Out-of-Hospital Endotracheal Intubation: Where Are We?

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While remaining prominent in paramedic care and beneficial to some patients, out-of-hospital endotracheal intubation has not clearly improved survival or reduced morbidity from critical illness or injury when studied more broadly. Recent studies identify equivocal or unfavorable clinical effects, adverse events and errors, interaction with other important resuscitation interventions, and challenges in providing and maintaining procedural skill. We provide an overview of current data evaluating the overall effectiveness, safety, and feasibility of paramedic out-of-hospital endotracheal intubation. These studies highlight our limited understanding of out-of-hospital endotracheal intubation and the need for new strategies to improve airway support in the out-of-hospital setting. [Ann Emerg Med. 2006;47: 532-541.]

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INTRODUCTION

Paramedic out-of-hospital endotracheal intubation originated in the 1970s from efforts to improve outcomes from cardiac arrest and major trauma.1–5 At that time, the best available methods for paramedic out-of-hospital airway management and ventilation were bag-valve-mask ventilation and the esophageal obturator airway.6–9 Bag-valve-mask performance was perceived to be inadequate, and esophageal obturator airway use resulted in many complications, including inadequate or delayed ventilation, aspiration, pharyngeal and esophageal injury, gastric rupture, tracheal occlusion, and inadvertent tracheal intubation.6,8,10–15 Out-of-hospital endotracheal intubation offered an alternative method to optimize care, promising superior airway protection, efficient ventilation, and a route to deliver endobronchial medications.16 Endotracheal intubation was also the standard for in-hospital resuscitation, classified as a “definitely helpful” intervention by then-current Advanced Cardiac Life Support guidelines.17 Several authors reported groundbreaking efforts to implement out-of-hospital endotracheal intubation in Boston, Columbus, San Diego, and Pittsburgh.1–4

Despite its accepted role in clinical practice for more than 25 years, a growing body of literature suggests that out-of-hospital endotracheal intubation is not achieving its intended overarching goals. In selected cases, the intervention may cause harm. In this article, we provide an overview of recent data evaluating the effectiveness, safety, and feasibility of paramedic out-of-hospital endotracheal intubation.

Is Out-of-Hospital Endotracheal Intubation Effective?

The fundamental test of a medical intervention is whether it improves the outcome of the targeted patients.18 In this light, the overarching goal of out-of-hospital endotracheal intubation is to reduce mortality and morbidity for those in need of airway support. Several investigators have evaluated survival and neurologic outcome after out-of-hospital endotracheal intubation19–33 (Table). These studies largely involve retrospective analyses of predominantly injured patients. Although 2 studies identified increased survival from out-of-hospital endotracheal intubation, the remaining efforts found either decreased or no effect on survival. No studies have identified improved neurologic outcome from out-of-hospital endotracheal intubation.

Of these out-of-hospital endotracheal intubation studies, the most notable effort is by Gausche et al.22 In this prospective trial, 830 critically ill pediatric out-of-hospital patients in Los Angeles County received either bag-valve-mask ventilation or bag-valve-mask followed by out-of-hospital endotracheal intubation. The authors found that an airway strategy incorporating out-of-hospital endotracheal intubation offered no survival or neurologic benefit over bag-valve-mask ventilation alone. Although limited by its patient population (primarily pediatric patients in a large urban location), this seminal effort represents the largest prospective, controlled evaluation of out-of-hospital airway management interventions.

