Advanced Airways, Improved Outcomes?
Do prehospital advanced airways improve outcomes in nontraumatic cardiac arrest patients?

Problem-Based Lecture
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My Experience

A 50 year old female with a history of COPD complained of shortness of breath. The family called EMS. On arrival, the patient refused transport and then collapsed in front of EMS personnel. Per EMS, the patient was in PEA. She was intubated and ACLS protocol was initiated.
Endotracheal intubation is widely used for airway management for patients with cardiac arrest in the out-of-hospital settings.

Does out-of-hospital intubation improve outcomes?
Why should I care?

- EMS is working as an extension of the physician.
- We want the best outcomes for our patients.
- Recent literature and AHA guidelines now emphasize CPR and defibrillation over ventilation.
  - Does this carry over to advanced airways?
The patient was brought to Room 2. I went to confirm the ET tube placement and found the tube in the patient’s esophagus.

The tube was removed, the patient was intubated, bilateral chest tubes were placed, but the patient expired.
Challenges with out-of-hospital advanced airways

- Advanced airways may disrupt chest compressions.
- Placement of an advanced airway may take too long.
- Paramedics may not perform ETI frequently enough to remain competent in the procedure.
- The prehospital setting may not be the ideal setting for intubation or other advanced airways.
- Paramedics have several simultaneous tasks. Advanced airways may distract and prevent timely administration of defibrillation, IV medication, and transport to definitive care. Are these things more important than a definitive advanced airway?
On the other hand…

- Bagging the patient for long periods of time may lead to regurgitation and aspiration.
- Lack of a definitive airway may lead to hypoxia.
Objectives

- To present literature regarding the success of placing prehospital advanced airways
- To present literature regarding the outcomes of patients receiving advanced airways in the prehospital setting
- To determine whether policy pertaining to prehospital advanced airways should be changed
- **P** – patient: non-traumatic cardiac arrest patients receiving prehospital EMS care
- **I** – intervention: advanced airway placement
- **C** – comparison: no advanced airway placement (BVM)
- **O** – outcome: patient survival
Success Rates
A Meta-Analysis of Prehospital Airway Control Techniques Part I: Orotracheal and Nasotracheal Intubation Success Rates
Hubble, et al

- Meta-analysis regarding the success rates for prehospital endotracheal intubation and nasotracheal intubation by pre-hospital personnel in the field
- Primary outcome: successful endotracheal or nasotracheal intubation
- English language articles from any country
- All published reports of airway procedures performed by EMTs, paramedics, nurses or physicians practicing in the prehospital setting
- Independent review by two authors
Variables:

- Technique
- Age
- Clinical setting (cardiac arrest vs. nonarrest, trauma vs. nontrauma)
- Drugs used
- Credentials of personnel
- Mechanism for validating placement
- Number of attempts and success
- Primary or salvage airway
ETI attempted in 54,933 patients
- Pooled success rate of 89.2% (CI 87.7-90.5%)
- Nonphysician success rate of 86.3% (82.6-89.4)
- Physician success rate 91.8% (85-95.6%)
- Nontrauma 88.6% (86.3-92.2%) vs trauma 73.7% (62.6-82.5%)
- Cardiac arrest 91.2% (88.8-93.1%) vs nonarrest 70.4% (58.7-80%)
- Nasotracheal 73.1% (67.8-77.7%)
- RSI 96.1% (94.5-97.3%)
- DFI 86.8% (80.2-91.4%)
- Non-RSI, non-DFI ETI 86.5%
A Meta-Analysis of Prehospital Airway Control Techniques Part I: Orotracheal and Nasotracheal Intubation Success Rates
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Success Rates

- Non-RSI, Non-DFI
- DFI
- RSI
- All NTI
- Pediatric
- Nonarrest
- Cardiac Arrest
- Nontrauma only
- Trauma only

Success Rates:
- Non-RSI, Non-DFI: 79.1%
- DFI: 86.8%
- RSI: 96.1%
- All NTI: 83.2%
- Pediatric: 69.8%
- Nonarrest: 91.1%
- Cardiac Arrest: 91.1%
- Nontrauma only: 87.9%
- Trauma only: 73.7%
For most analyses, success rates were based on **self-report** by the intubating clinician.

