Airway Management by US and Canadian Emergency Medicine Residents: A Multicenter Analysis of More Than 6,000 Endotracheal Intubation Attempts

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Study objective: We determine success rates of endotracheal intubation performed in emergency departments (EDs) by North American emergency medicine residents.

Methods: During 58 months, physicians performing intubations at 31 university-affiliated EDs in 3 nations completed a data form that was entered into the National Emergency Airway Registry 2 database. Included were all patients undergoing endotracheal intubation in the ED. The data form included patients’ age, sex, weight, indication for intubation, technique of airway management, names and dosages of all medications used to facilitate intubation, level of training and specialty of the intubator, number of attempts, success or failure, and adverse events. We queried this prospectively gathered, observational data to analyze intubations done by US and Canadian emergency medicine residents.

Results: Enrollment was incomplete (eg, 85% at the main study center), so the study sample did not include all consecutive patients. Emergency medicine residents performed 77% (5768/7498; 95% confidence interval [CI] 76% to 78%) of all initial intubation attempts in the United States and Canada. The first intubator was successful in 90% (5,193/5,757; 95% CI 89% to 91%) of cases, including 83% (4,775/5,757; 95% CI 82% to 84%) on the first attempt. Success rates on the first attempt were as follows: postgraduate year 1 = 72% (498/692; 95% CI 68% to 75%), postgraduate year 2 = 82% (2,081/2,544; 95% CI 80% to 83%), postgraduate year 3 = 88% (1,963/2,383; 95% CI 86% to 89%), postgraduate year 4+ = 82% (233/283; 95% CI 77% to 87%), and attending physician = 89% (689/772; 95% CI 87% to 91%). Success rates by the first intubator were as follows: postgraduate year 1 = 80% (553/692; 95% CI 77% to 83%), postgraduate year 2 = 89% (2,272/2,544; 95% CI 88% to 90%), postgraduate year 3 = 94% (2,105/2,238; 95% CI 93% to 95%), postgraduate year 4+ = 93% (263/283; 95% CI 89% to 96%), and attending physician = 98% (755/772; 95% CI 96% to 99%). Rapid sequence intubation technique was used in 78% (4,513/5,768; 95% CI 77% to 79%) of initial attempts: it resulted in 85% (3,843/4,513; 95% CI 84% to 86%) success on the first attempt and 91% (4,117/4,513; 95% CI 90% to 92%) success by the first intubator. The overall rate of cricothyrotomy for all emergency resident intubations was 0.9% (50/5,757; 95% CI 0.6% to 1.1%). When an initial intubator failed, 40% (385/954; 95% CI 37% to 44%) of rescue attempts were performed by emergency medicine residents. Among emergency medicine residents, success on the first rescue attempt was 80% (297/371; 95% CI 76% to 84%), and success by the first rescue intubator was 88% (328/371; 95% CI 85% to 91%).

Conclusion: Success of initial intubation attempts increased over the first 3 years of residency. This large multicenter study demonstrates the success of airway management by emergency medicine residents in North America. Using rapid-sequence intubation predominantly, emergency medicine residents achieved high levels of success. [Ann Emerg Med. 2005;46:328-336.]
INTRODUCTION

Background

Successful emergency airway management is a cornerstone of the modern practice of emergency medicine. Training in airway management is consequently one of the most essential components of emergency residency training. Yet the skill development of emergency medicine residents in emergency endotracheal intubation is not well understood.

Importance

In order to better understand the success of airway management by emergency medicine residents across North America, we analyzed prospectively gathered data from a large, multicenter, observational database of emergency department (ED) airway management. We hoped that this information would offer a better understanding of the present state of airway management by emergency medicine residents in North America.

Goals of This Investigation

Our primary outcome measures were success on the first attempt and success by the initial intubator.