The San Diego Rapid Sequence Intubation Trial tested the large-scale implementation of rapid sequence intubation performed by ground-based paramedic units.20 In this outcomes analysis, 209 traumatic brain injury patients receiving out-of-hospital rapid sequence intubation (neuromuscular blockade–
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<td>Higher mortality (OR 2.1; 95% CI 0.9–5.0)† in OOH-ETI group</td>
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<td>Retrospective; single trauma center (Seattle); multivariable adjusted</td>
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<td>No difference in mortality (OR 1.0; 95% CI 0.6–1.6)†</td>
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<td>Davis et al, 2003</td>
<td>Prospective interventional series, historical controls; countywide (San Diego); multivariable adjusted</td>
<td>Severe TBI; RSI in field vs non-ETI historical controls</td>
<td>OOH-RSI (209) vs non-OOH-ETI (627)</td>
<td>Higher mortality (OR 1.6; 95% CI 1.1–2.2) and poorer neurologic outcome (1.6; 1.2–2.3) in OOH-RSI group</td>
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<td>Retrospective; countywide trauma registry (San Diego) multivariable adjusted</td>
<td>Severe TBI; ETI in field or ED</td>
<td>OOH-ETI (2,665) vs ED-ETI (2,220)</td>
<td>Higher mortality (OR 2.1; 95% CI 1.8–2.5)† in OOH-ETI group</td>
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<td>Di Russo et al, 2005</td>
<td>Retrospective; National Pediatric Trauma Registry; multivariable adjusted</td>
<td>All pediatric trauma</td>
<td>OOH-ETI (1,928) vs non-trauma center ETI (1,647), trauma center ETI (1,874) and non-ETI (44,739)</td>
<td>Higher mortality for OOH-ETI vs non-trauma center ETI (OR 3.2; 95% CI 2.7–3.7)† vs trauma center ETI (4.1; 3.5–4.8)† vs non-ETI (142.0; 119.6–168.5)† Poorer neurologic outcome for OOH-ETI vs non-trauma center or trauma center ETI</td>
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<td>Gausche et al, 2000</td>
<td>Prospective controlled (pseudorandomized) interventional trial; countywide (Los Angeles)</td>
<td>Pediatrics; ETI or BVM in field</td>
<td>OOH-ETI/BVM (420) vs OOH-BVM (410)</td>
<td>No difference in mortality (OR 0.8; 95% CI 0.6–1.1) or neurologic outcome (0.9; 0.6–1.2)</td>
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<td>All trauma; ETI in field without drugs</td>
<td>Mortality of OOH-ETI without drugs (486)</td>
<td>Low (0.2%) survival</td>
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<td>Murray et al, 2000</td>
<td>Retrospective; countywide trauma registry (Los Angeles); multivariable matched/adjusted</td>
<td>Severe TBI</td>
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<td>Higher mortality (OR 4.2; 95% CI 2.1–8.9) in OOH-ETI group</td>
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<td>Sloane et al, 2000</td>
<td>Retrospective; single trauma center (San Diego); univariable</td>
<td>Severe TBI; RSI in field or ED</td>
<td>OOH-RSI (47) vs ED-RSI (267)</td>
<td>No difference in mortality (OR 0.6; 95% CI 0.1–2.6)† or neurologic outcome (1.1; 0.3–3.8)†</td>
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<td>Stockinger et al, 2004</td>
<td>Retrospective; single trauma center (New Orleans); univariable/stratified</td>
<td>All trauma; ETI or BVM in field</td>
<td>OOH-ETI (316) vs OOH-BVM (217)</td>
<td>Higher mortality (OR 18.0; 95% CI 11.2–29.1)† in OOH-ETI group</td>
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<td>Suominen et al, 2000</td>
<td>Retrospective; single trauma center (Finland); univariable</td>
<td>Severe pediatric TBI</td>
<td>OOH-ETI (24) vs non–trauma center ETI (13) vs trauma center ETI (22)</td>
<td>Lower mortality for OOH-ETI vs non–trauma center ETI (OR 0.1; 95% CI 0.002–1.1)†; no difference vs trauma center ETI (3.7; 0.9–15.8)†</td>
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<td>Wang et al, 2004</td>
<td>Retrospective; statewide trauma registry (Pennsylvania); multivariable and propensity-score adjusted</td>
<td>Severe TBI; ETI in field or ED</td>
<td>OOH-ETI (1,797) vs ED-ETI (2,301)</td>
<td>Higher mortality (OR 4.0, 95% CI 3.2–4.9), poorer neurologic outcome (1.6; 1.2–2.3), and poorer functional outcome (severe impairment 1.9; 1.3–2.5) in OOH-ETI group</td>
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assisted endotracheal intubation) were matched to 627 historical nonintubated controls, facilitating a comparison of out-of-hospital rapid sequence intubation with the alternative of no out-of-hospital endotracheal intubation at all. The authors observed higher mortality in patients receiving out-of-hospital rapid sequence intubation (odds ratio 1.6; 95% confidence interval [CI] 1.1 to 2.2). This study is notable because of its large-scale evaluation of one of the most advanced airway management techniques.