- Subanalysis revealed:
  - Self-reported independently verified placement success rate was 82.9% (CI = 79.3-85.9%)
  - Clinician self-reported verification (breath sounds, chest rise) 91.5% (CI = 89.0-93.4%)
  - Multiple objective techniques 93.8% (CI = 90.9-95.8%)
Limitations:

- Only placement success rates observed
  - Time to placement?
  - Attempts made?

- Dependent on quality of individual studies, of which they state that the overall quality is poor; most were retrospective and descriptive

- Most studies were self-reported

- Few studies used capnography or ED physician placement confirmation
Conclusions:

1. Global non-RSI/non-DFI ETI success rate is 86.5%, with generally lower success rates for trauma and nonarrest patients.
2. For nonarrest patients, DFI and RSI seem to increase the success rates.
3. Across all clinicians, NTI has a low rate of success. Safety and efficacy in a prehospital setting are questioned.
Outcomes
Objective:

- Determine if prehospital ETI attempts are associated with return of spontaneous circulation and survival to discharge among individuals with out-of-hospital cardiac arrest.
Methods:

- Retrospective cohort study
- Used an existing registry of OOHCA in Mecklenburg County, North Carolina
- Nontraumatic cardiac arrests from July 1, 2006 to Dec 31, 2008
- Resuscitation efforts initiated by paramedics
- Excluded if less than 18 years of age, transferred between facilities, drowning, electrocution, obvious signs of death, DNR order presented during resuscitation
- Excluded if ETI was attempted but the number of attempts to success or failure was not reported
Patients were transported to any of seven area hospitals. All ambulances are staffed with at least one paramedic and one basic EMT. ETI performed, depending on algorithm, after 2 mins of CPR, defibrillation if indicated, and concurrently or after epinephrine administration.

- Initiation of an ETI attempt was left to the discretion of the paramedic.
- Failed ETI attempts could be managed with BVM or LMAs.
- RSI not available.
The Association Between Prehospital Endotracheal Intubation Attempts and Survival to Hospital Discharge Among Out-of-Hospital Cardiac Arrest Patients
Studnek et al

Independent variable of interest: number of prehospital ETI attempts
  - ETI attempt defined as inserting the laryngoscope into the mouth, past the anterior teeth
  - Categorized as
    ● Single successful ETI
    ● Single unsuccessful ETI
    ● Multiattempt successful ETI
    ● Multiattempt unsuccessful ETI
    ● No ETI attempt

Main outcome variables
  - Sustained prehospital ROSC
  - Survival to hospital discharge
    ● Determined by review of hospital medical records
    ● If discharge status or medical record was not located at the time of the analysis, the patient was conservatively classified as not surviving to hospital discharge
    ● Neurologic status was not available
The Association Between Prehospital Endotracheal Intubation Attempts and Survival to Hospital Discharge Among Out-of-Hospital Cardiac Arrest Patients
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Total Cardiac Arrests
1323

Included:
1142

Excluded:
Age <18 68, Trauma 46
DNR 15, Lividity 11
Transfer 7, Incomplete Data 34

NO ETI Attempt
203 (17.8%)

Prehospital ROSC
92 (45.3%) SHD
58 (28.6%)

Single Successful ETI
577 (50.5%)

Prehospital ROSC
146 (25.3%) SHD
37 (6.4%)

Single Unsuccessful ETI
70 (6.1%)

Prehospital ROSC
20 (28.6%) SHD
11 (15.7%)

Multiple ETI Attempts Successful
132 (11.6%)

Prehospital ROSC
23 (17.4%) SHD
7 (5.3%)

Multiple ETI Attempts Unsuccessful
160 (14.0%)

Prehospital ROSC
18 (11.3%) SHD
4 (2.5%)
The Association Between Prehospital Endotracheal Intubation Attempts and Survival to Hospital Discharge Among Out-of-Hospital Cardiac Arrest Patients
Studnek et al

