

Airway Management in Trauma: Defining Expertise

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Published online: 8 September 2015
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Abstract Prompt attention to airway management is a fundamental component of the approach to trauma anesthesiology. While anesthesiologists manage the greatest number of airways in their training and practice, a variety of medical providers perform airway management in the trauma population (i.e., paramedics, emergency physicians, anesthesiologists, respiratory therapists). Rates of successful intubation can vary widely between groups; therefore, a definition of expertise is required to develop training plans, as well as standards for maintenance of proficiency. While competency is challenging to define in any field, the data suggest that individuals with the greatest experience achieve the highest level of success. Given that anesthesiologists manage several thousand airway encounters throughout their training and careers, their leadership as subject matter experts is essential to development of training curricula in airway management of all varieties. Consensus on training of less experienced providers, as well as tasking of the most difficult cases to the most

experienced provider, is imperative for successful airway management in trauma.

Keywords Airway · Trauma care · Trauma anesthesia · Intubation

Introduction

The ability to safely and efficiently secure the airway is a cornerstone of trauma anesthesia. While trauma patients in need of intubation can present with a range of co-morbid injuries as well as potentially difficult airway management during resuscitation; the handling of the airway can be assigned to different groups/specialties depending on the trauma system. In the United States, some patients receive airway management by paramedics with varied degrees of training and experience. Alternatively, in many European countries, physicians with differing degrees of airway expertise perform advanced airway procedures in the field.

Individual Emergency Medical Service (EMS) jurisdictions proscribe the minimum training requirements for their EMS personnel. However, the degree of training can vary dramatically, as can the use of various guidelines, devices, techniques, and medications. For example, some EMS systems prohibit the use of muscle relaxants for intubation, and other systems have moved away entirely from prehospital endotracheal intubation, instead favoring the use of supraglottic airway devices.

Airway management in the trauma bay of most centers across the county is similarly varied. While it is common that the anesthesiology department supervises most airway policies, the actual procedure of airway management is often outsourced to other providers. In some trauma

This article is part of the Topical Collection on *Anesthesia for Trauma*.

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centers, an anesthesiologist is available at all hours to assess and manage the airway of arriving trauma patients. Other centers, however, rely on emergency medicine physicians for airway management. In other medical centers, a variety of non-physician providers can be called upon to serve as airway consultants in emergencies. To define expertise required for airway management in trauma, it is important to have an understanding of the current literature, as well as the applied instruments used to measure expertise.

Timing of Intubation

It is widely accepted that the airway of a severely injured trauma patient should be appropriately managed as soon as possible. The decision to intubate a patient in the prehospital environment, the emergency department, or the operating room, however, depends not only on the etiology of the trauma but also on the specific patient situation, transport time, and expertise of the medical provider caring for the patient.

Prehospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury. A total of 312 patients with severe TBI were randomly assigned to paramedic rapid sequence intubation or hospital intubation. The success rate for paramedic intubation was 97 % [1]. The proportion of patients with favorable outcome (defined as extended Glasgow Outcome Score of 5–8) was 80 of 157 patients (51 %) in the paramedic intubation group, compared with 56 of 142 patients (39 %) of the hospital intubation. This demonstrates a statistically significant benefit with early paramedic intubation.

When early airway intervention in the field is required, it is important that the provider possess the necessary skill set to secure the airway. Davis showed an association between attempted intubation and increased mortality among individual trauma patients with a GCS \leq 8; however, a subgroup analysis of EMS systems exhibited lower overall mortality in EMS systems with higher intubation rates [2]. This suggests a need for proficient training and maintenance of airway management skills to favorably impact trauma care. Failed intubation, unrecognized esophageal intubation or prolonged intubation attempts can have profound impact in critically injured patients and potentially worsen outcome. The ideal method to train for and maintain the skill set required for successful field intubation is a subject for future outcome-associated investigations.

Some EMS systems do not allow paramedics to use muscle relaxation for intubation, presumably to ensure the maintenance of spontaneous ventilation, in the event of a failed intubation. Perhaps not surprisingly, intubation attempts without muscle relaxation can increase the number of failed intubations and subsequent complication rates [3].

With three or more attempts, success rates are low and a delay to employ other emergency airway management techniques may occur. Intubation success is more likely with muscle relaxants and EMS ground crews that use neuromuscular blockers have more successful intubation rates.

The airway management in the emergency room for the patient in extremis is often done by board certified emergency medicine physicians or residents. In trauma systems where field intubations are not performed by EMS, advanced airway management relies heavily upon the emergency department staff with emphasis on early airway intervention. For systems in which trauma patient airways are less aggressively managed by paramedics, early recognition and treatment of a compromised airway is essential.

Miraflor found that delayed intubation of moderately injured patients (ISS < 20) who arrived without a secure airway in the emergency room had a higher mortality (11.8 %), compared to those intubated earlier (1.8 %) [4]. This emphasizes that early airway management and intubation, whether in the field or in the emergency department, are crucial to successful advanced airway management in trauma.

