med 1988; 17:651–653.