- **ROSC**
  - 299 (26.2%) overall
  - Individuals with no ETI attempt were 2.44 times (1.75-3.41) more likely to have ROSC than those with one successful ETI attempt (45.3% vs. 25.3%)
    - Adjusted (OR 2.33, 1.63-3.33)
  - Regardless of success or failure, more than one attempt is less likely to have prehospital ROSC than one attempt
The Association Between Prehospital Endotracheal Intubation Attempts and Survival to Hospital Discharge Among Out-of-Hospital Cardiac Arrest Patients
Studnek et al

- **Survival to hospital discharge**
  - Of the 118 with prehospital ROSC, 118 (39.5%) were discharged alive from the hospital
    - 48 (16%) were unknown and were classified as not surviving
    - 137 (45.8%) had VF/VT
    - 55 (18.3%) arrested in the presence of EMS or first responders
  - Individuals with no ETI attempt were 4.96 times (3.22 to 7.67) more likely to be discharged from the hospital alive than those with one successful ETI attempt
    - Adjusted 5.46 (3.36 to 8.90)
The Association Between Prehospital Endotracheal Intubation Attempts and Survival to Hospital Discharge Among Out-of-Hospital Cardiac Arrest Patients

Studnek et al

Limitations:
- Retrospective, single-center study
- Time to care was not assessed
- Only 28 patients had documented ROSC with adequate ventilations prior to EMS performing any advanced level interventions other than defibrillation
- The number of ETI attempts was a self-reported variable
- Unsuccessful attempts: what about esophageal intubations?
- However, no ETI attempt, even in those patients with unwitnessed arrest and initial rhythm was not VT/VF, had an increased likelihood for ROSC and survival compared to one successful attempt.
Outcomes: Advanced Airway vs. BVM
Objective:
To determine whether advanced airway management during ambulance transport is associated with improved out-of-hospital cardiac arrest outcomes compared with bag-valve mask ventilation.
Out-of-Hospital Airway Management and Cardiac Arrest Outcomes: A Propensity Score Matched Analysis
Shin, et al

- Primary endpoint: survival to hospital admission
- Secondary endpoint: survival to hospital discharge
Out-of-Hospital Airway Management and Cardiac Arrest Outcomes: A Propensity Score Matched Analysis
Shin, et al

Methods:
- Retrospective cohort study
- Korean EMS system is a single-tier BLS ambulance service that in can provide care comparable to EMT-I's in the US (IVFs, intubation, epinephrine, etc.)
- Level 1-EMT graduates are allowed to perform ETI or LMA
- Utilized the cardiovascular disease surveillance database established by the Ministry of Health, Welfare and Family Affairs to improve the outcome of cardiovascular disease in Korea.
Methods:

- Ambulance run sheets are electronically stored
- Out-of-hospital cardiac arrest cases were identified from a review of the EMS run sheets
- Patients were EMS-assessed and treated OHCA patients with known outcomes of all ages, initial EKG and cardiac etiology
- Patients treated by level 2 EMTs and those not receiving CPR from both EMS and ED personnel were excluded
Out-of-Hospital Airway Management and Cardiac Arrest Outcomes: A Propensity Score Matched Analysis
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Methods:

- CPR protocol: Attach AED pads on arrival of suspected arrest; give shock or continue CPR; if unwitnessed, do 2 mins of CPR before shocking. While this is occurring, the other EMT is performing airway management
- **BVM was mandatory, LMA or ETI was not**
- LMA or ETI was determined by the EMT’s preference
Out-of-Hospital Airway Management and Cardiac Arrest Outcomes: A Propensity Score Matched Analysis
Shin, et al

54,496 patient with OHCA

Excluded 49,218

7,012 (12.9%) Treated by level 2 EMTs
11,121 (20.4%) Not treated by ED physicians
20,536 (37.7%) Non-cardiac etiology
2,096 (3.7%) unknown outcome
8,520 (15.6%) Not treated by EMS

Included 5,278

5,637 (87.9%) BVM
250 (4.7%) ETI
391 (7.4%) LMA
Out-of-Hospital Airway Management and Cardiac Arrest Outcomes: A Propensity Score Matched Analysis
Shin, et al

BVM  LMA  ETI
Survival to Admission  Survival to Discharge
Adjusted survival to admission and discharge were similar for the ETI and BVM (OR 0.91, CI 0.66-1.27) and (OR 1.00, CI 0.6-1.66). This was also the case for propensity-matched samples.