In the evaluation of this series of studies (listed in the Table and discussed above), several important observations arise about their methods, designs, and limitations. Most of these efforts used retrospective designs involving a single-center or countywide trauma registry and included primarily injured or head-injured patients.19–21,23–33 The Gausche study is the only effort using a prospective, controlled design in medical (nontrauma) cases.22 The studies noted in the Table evaluated survival to hospital discharge only; they did not study long-term outcomes and often inferred neurologic outcome from discharge destination (ie, discharge to home, rehabilitation center, psychiatric facility, or jail = “good neurologic outcome”; discharge to nursing home or other extended care facility = “poor” neurologic outcome). None used formal neurologic or functional measures such as the Glasgow Outcome Scale or the Functional Independence Measure.34,35

Risk adjustment is important in retrospective analyses because many confounding factors can lead to adverse outcome, not just the manner of airway management.36 However, only some authors used multivariable adjustment to account for these variations.19–21,24,27,32 Several studies using univariable analysis (including the 2 efforts identifying a survival benefit for out-of-hospital endotracheal intubation) may not have adequately accounted for confounders.28,33 For example, Winchell and Hoyt28 analyzed 1,098 head-injured patients and found that out-of-hospital endotracheal intubation increased survival by 21%, but this effort did not adjust for severity of injury or illness. Suominen et al33 evaluated 59 pediatric traumatic brain injury patients and found that out-of-hospital endotracheal intubation resulted in a 34% increase in survival over patients intubated in the emergency department (ED) of a referring hospital; however, this small effort similarly did not adjust for severity of injury or illness.

The comparison (exposure) groups in these studies differ, each posing a different scientific question. For example, the Davis et al,20 Murray et al,24 and Winchell and Hoyt28 studies used controls that did not receive out-of-hospital endotracheal intubation; we do not know whether these individuals later received ED endotracheal intubation or no endotracheal intubation at all. In our analysis of intubated traumatic brain injury patients in Pennsylvania, we excluded patients not receiving endotracheal intubation in either the out-of-hospital or ED setting, hence facilitating a comparison of endotracheal intubation during the acute out-of-hospital or ED phases only.27 In contrast, the Bulger et al19 study compared out-of-hospital conventional and rapid sequence endotracheal intubation techniques, excluding patients not intubated in the out-of-hospital setting. This latter study compares different out-of-hospital endotracheal intubation techniques, not out-of-hospital endotracheal intubation versus non-out-of-hospital endotracheal intubation.

In summary, few studies have demonstrated benefit from out-of-hospital endotracheal intubation.28,35 Most showed an adverse or no effect on outcome.20–22,24,26,27,29,31,32 These observations contradict the assumption that aggressive airway intervention is associated with improved resuscitation outcomes. Larger studies with prospective designs may be instrumental in revealing an undetected benefit. However, an important alternate reaction is to recognize that multiple studies arrived at similar conclusions and identified substantial effect sizes, despite their differing populations, disease groups, designs, and limitations. If not directly causative, out-of-hospital endotracheal intubation may have close parallel relationships with factors leading to adverse outcome. A logical direction is to better identify the underlying relationships.

Table. Continued

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<tr>
<td>Winchell and Hoyt, 199728</td>
<td>Retrospective; countywide trauma registry (San Diego); univariable/stratified</td>
<td>Blunt trauma, GCS score ≤8</td>
<td>OOH-ETI (527) vs non–OOH-ETI (565)</td>
<td>Lower mortality (OR 0.6; 95% CI 0.5–0.8)† in OOH-ETI group; no difference in neurologic outcome (1.4; 1.0–1.9)†</td>
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BVM, Bag-valve-mask ventilation; ETI, endotracheal intubation; GCS, Glasgow Coma Scale; OOH, out-of-hospital; RSI, rapid sequence intubation; TBI, traumatic brain injury.