Success Rates for Advanced Airway Management

A range of medical providers performs advanced airway management in trauma patients. In North America, many paramedics receive training in advanced airway management and the use of induction drugs. However, there is no standardized approach to this teaching and it varies by region. As noted above, some EMS systems allow the use of rapid sequence induction (RSI) drugs, whereas other systems allow RSI drugs only after failed intubation attempts without drugs. Still other systems do not allow RSI drugs at all. The extent of airway training of paramedics varies from as few as five intubations to advanced airway training in the operating room under anesthesia supervision with up to 50 intubations. In many European countries, emergency medicine physicians and anesthesiologists staff advanced EMS units and perform airway management in the field. Given the difference in training and experience, it is difficult to perform outcome studies in trauma airway management across these populations. The difference in airway management skills and training among paramedics, emergency physicians, and anesthesiologists, as well as differences among American, Canadian, and European system, makes analysis difficult.

Cobas studied prehospital airway intervention rates and mortality at the Ryder Trauma Center in Miami in 1320 patients over a 3-year period [5]. Of that total, 1117 patients were intubated by an anesthesiologist in the trauma bay and 203 (15 %) had prehospital airway management

by paramedics. Of the 203 prehospital patients, 140 (69 %) were successfully intubated and 63 (31 %) had a failed prehospital intubation of which 25 (12 %) had an unrecognized esophageal intubation. It is important to note that paramedics in this study performed 1–3 tracheal intubations per year. Mortality in the failed prehospital intubation group was 71 %, as compared to 60 % for the successful prehospital intubation group; however, this result was not statistically significant, suggesting that the use of a bag-valve-mask was adequate for airway management in critically ill trauma patients.

A recent British study by Lockey examined prehospital airway intervention in trauma patients in the London area [6•]. Patients were initially treated by paramedics who attempted intubation without medication. A tiered response by a later arriving advanced paramedic–physician team then assessed the airway management by the primary responding paramedics. Out of a total of 45 intubation attempts by the primary paramedic team, 64 % were successful and 11 % had unrecognized esophageal intubation. The physician intubations were 100 % successful, and medications were used for induction as required. The physicians in this study had a minimum of 5 years of postgraduate experience, and almost half of them were anesthesiologists.

The same group found a statistically different success rate for prehospital intubation between anesthesiologists and non-anesthesiologists. Non-anesthesiologists performed 4394 intubations with 41 failures (0.9 %), whereas anesthesiologists performed 2587 intubations with 11 failures (0.4 %) ($P = 0.02$) [7•]. A high rate of anesthesiologist success in airway management in trauma was also demonstrated in a Norwegian study [8]. The authors evaluated endotracheal intubation (ETI) in trauma by prehospital anesthesiologists and found a 99.2 % success rate.

Breckwoldt evaluated the expertise in prehospital intubation by prehospital physicians using the Dreyfus and Dreyfus framework of expertise [9]. The groups were classified into “experts” (i.e., anesthesiologists) and “proficient performers” (i.e., internal medicine physicians). The mean years of professional experience were similar between the physician groups, but the median ETI experience differed significantly with 18/year for “proficient performers” and 304/year for “experts” ($P < 0.001$). The incidence of difficult ETI was 17.7 % for “proficient performers” and 8.9 % for “experts” ($P < 0.05$). Unexpected difficult ETI occurred in 6.1 % for “proficient performers” compared with 2.0 % for “experts” ($P = 0.08$).

While these data demonstrate higher success rates in endotracheal intubation with anesthesiologists, another group found no difference in success rates between

physician specialties. A prospective, observational study described trauma intubations supervised by anesthesiology staff compared to those supervised by emergency medicine staff in 673 adult trauma patients [10]. Intubation within two attempts was accomplished with anesthesiology supervision in 94.6 % of cases in comparison to 95.25 % of cases with emergency physicians (OR 1.1, 95 % CI 0.498–2.522). Failure of intubation with anesthesiologist supervision occurred in 3.4 % of cases in comparison to 1.9 % of cases with emergency physicians (OR 0.55, 95 % CI 0.15–1.8). The authors cite several limitations including the fact that 80 % of patients in the first phase (i.e., anesthesiology supervision) were intubated by emergency physicians, suggesting that the study does not accurately reflect a side-by-side comparison.

Ultimately, it is reassuring to know that physician-led RSI in trauma is safe. A retrospective study from the Shock Trauma Center in Baltimore showed a very high success rate for RSI with direct laryngoscopy [11••]. In the study by Stephens, 6088 patients arriving in the trauma bay who required intubation within the first hour of arrival were intubated by anesthesia or emergency medicine residents under supervision of an experienced trauma anesthesiology attending. Intubation was successful in 99.7 % and a surgical airway was required in 0.3 % of the patients.