Adjusted survival to admission and discharge were significantly lower in LMA than BVM {((OR 0.72, 0.54-0.95) and (OR 0.52, 0.32-0.85))}. For propensity matched samples, adjusted survival to admission was similar for LMA and BVM (OR 0.72, 0.5-1.02). Survival to discharge was significantly lower for LMA than BVM (OR 0.45, 0.25-0.82)
Limitations:

- Retrospective and observational
- Many patients were excluded
- Single-tiered system
- Unknown CPR interruption times
- Classic LMA was used as the later generation was not yet available
Outcome: ETI vs. BVM
Objective:
To compare survival to hospital discharge among adult OOHCA patients receiving ETI to those managed with BVM.

Retrospective cohort study from a 553-bed southwestern LA County general municipal hospital
Advanced Airway Management Does Not Improve Outcome of Out-of-hospital Cardiac Arrest
Hanif, et al

Methods

- Data collected from field rescue reports, verbal reports documented in nursing and physician notes, ED cardiac arrest flow sheet, ED record, and in-hospital records
- Two abstractors (not blinded to the study)
- Included all consecutive adult (>18 years) out-of-hospital nontraumatic cardiac arrests presenting to the ED between 11.01.94 to 6.30.08
Exclusion criteria:
- DNR
- Age <18 years
- Cardiac arrest from trauma, drowning or drug overdose

Also collected data regarding age, sex, race, PMH, site of arrest, rhythm on EMS arrival, witnessed arrests, bystander CPR or ROSC, and type of field airway implemented, survival to hospital admission and survival to hospital discharge
Advanced Airway Management Does Not Improve Outcome of Out-of-hospital Cardiac Arrest
Hanif, et al

OOHCA
1294
SHA: 197 (15%)
SHD: 55 (4%)

Unknown
5
SHA: 5
SHD: 3

ETI
1027
SHA: 152 (15%)
SHD: 38 (4%)

BVM
131
SHA: 35 (27%)
SHD: 14 (11%)

Combitube/EOA
131
SHA: 5 (4%)
SHD: 0 (0%)
Advanced Airway Management Does Not Improve Outcome of Out-of-hospital Cardiac Arrest
Hanif, et al

Results:

- Survival to discharge for BVM compared to ETI (OR 3.3, CI 1.8-6.3, p=0.0002)
  - Same results when adjusting for covariates or when adding in the three unknown patients to the ETI group
- VT/VF vs. other rhythm (OR 8.6, 2.7-27.9, p<0.0001)
- Witnessed vs. unwitnessed (OR 4.10, 2.2-7.7, p<0.0001)
- Nursing home vs. other sites (OR 0.40, 0.2-0.9, p=0.03)
Discussion:

- Lower survival to hospital discharge rates among nontraumatic OOHCA in patients undergoing ETI vs. BVM

Limitations:

- Retrospective
- Unknown if there is a reason why BVM was used instead of ETI
- One urban hospital system
- Assumed that all advanced airways were properly positioned
- Patients transferred to other facilities were classified as survivors
Outcome: Pediatric Survival and Neurologic Outcome
Objective: To compare the survival and neurological outcomes of pediatric patients treated with bag-valve-mask ventilation with those of patients treated with bag-valve-mask ventilation followed by endotracheal intubation.
Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome: A Controlled Clinical Trial
Gausche, et al

Methods:

- Prior to this study, pediatric ETI was not in the paramedic scope of practice.
- 2584 licensed paramedics were trained in pediatric airway management and resuscitation protocol in two (three hour) sessions by two educators using a standard curriculum. The training included mannequins (similar to adult training). The training included:
  - Sizing and placement of oropharyngeal and nasopharyngeal airways
  - Use of a length-based resuscitation tape
  - BVM
  - ETI
  - Foreign body removal with pediatric Magill forceps
  - Use of carbon dioxide detector
  - ET drug delivery
  - BVM instruction used a “squeeze, release, release” technique to achieve a ventilation rate of no more than 20/min for children older than one year and no more than 30/min for children younger than one year
  - Investigators provided continuing education opportunities in pediatric airway management throughout the study
Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome: A Controlled Clinical Trial
Gausche, et al