*Only the primary findings (survival and neurologic outcome) are summarized; results of other outcomes and subgroup analyses are not presented.
†Odds ratio calculated from published results.
‡Author stated significant at P<.05.
§Calculated univariable odds ratios; multivariable adjusted figures not published.
‖Odds ratios could not be calculated from published results.
Is Out-of-Hospital Endotracheal Intubation Safe?

Therapeutic "safety" refers to freedom from accidental injury during the course of medical care. Adverse events and errors may contribute to the poor outcomes associated with out-of-hospital endotracheal intubation. This relationship is plausible, given that out-of-hospital endotracheal intubation is a complex procedure with many potential pitfalls, including key errors (e.g., unrecognized esophageal tube placement) that can result in morbidity or death. Errors may be more likely in the uncontrolled out-of-hospital environment than in other settings. Several recent efforts highlight the underrecognition of out-of-hospital endotracheal intubation errors.

Katz and Falk evaluated 108 paramedic endotracheal intubation patients arriving at a regional trauma center in Florida. The authors used a systematic physician approach to confirm proper tube placement on ED arrival, including the selected use of direct revisualisation. The authors found that more than 25% of the endotracheal tubes were misplaced, two thirds of these in the esophagus. The authors partially attributed the results to noncompliance with out-of-hospital protocols requiring placement confirmation using carbon dioxide detection. Jemmett et al conducted a similar study of 109 paramedic endotracheal intubation patients in Maine (an emergency medical services [EMS] system with no carbon dioxide detection protocol) and found a similar tube misplacement rate of 12%. Jones et al reported a lower (5.8%) tube misplacement rate for 208 paramedic endotracheal intubation in Indianapolis, but this study occurred in a region serviced primarily by a single EMS agency with close medical oversight.

Dunford et al examined a subset from the San Diego Rapid Sequence Intubation Trial, finding that accidental oxygen desaturation (SaO2 <90%) occurred in 31 of 54 (57%) patients and marked bradycardia (pulse rate <50 beats/min) in 6 of 54 (19%) patients. Moreover, in 84% of these adverse events, the paramedic described the intubation effort as "easy." Ehrlich et al compared field (out-of-hospital), referring hospital and trauma center endotracheal intubation of pediatric trauma patients. Complications (esophageal intubation, mainstem intubation, aspiration, barotrauma, incorrect tube size, tube dislodgment) occurred in two thirds of the 59 out-of-hospital endotracheal intubations.

Self-reporting methods are often used to identify medical errors in the in-hospital setting. In the Gausche et al study, of 186 initially successful endotracheal intubations, paramedics reported unrecognized esophageal intubation in 2%, tube dislodgment in 14%, and mainstem intubation in 18%. In a prospective multicenter effort involving 45 EMS services, we systematically identified. Cases series describing tracheal and pulmonary injury from out-of-hospital endotracheal intubation indicate that many errors are identified only through invasive tests or autopsy. Dunford et al showed that during the course of routine care, rescuers are often unaware of adverse events, even when equipped with the most advanced monitoring techniques. Although none of these efforts formally linked out-of-hospital endotracheal intubation errors to outcome, these events have plausible connections with patient outcome. These studies highlight our underrecognition and incomplete understanding of the range of errors occurring during out-of-hospital endotracheal intubation.

Does Out-of-Hospital Endotracheal Intubation Affect Other Aspects of Care?

Current paramedic textbooks portray endotracheal intubation as a procedure to be completed independent of other patient care tasks. However, other interventions often occur concurrently with endotracheal intubation; for example, chest compressions, electrical therapy, intravenous access, or the administration of drugs. An important recent realization is that out-of-hospital endotracheal intubation may influence patient outcome by interacting with or affecting the execution of these simultaneous therapies. These observations have occurred in several disease groups. For example, after successful out-of-hospital endotracheal intubation, rescuers commonly perform ventilation manually (without the assistance of portable ventilators) using tactile feedback only. Consequently, out-of-hospital endotracheal intubation may result in unintended hyperventilation, which may be deleterious in certain conditions. In porcine models of hemorrhagic shock, Pepe et al found that increased respiratory rates (20 and 30 breaths/min) resulted in decreased systolic blood pressure and cardiac output, respectively. Davis et al showed that hyperventilation occurs frequently after out-of-hospital rapid-sequence intubation for traumatic brain injury, a condition in which hyperventilation can reduce cerebral perfusion. The investigators noted an association between hyperventilation and increased mortality.