MATERIALS AND METHODS

Setting

Data used in this analysis were obtained in the second phase of the National Emergency Airway Registry (NEAR 2). NEAR 2 was initiated in August 1996 as a consortium of 31 academic EDs in the United States, Canada, and Singapore. All departments were staffed by full-time emergency attending physicians, and 29 were affiliated with fully accredited emergency residency training programs. Non–emergency medicine resident physicians also rotated through all of these departments and participated in intubations. Participating institutions were certified as Level I (n=25) or Level III (n=6) trauma centers and had an average ED census of 61,000 patient visits per year (range, 18,000 to 200,000). Pediatric patients were treated in 29 of the EDs, which included 1 designated children’s hospital. Each hospital maintains individual protocols about the policy and procedures for ED airway management. Intubations are performed by resident physicians at the discretion of, and are supervised by, emergency attending physicians.

Permission to conduct this study was obtained from the institutional review board of each participating institution.

Selection of Participants

During NEAR 2, data were gathered prospectively during a 58-month period (September 1996 to June 2001) on patients who presented to these 31 institutions’ EDs and underwent endotracheal intubation.

In order to focus on airway management by North American emergency medicine residents, we excluded patients in the NEAR 2 database who were intubated in either of 2 hospitals in Singapore. We thought that the training of residents in Singapore is likely so different from training in the United States and Canada that it would render the sample less representative of the type of training emergency medicine residents obtain in North America. The remaining patients were intubated in 29 hospitals in the United States and Canada.

We also excluded patients with data inconsistencies, such as an apparent inaccurate order of entry of attempts. An example of this is a patient who had several intubation attempts by an attending physician who fails and is “rescued” by a first-year resident. Although this scenario is feasible in rare instances, we recognized that the bulk of such data was in fact documented in the incorrect order. We did not have institutional review board approval for retrospective medical record review to clarify these documentations, and thus we excluded these cases. We did allow for and did not exclude any intubations done by a physician in anesthesia, even if, for instance, this was an anesthesia resident “rescuing” an emergency attending physician.

Study Design

Study coordinators collaborated to develop standard definitions and a data form that was thought to contain the most valuable data points.
Data Collection and Processing

The physician performing each intubation was referred to as the “intubator.”

After each intubation, the intubator completed a data form that included patients’ age, sex, weight, indication for intubation, level of training and specialty of the intubator, number of attempts, success or failure, and adverse events. Emergency medicine residents who classified themselves as postgraduate year 5 or postgraduate year 6 were included with postgraduate year 4 residents in a group called “postgraduate year 4+.”

Intubations are classified according to whether they are nasotracheal, oral with no medications, oral with sedation only, oral rapid sequence intubation, or surgical by cricothyrotomy or tracheostomy. Hereafter, these surgical airways will be referred to as “cricothyrotomy,” even though a subset may have technically been tracheostomies. This distinction is not made clearly on our data forms. The designations “no medications” or “sedation only” refer only to oral intubations. Data entry personnel verified that neuromuscular blockade was used whenever the designation “rapid sequence intubation” was indicated.

All data from the participating centers were entered into a customized relational database (Microsoft Access) managed on a dedicated personal computer in the coordinating center at [omitted for blinding] Hospital.

Primary Data Analysis

We conducted systematic queries of this prospectively collected database of ED intubations. Ninety-five percent confidence intervals (CIs) for means and for proportions were calculated using standard published formulae and Microsoft Excel.

Outcome Measures

Data forms were analyzed to determine success rates among emergency medicine residents at various levels. Emergency attending physician data were also analyzed to provide a comparison with emergency medicine residents. An “attempt” was defined as a single insertion of the laryngoscope for oral attempts or a single insertion of an endotracheal tube for nasal attempts, which was successful if it resulted in an endotracheal tube’s being placed through the vocal cords. An “intubator” was defined as a physician who attempted to pass an endotracheal tube through the vocal cords of a patient. Success on the first attempt and success by first intubator were calculated for each postgraduate year level. An attempted intubation was defined as a failure if another physician took over and performed a rescue attempt, regardless of whether the rescuing physician then intubated the patient successfully. An “initial intubation attempt” was defined as an attempt or series of attempts at endotracheal intubation of a patient for whom no other physicians had attempted intubation. A “rescue intubation attempt” was defined as an attempt or series of attempts at intubation in a patient for whom another physician had previously tried and failed to intubate. Success rates on the first attempt and by the first intubator were calculated for initial and rescue attempts.