Subjects:
- Consecutive patients 12 years or younger or an estimated weight of 40 kg or less from 3.15.1994 to 1.01.1997 were enrolled based on one or more of the following:
  - Cardiopulmonary arrest
  - Respiratory arrest
  - Respiratory failure
  - Nonpurposeful response or no response to pain
  - Complete or severe partial airway obstruction
  - Traumatic cardiopulmonary arrest
  - Traumatic respiratory arrest
  - Closed or open head trauma with a nonpurposeful response or no response to pain
  - Paramedic assessment that assisted ventilation was necessary
Intervention:

Patients were assigned by calendar day to receive BVM (odd days) or BVM followed by ETI (even days). Paralytics and/or sedation were NOT used.

The use of Magill forceps when basic life support maneuvers failed could be used on either day.

An attempt was placing a laryngoscope in the airway with the intent to intubate.
A success was placing the ET tube into the trachea or mainstem bronchus.
Data Collection:

Standardized forms were completed in the ED by the emergency physician and paramedic and mailed to the investigator. Data included: correct placement of ET tube (trachea or mainstem bronchus), pulse oximetry on arrival, appropriate mask size, appropriate ET tube size, and complications associated with ETI.
Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome: A Controlled Clinical Trial
Gausche, et al

830 Patients

410 BVM Days
- 391 BVM
- 9 BVM after ETI attempt
- 10 ETI
- 6 Lost to follow-up

420 ETI Days
- 115 BVM (3 violations)
- 128 BVM after ETI attempt
- 177 ETI
- 4 Lost to follow-up
Complications:

- 3 (2%) esophageal intubation
- 12 (6%) unrecognized dislodgment of ETT enroute to ED
- 15 (8%) recognized dislodgment
- 33 (18%) main stem intubation
- 44 (24%) intubated with a tube of the incorrect size

- The paramedic attempt success rate for ETI was 57%
### Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome: A Controlled Clinical Trial
Gausche, et al

<table>
<thead>
<tr>
<th>Grouped</th>
<th>BVM (404)</th>
<th>ETI (416)</th>
<th>OR, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survival</strong></td>
<td>123 (30%)</td>
<td>110 (26%)</td>
<td><strong>0.82, 0.61-1.11</strong></td>
</tr>
<tr>
<td><strong>Good neuro outcome</strong></td>
<td>92 (23%)</td>
<td>85 (20%)</td>
<td><strong>0.87, 0.62-1.22</strong></td>
</tr>
<tr>
<td><strong>Paramedic Intent</strong></td>
<td>BVM (387)</td>
<td>ETI (433)</td>
<td></td>
</tr>
<tr>
<td><strong>Survival</strong></td>
<td>119 (31%)</td>
<td>114 (26%)</td>
<td><strong>0.81, 0.6-1.09</strong></td>
</tr>
<tr>
<td><strong>Good neuro outcome</strong></td>
<td>91 (24%)</td>
<td>86 (20%)</td>
<td><strong>0.81, 0.58-1.12</strong></td>
</tr>
<tr>
<td><strong>Treatment Received</strong></td>
<td>BVM (635)</td>
<td>ETI (185)</td>
<td></td>
</tr>
<tr>
<td><strong>Survival</strong></td>
<td>298 (33%)</td>
<td>25 (14%)</td>
<td><strong>0.32, 0.2-0.50</strong></td>
</tr>
<tr>
<td><strong>Good Neuro outcome</strong></td>
<td>162 (26%)</td>
<td>15 (8%)</td>
<td><strong>0.26, 0.15-0.45</strong></td>
</tr>
</tbody>
</table>
When comparing outcomes by final diagnosis subgroup:

- Survival of those with child maltreatment was higher in BVM group vs. ETI (42% vs. 5%), (OR 0.07, 0.01-0.58)
- Survival of those with respiratory arrest was higher in the BVM group vs. ETI (85% vs. 61%) (OR 0.27, 0.11-0.69)
- Good neurological outcome for those with foreign body aspiration was better in the BVM group vs. the ETI group (69% vs. 23%) (OR 0.13, CI 0.02-0.76)
Effect of Out-of-Hospital Pediatric Endotracheal Intubation on Survival and Neurological Outcome: A Controlled Clinical Trial
Gausche, et al

Conclusion:
Results of survival and neurological outcome by paramedic intent is not statistically different between the groups.