Aufderheide and Lurie and Aufderheide et al identified the same hyperventilation phenomenon in intubated cardiac arrest patients. Using physician responders to monitor out-of-
hospital cardiac arrest victims, the authors also found that accidental hyperventilation raised intrathoracic pressure during chest compressions, thereby impeding coronary perfusion pressure, an important element for successful resuscitation. They observed that these episodes occurred despite the specific training of the paramedics in this study.

Experts believe that control of intracranial pressure is important in the treatment of traumatic brain injury. Physicians often use rapid sequence intubation to attenuate intracranial pressure response to the stress of endotracheal intubation. The aim to control intracranial pressure led to the proposal to replace nasotracheal intubation with rapid sequence intubation in these patients. However, the San Diego Rapid Sequence Intubation Trial found that adverse events such as inadvertent hyperventilation, oxygen desaturation, bradycardia, and increased mortality occurred with rapid sequence intubation approaches. Thus, efforts to precisely control one aspect of physiology during airway management disturbed other systems.

Although meriting additional study, these findings in different disease states suggest that unanticipated physiologic effects may offset the potential benefits of proper endotracheal intubation. These observations underscore our poor understanding of how current field airway management, oxygenation, ventilation, and other physiologic processes interact during the resuscitation of different disease states.

How Do Paramedics Learn and Maintain Intubation Skills?

Because the manner of intubation may affect patient outcome, a logical area of concern involves paramedic acquisition and maintenance of out-of-hospital endotracheal intubation skill. For example, in the Gausche et al study, paramedics did not perform pediatric out-of-hospital endotracheal intubation before the trial. In the San Diego Rapid Sequence Intubation Trial, paramedics received a 7-hour didactic session without supplemental live training. These factors may have reduced the potential benefit of out-of-hospital endotracheal intubation.

Endotracheal intubation is a complex procedure, arguably more difficult when attempted in the uncontrolled out-of-hospital setting. Unlike physicians working in protected, stable, and well-illuminated settings (such as the operating room and ED), paramedics often attempt endotracheal intubation in awkward situations; for example, on the floor, in cramped rooms, or in the twisted metal of a motor vehicle. Out-of-hospital patients are critically ill and often severely injured, and most would be considered “difficult” or high-risk intubations by in-hospital anesthesia standards. Given these challenges, one would expect paramedics to acquire and maintain endotracheal intubation skills well above minimum levels. However, paramedic endotracheal intubation training and clinical experience are relatively limited.

For example, there is significant disparity between consensus procedural standards for paramedic students and other endotracheal intubation providers. The national paramedic curriculum requires students to perform 5 successful endotracheal intubations to graduate. In contrast, emergency medicine residents, anesthesiology residents, and nurse anesthetist trainees are expected to perform between 35 and 200 endotracheal intubations before graduating from their respective training programs.

Using data on 7,635 endotracheal intubations attempted by 802 paramedic trainees from 60 training programs, we found that across all clinical settings (operating room, field, ED, other in-hospital), paramedic students attempted a median of 7 endotracheal intubation (interquartile range 4-12). Using multivariable modeling, we predicted that paramedic students in this cohort required 15 to 20 endotracheal intubation encounters to attain baseline “proficiency” (predicted endotracheal intubation success threshold of 90%). Similar modeling efforts using cohorts of medical students, paramedic students, and anesthesia residents have identified even higher thresholds for attaining proficiency. These observations suggest that the ideal level of baseline endotracheal intubation experience is much higher than the current national standard of 5 endotracheal intubations.