RESULTS

Characteristics of Study Subjects

Figure 1 demonstrates the derivation of the study groups. Of 8,495 initial intubation attempts in the database, 923 were excluded because they were performed in Singapore, and 74 were excluded because of internal data consistencies, leaving 7,498 initial intubation attempts in EDs in the United States and Canada. Of these, 6,661 (89%; 95% CI 88% to 90%) initial attempts were performed by emergency physicians, including 5,768 (77%; 95% CI 76% to 78%) by emergency medicine residents. An additional 3% were performed by internal medicine physicians, 2% by anesthesiologists, 2% by emergency medical technicians, and less than 2% by several other specialists. An analysis of form completion by the International Classification of Diseases, Ninth Revision code was performed at the primary center during a 1-year period, which demonstrated an 85% compliance rate. No similar analysis was performed at other centers.

Main Results

Figure 2 breaks down the outcomes of initial intubation attempts by emergency medicine residents. After a failed
intubation, the resident either would be rescued by another physician or would try again, resulting in either a success or failure. Figure 3 demonstrates graphically success on first and multiple attempts by emergency physicians by level of training.

Among initial attempts by emergency medicine residents, success on the first attempt was 83% (4,775/5,757; 95% CI 82% to 84%) and success by first intubator was 90% (5,193/5,757; 95% CI 89% to 91%). By level of training, success rates on the first attempt were as follows: postgraduate year 1 = 72% (498/692; 95% CI 68% to 75%), postgraduate year 2 = 82% (2,081/2,544; 95% CI 80% to 83%), postgraduate year 3 = 88% (1,963/2,238; 95% CI 86% to 89%), postgraduate year 4 = 82% (233/283; 95% CI 77% to 87%), and attending physician = 89% (689/772; 95% CI 87% to 91%).

By level of training, success rates by the first intubator were as follows: postgraduate year 1 = 80% (553/692; 95% CI 77% to 83%), postgraduate year 2 = 89% (2,272/2,544; 95% CI 88% to 90%), postgraduate year 3 = 94% (2,105/2,238; 95% CI 93% to 95%), postgraduate year 4+ = 93% (263/283; 95% CI 89% to 96%), and attending physician = 98% (755/772; 95% CI 96% to 99%).

After 1 failed attempt, postgraduate year 1 emergency medicine residents were allowed a second attempt 36% (70/194; 95% CI 29% to 43%) of the time, as compared with 56% (258/463; 95% CI 51% to 60%) for postgraduate year 2, 64% (175/275; 95% CI 58% to 69%) for postgraduate year 3, and 78% (39/50; 95% CI 64% to 88%) for postgraduate year 4+. If an emergency medicine resident failed an initial attempt and was not rescued after this failed attempt, there was a 67% (361/542; 95% CI 62% to 71%) likelihood of successful intubation on the second attempt. After 2 failed attempts, the success rate was 69% (53/77; 95% CI 57% to 79%) on the third attempt.

The primary indication for intubation was medical in 68% (3,720/5,420; 95% CI 67% to 70%) and traumatic in 32%
in 4% (223/5,768; 95% CI 3% to 4%), nasotracheal intubation in 5% (317/5,768; 95% CI 5% to 6%), cricothyrotomy in 0.2% (11/5,768; 95% CI 0.1% to 0.3%), and other in 0.9% (50/5,768; 95% CI 0.6% to 1.1%). Rapid sequence intubation was successful on the first attempt in 85% of cases (3,843/4,513; 95% CI 84% to 86%). As demonstrated in Table 1, the first-attempt success rate for no medication, sedation only, and nasotracheal intubations ranged from 72% to 76%.

Rapid sequence intubation was successful by the first intubator in 91% of cases (4,117/4,513; 95% CI 90% to 92%). As demonstrated in Table 1, the first-intubator success rate for no medication, sedation only, and nasotracheal intubations ranged from 84% to 88%. Note that some of these successes occurred only after a switch to an alternate technique, often rapid sequence intubation.