It appears that the more intubations one performs, the better his/her skill set becomes. What exactly leads to an expert skill set? Perhaps standardization of training can offer higher success rates across all specialties.

Training for Advanced Airway Management

Problems with airway management can arise for less experienced providers. Lower numbers of airway management opportunities result in fewer opportunities to learn different methods or to use different equipment. Laryngoscopy skills can be limited to one or two different intubation techniques and some may lack the skills in rescue/alternative airway management techniques (e.g., awake fiberoptic intubation, intubating LMA, supraglottic airway devices, different laryngoscope blades).

It remains difficult to define how many intubations and what sort of advanced airway training is required to gain expertise in advanced airway management. Emergency medicine residents are required to perform 35 intubations for graduation, and some physicians have limited opportunity to maintain their skill set later in their career. While the number of intubations for anesthesia residents is not typically tabulated during residency, it is not uncommon for them to perform over a thousand intubations throughout residency. Both anesthesiology and emergency medicine residents are trained in alternatives to endotracheal

intubation during an emergency (e.g., catheter access, surgical cricothyroidotomy).

The importance of a rigorous airway training system for prehospital care provider was shown in a study by Prekker, which examined prehospital airway interventions in 7523 patients, over a period of 5 years in King County, Washington [12]. Although, this study did not differentiate between trauma and non-trauma patients, 77 % were successfully intubated on the first attempt and over 99 % were successfully intubated by the third attempt. Paramedics in this study underwent initial airway training with up to 50 intubations in the operating room and the field. Annual currency training included a minimum of 12 successful intubations, either in the field or in the operating room. The use of RSI drugs was encouraged as part of the intubation protocol.

A recent study by Bernhard concluded that complications during the first 200 attempts at endotracheal intubation performed by anesthesiology residents justified experienced supervision [13]. Out of all residents, 52 % reached the target of 200 intubations after 50.2 ± 14.8 weeks, with a success rate of 95 % stabilizing after 150 intubations were performed.

While a specific number of intubations required to demonstrate expertise are difficult to quantify, the assessment of competency in this procedure is integral to the safe conduct of airway management in trauma.

Competency

Competency in any skill can be difficult to assess. Given the complex nature of medical procedures (e.g., varied patient condition, provider experience, clinical setting, time of day), complex techniques are sometimes required to provide a thoughtful assessment of competency.

DeMeo used Bayesian analysis to evaluate 477 intubation attempts by 105 pediatric residents in the neonatal intensive care unit [14•]. Bayesian analysis is a unique methodological technique that relies on the initial conditions set in a mathematical analysis to predict an outcome and may be useful in modeling complex systems. In this investigation, competency was defined as four cumulative successful intubations. Roughly one quarter (23 %) of residents achieved competency in the 8-year study period. Initial failure on two intubation opportunities predicted a requirement of nearly double the time to achieve competence, as compared to those residents that were successful on their first two intubation opportunities. This study is remarkable in that it illustrates how challenging it can be to define and achieve competence in intubation regardless of the setting.

A variety of devices have been developed to assist less skilled providers with endotracheal intubation. Video

laryngoscopy provides an improved view of the vocal cords; however, this does not always translate to improved first pass success or decreased time to intubation [15]. When used by “non-expert” laryngoscopists video laryngoscopy can be beneficial, however, that benefit is not statistically significant after the fourth intubation [16].

In other medical procedures, competency is similarly difficult to define. An evaluation of competency in performing basic critical care echocardiography evaluated seven critical care fellows who performed 343 scans [17]. After thirty scans, fellows were able to reliably produce imaging/assessments in >90 % of six pre-defined domains. This varies remarkably from the lower numbers noted above for intubation and demonstrates that definition of competency remains an elusive goal, perhaps best described as “you know it when you see it.”

Conclusion

Prompt attention to airway management is a fundamental component of the approach to trauma anesthesiology. While anesthesiologists manage the greatest number of airways in their training and practice, a variety of medical providers perform airway management in the trauma population (i.e., paramedics, emergency physicians, anesthesiologists, respiratory therapists). Rates of successful intubation can vary widely between groups; therefore, a definition of expertise is required to develop training plans, as well as standards for maintenance of proficiency. While competency is challenging to define in any field, the data suggest that individuals with the greatest experience achieve the highest level of success. Given that anesthesiologists manage several thousand airway encounters throughout their training and careers, their leadership as subject matter experts is essential to development of training curricula in airway management of all varieties. Consensus on training of less experienced providers, as well as tasking of the most difficult cases to the most experienced provider, is imperative for successful airway management in trauma.

Compliance with Ethics Guidelines

Conflict of Interest Andreas Grabinsky declares that he has no conflict of interest. Nancy Vinca has served as a board member of both the American Board of Emergency Medicine and the American Board of Anesthesiology. Joshua M. Tobin declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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