Endotracheal intubation training in the controlled operating room setting is ideal, but according to these figures, the number of operating room cases needed to train paramedic students is formidable, approximately 80,000 operating room cases nationally each year (approximately 200 accredited paramedic training programs times approximately 20 graduating students/year times 20 endotracheal intubations/student/year = 80,000 intubations/year). This estimate does not include students in nonaccredited paramedic programs or paramedics already in clinical practice. Furthermore, although increasing opportunities for operating room endotracheal intubation training is desired, paramedic training programs nationally have observed a general reduction in these opportunities, a phenomenon attributed to competition with other students, the widespread use of nonintubation techniques (such as the laryngeal mask airway), and anesthesiologists’ medicolegal concerns.

Mannequins and human simulators provide opportunities for paramedic endotracheal intubation training, but only 1 study has evaluated how these platforms translate to clinical skill. In an effort occurring more than 20 years ago, Stewart et al assigned paramedics to different training strategies, including combinations of mannequin, animal, and operating room endotracheal intubation. Although the authors indicated no difference in clinical endotracheal intubation success rates between the groups on limited multivariable analysis, the unadjusted data suggested higher initial and ongoing endotracheal intubation success in the operating room–trained groups. A more recent effort by Hall et al compared paramedic operating room training with human simulator training. Although the authors stated equivalence between the 2 modalities, the evaluated outcome was operating room...

Cadavers (ie, recently dead patients) have also been used for paramedic endotracheal intubation training, but only 1 study has evaluated the connection with clinical performance. Stratton et al94 compared mannequin with mannequin + cadaver training and found no difference in clinical endotracheal intubation performance between these groups. However, this inference was based on 60 paramedics, each performing a mean of only 3 endotracheal intubations. There are no direct comparisons of cadaver and operating room–based training. Cadavers were once widely used for teaching paramedic endotracheal intubation, but recent ethical concerns have curtailed learning opportunities on the recently dead.75,76

Beyond baseline proficiency, regular clinical experience is likely an important element for maintaining endotracheal intubation skill. Studies of complex medical procedures (such as cardiac catheterization and bypass) suggest that centers and practitioners who perform these interventions frequently have improved survival and lower complication rates.77–80 In Maine, Burton et al81 found that only 40% of paramedics attempted out-of-hospital endotracheal intubation annually, and only 1% to 2% of all paramedics performed 5 or more out-of-hospital endotracheal intubations annually. Separate from that study, we used 2003 statewide data from Pennsylvania, tallying the number of out-of-hospital endotracheal intubations performed by certified advanced life support rescuers (paramedics, out-of-hospital nurses, EMS physicians).82 We found that rescuers performed a median of only 1 out-of-hospital endotracheal intubation (interquartile range 0 to 3) during the study period; 39% performed no out-of-hospital endotracheal intubations, and 67% performed fewer than 2 out-of-hospital endotracheal intubations. Thus, contrary to common assumptions, most individual paramedics performed the procedure infrequently. Although the exact numbers needed to maintain out-of-hospital endotracheal intubation skill are unknown, these procedural frequency figures seem relatively low.

The original models of out-of-hospital endotracheal intubations in Boston, Columbus, San Diego, and Pittsburgh were designed for small, closely supervised, highly skilled cadres of paramedics working in busy urban EMS systems and supported by intensive training.3–4 Today, although many individual paramedics demonstrate exceptional endotracheal intubation skill, one must reconsider whether all paramedics nationally can attain the same level of excellence, given current limits in endotracheal intubation training and clinical experience.

Can We Improve Out-of-Hospital Endotracheal Intubation?

The current literature draws attention to many problematic aspects of out-of-hospital endotracheal intubation while offering few affirmations of current practice. Proposed solutions address only isolated aspects of the procedure, and none provide perfect or complete answers. For example, some have proposed that systematic use of waveform capnography could eliminate endotracheal tube misplacements in the out-of-hospital setting.39,83,84 Silvestri et al83 recently reviewed 213 out-of-hospital endotracheal intubations arriving at a Florida Level I trauma center. The authors found that the tube misplacement rate was zero percent when waveform capnography was used and 23.3% when waveform capnography was not used. However, only limited formal data describe the accuracy of these devices on cardiac arrests, which comprise most of the endotracheal intubations in the out-of-hospital setting.83,85–87