It was not uncommon in non–rapid sequence intubation attempts to undergo a switch to an alternative technique before successful intubation. Of no-medications attempts, 8% (51/654; 95% CI 6% to 10%) were changed to a different technique, including 67% (34/51; 95% CI 52% to 79%) to rapid sequence intubation and 22% (11/51; 95% CI 11% to 35%) to cricothyrotomy. Sedation-only attempts were changed to another technique 11% (24/223; 95% CI 7% to 16%) of the time, including 92% (23/25; 95% CI 74% to 99%) to rapid sequence intubation and 8% (2/25; 95% CI 1% to 26%) to cricothyrotomy. Nasotracheal intubation attempts were changed to another technique 8% (24/317; 95% CI 5% to 11%) of the time, including 75% (18/24; 95% CI 53% to 90%) to rapid sequence intubation and 4% (1/24; 95% CI 0% to 21%) to cricothyrotomy. After rapid sequence intubation, the only technique to change to was cricothyrotomy, which occurred 0.6% (25/4,513; 95% CI 0.4% to 0.8%) of the time.

Excluded from the preceding analysis of initial attempts are 11 cricothyrotomies done by emergency medicine residents before any nasal or oral attempts: 2 by postgraduate year 2 residents, 7 by postgraduate year 3 residents, and 2 by postgraduate year 4 residents.

Because the rate of nasotracheal intubation is generally institution dependent, we looked more closely at the proportion of nasotracheal intubation by institution. In fact, of 317 nasotracheal intubations in our data set, 76% (241/317; 95% CI 77% to 79%)

Table 1 outlines the success rates by technique. As demonstrated, 78% (4,513/5,768; 95% CI 77% to 79%) of initial attempts by emergency medicine residents used a rapid sequence intubation technique. Other techniques included no medications in 11% (654/5,768; 95% CI 11% to 12%), sedation only in 3% (194/5,768; 95% CI 3% to 4%), and cricothyrotomy in 0.2% (11/5,768; 95% CI 0.1% to 0.3%).

<table>
<thead>
<tr>
<th>Technique</th>
<th>No. (%)</th>
<th>Success First Attempt, %</th>
<th>Success First Intubator, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid sequence intubation</td>
<td>4,513 (78)</td>
<td>85 (3,843/4,513; 95% CI 84% to 86%)</td>
<td>91 (4,117/4,513; 95% CI 90% to 92%)</td>
</tr>
<tr>
<td>Oral no medication</td>
<td>654 (11)</td>
<td>76 (497/654; 95% CI 73% to 79%)</td>
<td>88* (575/654; 95% CI 85% to 90%)</td>
</tr>
<tr>
<td>Oral sedation only</td>
<td>223 (4)</td>
<td>72 (160/223; 95% CI 65% to 78%)</td>
<td>84* (188/223; 95% CI 79% to 89%)</td>
</tr>
<tr>
<td>Nasotracheal</td>
<td>317 (5)</td>
<td>76 (242/317; 95% CI 71% to 81%)</td>
<td>86* (272/317; 95% CI 81% to 89%)</td>
</tr>
<tr>
<td>Cricothyrotomy</td>
<td>11 (0.2)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Other</td>
<td>50 (1)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Total</td>
<td>5,768 (100)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note that a proportion of these were successfully performed by the first intubator after a switch to an alternative technique, most commonly rapid sequence intubation (see text for additional detail).
CI 71% to 81%) came from a single institution, which used this technique in 67% (241/359; 95% CI 62% to 72%) of their initial attempts. Of institutions contributing more than 100 patients to the data, the next closest used nasotracheal intubation in 7% (8/123; 95% CI 3% to 12%), and all others used it in 2% or less of initial attempts.

Among the rapid sequence intubation intubations, the most commonly used induction agents were etomidate (69%; 3,107/4,513; 95% CI 67% to 70%), midazolam (16%; 714/4,513; 95% CI 15% to 17%), fentanyl (6%; 270/4,513; 95% CI 5% to 7%), and ketamine (3%; 126/4,513; 95% CI 2% to 3%). The neuromuscular blocking agents most commonly used for paralysis in rapid sequence intubation were succinylcholine (82%; 3,705/4,513; 95% CI 81% to 83%), rocuronium (12%; 519/4,513; 95% CI 11% to 12%), and vecuronium (5%; 207/4,513; 95% CI 4% to 5%).