Survival and neurological outcome by treatment received is statistically significant with a benefit of BVM.

Survival in certain subgroups of patients (child maltreatment and respiratory arrest) statistically significant with a benefit of BVM. Good neurologic outcome is statistically significant in foreign body aspiration with a benefit of BVM.

Pediatric ETI does not improve patient outcomes in a rapid-transport urban EMS system. BVM results in the same outcome as ETI without the fatal complications of ETI.

As a result, Los Angeles County paramedics now only perform BVM ventilation for pediatric OOHCA patients.
Limitations:

- Although survival and neurological outcome by treatment received is statistically significant with a benefit of BVM, the success of intubation is not independent of the prognosis; those patients most likely to have a successful intubation are likely the sickest.
- This was in an urban setting with short transit time
- No drugs were used for intubation
- The young age (median age 1.2 years) of the patients may contribute to a lower overall ETI success rate
Cochrane Review
Objective:
To determine in acutely ill and injured patients who have real or anticipated problems in maintaining an adequate airway, whether emergency endotracheal intubation, as opposed to other airway management techniques, improves the outcome in terms of survival, degree of disability at discharge or length of stay and complications occurring in hospital.

Other airway techniques include combi-tube, esophageal gastric tube airway (EGTA), LMA.
Methods:

- Consideration for review
  - Searched for randomized or controlled trials involving emergency use of ETI in the injured or acutely ill patient.
  - Any age
  - Those with longstanding respiratory disease were excluded
- Outcome measures:
  - primary all-cause mortality or degree of disability at hospital discharge
  - secondary measures of morbidity (pulmonary, c-spine injury, number of organs affected by multiple organ failure, length of stay in the hospital or ICU)
Results:

- 452 full text studies were reviewed independently
- Three eligible RCTs, each in an urban setting with short prehospital to hospital transit times
   - No survival (26% vs. 30%) or good neurologic outcome (23 vs. 20%) advantage in children randomized to receive ETI vs. BVM and later ED ETI should resuscitation be continued.
   - Intention-to-treat analysis.

- Small, non-significant difference in survival to hospital discharge (11.1% ETI vs. 12.9% EGTA) in an intention-to-treat analysis of 175 patients.
- Insertion success for ETI and EGTA (90% and 90%) and adequacy of ventilation (90% and 70 – 90%) were similar

- Doubling of survival to hospital discharge was seen in the combi-tube group (3% vs. 6%)
- Similar insertion rates (94% vs. 98%)
- No significant difference, RR of survival with ETI was 0.43, (0.09-1.99)
- Pulmonary aspiration was 2% in combi-tube and 0% with ETI
Conclusions:

- Clinicians need to establish a safe airway and adequate ventilation in the prehospital setting. The efficacy of emergency endotracheal intubation in this setting has not been rigorously studied.
- The operator’s skill may be a key determinant of efficacy. Success rates of paramedics that have been quoted are less than desirable (<95% after three attempts).
- In non-traumatic cardiac arrest, intubation is not likely to carry the same benefit as early defibrillation and bystander CPR.
- In pediatric and trauma patients, the current evidence provides no imperative to extend prehospital intubation practice in urban and short transit time systems.
Limitations:

- Only three studies
- Were not statistically significant
- May not be able to generalize to other populations
Conclusions

- Prehospital endotracheal intubation has not been shown to improve patient outcomes.
- Most studies suggest a *decrease* in survival of those patients who receive prehospital ETI compared to BVM. However, few studies show a statistical significance.
- More work needs to be done to determine whether or not there is a clear disadvantage to prehospital ETI.
- EMS protocols regarding out-of-hospital cardiac arrest and the placement of advanced airways should be revisited, particularly in urban settings with short transit times.
Prehospital endotracheal intubation in adult major trauma patients with head injury
Report by Ayan Sen, Senior House Officer, Critical Care

CLINICAL BOTTOM LINE
Prehospital endotracheal intubation is associated with increased mortality in patients with moderate to severe traumatic brain injury.