Some directors have expanded the use of sedative or neuromuscular blocking agents to improve the out-of-hospital endotracheal intubation success.88 However, as discussed previously, the San Diego Rapid-Sequence Intubation Trial showed that important complications may result when these advanced techniques are introduced on a large-scale basis.20,42 Because of its profound sedative effects and stable hemodynamic profile, some EMS systems have used etomidate alone (without neuromuscular blockade) to facilitate out-of-hospital endotracheal intubation of nonarrest patients.89,90 However, a recent randomized controlled trial comparing etomidate-only with midazolam-only facilitated cases found no difference in out-of-hospital endotracheal intubation success rates.91 The observed etomidate endotracheal intubation success rate in this trial was 76% (95% CI 65% to 87%), which may be below desired success thresholds. Furthermore, the authors performed only a limited outcomes analysis.

Some EMS services have improved procedural experience and proficiency by using fewer targeted-response paramedics.5,92,93 In the original implementation effort by DeLeo, the investigator purposely constrained the number of paramedic units to maximize out-of-hospital endotracheal intubation procedural exposure.5 Although feasible in dense urban settings, these strategies may not be possible in remote rural areas where ambulances already cover large geographic distances. These approaches are also at odds with the efforts of communities seeking to increase the number of paramedics in their regions.94

In the spirit of seeking system-level improvements, one cannot ignore the question, Should we intubate at all? For apneic or near-apneic patients, alternate airways such as the Combitube (esophageal–tracheal twin-lumen airway device; Kendall, Inc., Mansfield, MA) and laryngeal mask airway (LMA North America, San Diego, CA) have appealing characteristics and are supported by some data.95–98 These devices are conceptually simpler than endotracheal intubation, easier to insert than endotracheal tubes, require less training, and are less subject to skill decay.71,96,99–101

These devices have been extensively used as primary and secondary airway management devices.102–104 There is wide experience with the use of these devices by nonphysicians and even basic-level rescuers.97,101,105–112 Combitubes and laryngeal mask airways offer ventilation and oxygenation comparable with endotracheal intubation in controlled and field settings.96,100,113–115 Current advanced cardiac life support guidelines recommend the use of
these devices when rescuers have only limited endotracheal intubation experience.²¹

Combitubes and laryngeal mask airways have important adverse effects, limitations, and concerns, including many similar to those of endotracheal intubation.⁴⁵,¹¹⁷–¹²² Most important, their links to patient outcome have not been defined. Before Combitubes and laryngeal mask airways can formally replace endotracheal intubation, we must perform careful systematic evaluations to verify their safety and effectiveness.

CONCLUSION

The current literature highlights shortcomings associated with out-of-hospital endotracheal intubation. Few studies affirm current practice. Few studies have demonstrated improved outcome from out-of-hospital endotracheal intubation in any disease group, and several studies describe worsened outcomes. In many studies, adverse events and errors associated with out-of-hospital endotracheal intubation are frequent. Out-of-

hospital endotracheal intubation may inadvertently interact with other physiologic processes key to optimizing resuscitation. Significant system-level barriers limit opportunities for endotracheal intubation training and clinical experience. Scientists, medical directors, and clinicians must strive to better understand and ultimately improve this key intervention.

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Out-of-Hospital Endotracheal Intubation

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2006 Undersea and Hyperbaric Medicine Subspecialty Examination

The American Board of Emergency Medicine (ABEM) and the American Board of Preventive Medicine (ABPM) will administer the certifying examination in Undersea and Hyperbaric Medicine on October 2–6 and October 9–13, 2006.

Physicians must submit an application to the board through which they are certified. Physicians certified by an American Board of Medical Specialties member board other than ABEM and ABPM and who fulfill the eligibility criteria must apply to ABPM. Upon successful completion of the examination, certification is awarded by the board through which the physician submitted the application.

The eligibility criteria are available from the ABEM office or at www.abem.org.

Application materials are now available for ABEM diplomates and will be accepted with postmark dates through July 1, 2006. ABPM diplomates should contact ABPM for application cycle information.

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