In the entire database (Singapore excluded), there were 954 instances in which an initial or subsequent intubator failed, and thus the patient required a rescue intubator. Of these, 40% (385/954; 95% CI 37% to 44%) of rescue attempts were by emergency medicine residents, and 40% (382/954; 95% CI 37% to 43%) were by emergency attending physicians. Anesthesia physicians attempted 11% (106/954; 95% CI 9% to 13%) of rescues, surgery physicians attempted 3% (32/954; 95% CI 2% to 5%) of rescues, and various other specialty physicians attempted 2% or less of rescues. Of the overall total of initial and rescue attempts, anesthesia was involved in 3% (292/8,452; 95% CI 3% to 4%).

Figure 4 demonstrates the success rates in rescue intubations done by emergency physicians stratified by level of training. For emergency medicine residents, success on the first rescue attempt was 80% (297/371; 95% CI 76% to 84%), and success by first rescue intubator was 88% (328/371; 95% CI 85% to 91%). Note that 14 patients who underwent immediate cricothyrotomy by the initial rescue intubator are excluded from these analyses. These success rates are not substantially different from the success rates for initial attempts (which were 83% and 90%, respectively).

By level of training, success rates on the first rescue attempt were as follows: postgraduate year 1 = 40% (2/5; 95% CI 5% to 85%), postgraduate year 2 = 77% (40/52; 95% CI 63% to 87%), postgraduate year 3 = 81% (199/246; 95% CI 75% to 86%), postgraduate year 4+ = 82% (56/68; 95% CI 71% to 91%), and attending physician = 75% (276/369; 95% CI 70% to 79%). By level of training, success rates by the first rescue intubator were as follows: postgraduate year 1 = 40% (2/5; 95% CI 5% to 85%), postgraduate year 2 = 85% (44/52; 95% CI 72% to 93%), postgraduate year 3 = 89% (220/246; 95% CI 85% to 93%), postgraduate year 4+ = 91% (62/68; 95% CI 82% to 97%), and attending physician = 90% (331/369; 95% CI 86% to 93%).

The overall rate of cricothyrotomy for all emergency medicine resident intubations was 0.9% (50/5,757; 95% CI 0.6% to 1.1%). The overall rate of “rescue” cricothyrotomy (a subset of the 0.9% above, excluding 11 cricothyrotomies by emergency medicine residents before any oral or nasal intubation attempt) was 0.7% (39/5,746; 95% CI 0.5% to 0.9%). Rates of rescue cricothyrotomy by postgraduate year level were as follows: postgraduate year 1 = 0.6% (4/692; 95% CI 0.2% to 1.5%), postgraduate year 2 = 0.2% (6/2,542; 95% CI 0.1% to 0.5%), postgraduate year 3 = 1.0% (23/2,231; 95% CI 0.7% to 1.5%), postgraduate year 4+ = 2.1% (6/281; 95% CI 0.8% to 4.6%).

LIMITATIONS

There are several limitations to our study. Although we believe that we obtained prospective data on the majority of intubations performed in each ED, we did not conduct an overall audit to determine the proportion of intubations entered into the study. It is possible that there is a reporting bias in that those intubations that were entered were not typical of all intubations at these centers. We relied on hundreds of physicians at many centers to complete the data forms accurately, and our results depend on the accuracy of their reporting.

We did not perform a retrospective analysis of patient medical records to confirm existing data, complete missing data, and compare our patients with those intubated but not entered into the study. Such an analysis would have strengthened the study but was not logistically feasible.

Analysis of adverse events was not reported in this study, because of questions about possible bias and the overall accuracy of these self-reported data in the absence of clinical follow-up.
data. We determined that self-reporting immediately after intubation could result in incomplete reporting of adverse events. A more accurate analysis of adverse events might require follow-up with patients in the remainder of their hospitalization or on autopsy.

This study was purely observational and neither randomized nor controlled. It is therefore possible that residents at more advanced levels of training selectively attempted to intubate the more difficult patients. Consequently, it is possible that the true learning curve is different than that demonstrated in this study.

There may be some misclassification of residents by postgraduate-year level because there may be some residents who began training in another field before switching into emergency medicine. This appears to be the case because there were some self-reported postgraduate year 5 and postgraduate year 6 emergency medicine residents, even though training programs in the study centers are all 3 or 4 years long. Therefore, the postgraduate-year level may not accurately reflect a resident’s experience in airway management in some cases.

**DISCUSSION**

Emergency medicine residents in this study performed initial intubations with high levels of success, which improved from the postgraduate year 1 through postgraduate year 3, with a surprising decline in postgraduate year 4. We demonstrated that residents given a second chance to intubate will be successful two thirds of the time on the second attempt. Emergency medicine residents performed rescue intubations with success rates similar to their initial intubation attempts, despite the fact that another physician had already failed intubating the patient. Most intubation attempts by emergency medicine residents were performed using a rapid sequence intubation technique, and intubations using this technique were associated with high success rates. We showed that the rate of cricothyrotomy for emergency medicine resident intubations was less than 1%.

Table 2 summarizes 5 recent studies focusing on ED intubations done primarily by emergency medicine residents. Success rates on the first attempt ranged from 74% to 86%, and surgical airway rates averaged 0.9% overall. Rates of successful intubation by the initial resident were not uniformly available.

These studies provide important preliminary evidence that ED intubations by emergency medicine residents, most done using a rapid sequence intubation technique, can be performed safely and with high levels of success. Although these ED-based studies evaluated reasonably large numbers of intubations, all but the relatively small pediatric study by Sagarin et al were limited to a single site, and their applicability to the many emergency residency programs in North America is unknown.

Our data demonstrated a gradual improvement in success rates on the first attempt and by the first operator in the first 3 years of residency training. These findings were to be expected, given the increase in experience gained during the first few years of residency training. It is possible that the improvement over time is even greater than our numbers suggest because postgraduate year 1 residents are more likely to be allowed attempts on the anticipated “easy” airways, whereas more difficult cases may be reserved for higher-level residents. There is a clear clinical difference in these success rates: the first attempt and first intubator success rates increased by 16% and 14%, respectively, from postgraduate year 1 to postgraduate year 3. This clinical significance may be even greater if these values actually underestimate the differences, as suggested above.

There was no further improvement in success by the first intubator, and even a slight decline in success on the first attempt, from the postgraduate year 3 to postgraduate year 4 level. This finding was surprising. On the surface, it may support proponents of 3-year emergency residency training programs, who would argue that emergency medicine residents’ airway skills are mature by postgraduate year 3. However, whereas there is often a role for “routine” airway management by the postgraduate year 3 resident (eg, in trauma resuscitations) at many 3-year programs, this is less often the case in 4-year programs, in which residents more commonly assume a supervisory role. Thus, the postgraduate year 4 residents may be handling a select group of only the most difficult cases. The rate of rescue cricothyrotomies was highest after initial attempts by postgraduate year 4+ residents (2.1%), which supports this hypothesis. Furthermore, the fact that there were some postgraduate year 4 emergency medicine residents listed at sites where the residency is only 3 years long and the existence of self-proclaimed postgraduate year 5 and postgraduate year 6 emergency medicine residents suggest there are some physicians who trained in other fields and then switched into emergency medicine. There may be a disproportionate share of these

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**Table 2. Summary of previous studies focusing on emergency airway management by emergency medicine residents.**

<table>
<thead>
<tr>
<th>Lead Author</th>
<th>No.</th>
<th>By Rapid Sequence Intubation, %</th>
<th>By Emergency Medicine Residents, %</th>
<th>Success on First Attempt, %</th>
<th>Success by First Intubator, %</th>
<th>Cricothyrotomy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calderon³</td>
<td>324</td>
<td>n/a</td>
<td>88 (n/a)</td>
<td>74* (n/a)</td>
<td>n/a</td>
<td>1.2 (4/324)</td>
</tr>
<tr>
<td>Sagarin²</td>
<td>417</td>
<td>100 (417/417)</td>
<td>97 (n/a)</td>
<td>80 (n/a)</td>
<td>n/a</td>
<td>0.7 (3/417)</td>
</tr>
<tr>
<td>Tayal⁵</td>
<td>670</td>
<td>84 (515/610)</td>
<td>88 (534/610)</td>
<td>81 (n/a)</td>
<td>n/a</td>
<td>1.1 (7/610)</td>
</tr>
<tr>
<td>Levitan⁶</td>
<td>456</td>
<td>n/a</td>
<td>100 (456/456)</td>
<td>86 (394/486)</td>
<td>n/a</td>
<td>0.4 (2/456)</td>
</tr>
<tr>
<td>Total</td>
<td>1899</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0.9 (17/1963)</td>
</tr>
</tbody>
</table>

*Percent success for postgraduate year 1 residents only is reported.

¹Pediatric patients only.

²Cricothyrotomy numbers reported only with emergency medicine residents and others combined.
physicians in the postgraduate year 4+ group. A resident who has completed a residency in internal medicine, with minimal airway training, and switches into emergency medicine might have reported himself as postgraduate year 4 even though he or she is in fact a novice intubator, which may have contributed to the decrease in first-attempt success rates by postgraduate year 4+ residents.

Given that 67% of emergency medicine residents given a “second chance” were successful on the second attempt (and this rate did not vary substantially by postgraduate year level), it is probable that had more lower-level residents had a second chance, their first intubator success rates would have been higher. Although it is difficult for an emergency attending physician to allow a lower-level resident multiple attempts at intubation on a critically ill patient who could deteriorate at any moment, this 67% second-chance success rate may help emergency attending physicians to decide whether to offer a second attempt to the resident versus taking over themselves. Education in airway management is one of the most difficult tasks of the emergency attending physician because he or she must continually find the right balance between rapid care of the patient and resident education.

The similarly high success rates seen in medical and trauma patients add further to the growing body of literature that supports the role of emergency physicians in the initial airway management of the trauma patient.6,7

Because of the nonrandomized nature of this study, we have avoided comparing rapid sequence intubation to other techniques of airway management. However, the higher success rates of rapid sequence intubation versus other techniques of airway management in our data are consistent with numerous other studies in the recent literature.2,8-14 That rapid sequence intubation was superior to nasotracheal intubation, despite the fact that most nasotracheal intubations came from a center that does them quite regularly, is further evidence (though nonrandomized) that rapid sequence intubation is usually the optimal choice for patients who do not present with cardiac arrest. Given the accumulated evidence of rapid sequence intubation’s superiority in the abovementioned nonrandomized comparisons, it would probably be unethical to initiate a randomized trial of rapid sequence intubation versus other techniques at this point, and we will likely never see such a study.

Our data on induction agents were consistent with a trend in the recent airway literature away from the use of midazolam and toward increasing use of etomidate.8 Etmidate’s hemodynamic stability, short duration of action, and cerebroprotective activity make it an ideal agent for most intubations. The choice of induction agent remains institution dependent, however, with some institutions continuing to favor midazolam.5 Among neuromuscular blockers, succinylcholine remains the drug of choice for most rapid sequence intubations because of its rapid onset and short duration. Rocuronium is the next most commonly used agent.

Our rates of overall cricothyrotomies were comparable to other recent studies of emergency medicine resident intubations. The low rate of cricothyrotomies and nasotracheal intubations in these centers may be good for patients but raises some concerns for emergency medicine resident training. Cricothyrotomy rates of around 1% appear to be the norm in recent studies3-6,9 as opposed to 10% or higher in older studies15 and in some out-of-hospital systems.16 It is now not uncommon for emergency medicine residents to graduate having done no, or very few, cricothyrotomies and nasotracheal intubations.17-19

To our knowledge, this large multicenter study represents the largest analysis to date of airway management by emergency medicine residents. It demonstrates the success of airway management as practiced in university-affiliated EDs across North America: initial attempts are primarily by emergency medicine residents, with backup primarily by higher-level emergency medicine residents and emergency attending physicians. It establishes benchmarks for North American residency training programs so that residency program directors can assess their own residents’ success rates and encourage further airway training for residents who fall below the mean. The finding that emergency medicine residents are as successful on rescue intubations as on initial intubations may encourage emergency attending physicians to offer higher-level emergency medicine residents the opportunity to “back up” less-experienced intubators in cases in which the attending physician believes this is safe to do. Now that a baseline has been established in this report, investigators can evaluate educational and other interventions that improve emergency medicine resident success rates at endotracheal intubation. It is our hope that researching education in emergency airway management will ultimately result in safer clinical practice and better patient outcomes.

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