The First Shot Is Often the Best Shot: First-Pass Intubation Success in Emergency Airway Management

Michael Bernhard, MD,* Torben K. Becker, MD,*‡ André Gries, MD,* Jurgen Knapp, MD,*‡ and Volker Wenzel, MD, MSc§

Emergency airway management is often lifesaving but may occasionally result in severe or fatal complications.1-4 A fatal outcome after airway management may be especially tragic when a patient was spontaneously breathing beforehand, or a rescuer induces anesthesia but fails to effectively manage subsequent apnea.5-8

Although alternative airway devices have been described, endotracheal intubation remains the gold standard in emergency airway management.9 However, even experienced care providers may encounter an unanticipated difficult airway,10-12 underestimate airway problems, or be called to help a colleague. In these circumstances, multiple intubation attempts may result in bleeding, swelling of soft tissues, and/or oxygen desaturation,13 all of which can render endotracheal intubation increasingly difficult and stressful. To minimize complications of emergent airway management, we propose that airway managers should prioritize successful intubation during the first attempt.3

A doctrine of “first-pass success” does not mean routinely performing a tracheostomy or cricothyroidotomy on every patient, because these invasive techniques are associated with a high rate of complications and are not necessary in most airway management episodes. Rather, we argue that anesthesiologists should develop judgment with respect to their skills, experience, and knowledge regarding the choice of technique and drugs, with the goal of optimizing the first nonsurgical attempt. To evaluate the literature support for our argument, we reviewed the evidence with respect to (1) the concept of first-pass intubation success, (2) intubation success rates for physicians and nonphysician providers, and (3) the impact of training on first-pass and overall pass success rates.

METHODS

By using the key words “multiple intubation attempts,” “first-pass success,” “intubation,” “learning curve,” we searched MEDLINE, EMBASE, and PubMed to identify relevant studies and expanded our search to include references from those articles. Citations from the past 5 years in which paramedics, in-hospital physicians, and prehospital physicians performed emergency airway management were also reviewed (n = 153). Articles judged relevant by 2 authors were included for full review (n = 35).

RESULTS

The Effects of Multiple Intubations Attempts on Complication Rate

We found 8 studies demonstrating an association between multiple intubation attempts and complications (Table 1). Three studies evaluated the magnitude of the increase in complication rate (with ≥3 intubation attempts) with odds ratios of 6.7 (n = 2284),4.7 (n = 1903),13 and 4.5 (n = 2616).16 A fourth study found a similar association with the largest increase occurring during the second attempt, and an odds ratio of 7.5 for multiple attempts (n = 1828).3

A 2004 analysis of 2833 airway management episodes further supports the increase in risk with multiple laryngoscopies.17 Multiple attempts were associated with an almost 10-fold increase in the risk of hypoxemia, esophageal intubation, aspiration, and cardiac arrest. In another 2014 abstract, >1 intubation attempt was associated with a 4-fold increase in severe complication rate and a 5-fold increase in total complication rate.18 A contemporaneous study of prehospital critical care teams found a similar result.19

A 2014 emergency room registry review found that patients with a first-pass intubation failure were less likely to achieve return of spontaneous circulation.20 Data from paramedics,21-24 prehospital physicians,19,22,25,26 and in-hospital physicians3,32-34 also indicate that first-pass success rates differ by provider type (Table 2 and Figs. 1 and 2). First-pass success rates ranged from 46.4% to 77.2% for paramedics, 71.2% to 87.5% for prehospital physicians, and 60.7% to 97.3% for in-hospital physicians.

If multiple attempts increase the risk of adverse airway events, then one strategy to improve airway management outcomes is to focus on training in airway management. Evidence suggests that training indeed improves first-pass success rates. One 2011 study of prehospital intubation25 found a higher first-pass success rate with experience of >6 months. Another study of paramedics with a median of 10 previous intubations found an odds ratio of 1.09 for success with each increase in the number of previous intubations.24 A 2012 study in anesthesia residents found that first-pass success rates did not stabilize until >150 intubations had been.
performed. Studies of nonanesthesiologists in the intensive care unit also found that more airway management experience correlated with a lower incidence of multiple intubation attempts and that a higher number of previous attempts correlated with greater first-pass success. 

**DISCUSSION**

Although it seems intuitively obvious that the first intubation attempt during emergent airway management should be optimized for success, real-world considerations often intervene. Among these are equipment availability, practical issues, and cost. Unfortunately, airway managers often lack accurate data to help them decide the value of a successful first-pass intubation. We found that multiple intubation attempts were associated with an increased rate of severe morbidity, such as hypoxia, aspiration, and bradycardia (Table 1). Succeeding with the first intubation attempt is also important because intubation conditions may deteriorate substantially after an unsuccessful initial attempt. 

Thus, targeting a high first-pass intubation success rate during emergency airway management may reduce severe airway management-related complications. 

Available data suggest that both amount (number of previous intubations) and type (in-hospital or anesthesia specialty [versus nonanesthesia personnel]) of airway training play a role in increasing first-pass success. However, particularly for nonanesthesiologists, sufficient experience can be difficult to obtain. Observations from a large database of emergency medical service calls in Germany revealed that intubation of severely injured patients outside the hospital is performed less than once a month per provider, suggesting that maintaining airway management skills is difficult with on the job experience alone. 

The question arises: How much training do airway providers need to optimize the first-pass intubation success rate? We found that anesthesia residents did better than nonanesthesia residents at all levels of training. Further, in our own hospital, at least 150 intubations were needed to reach a “plateau” in terms of future intubation success, particularly for nonanesthesiologists, sufficient experience can be difficult to obtain. Observations from a large database of emergency medical service calls in Germany revealed that intubation of severely injured patients outside the hospital is performed less than once a month per provider, suggesting that maintaining airway management skills is difficult with on the job experience alone.

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we may not have identified all available studies. Of the ones we did identify, a control group was often lacking and patient factors may have contributed to intubation success. Because of lack of survival data, we could not determine whether intubation attempts correlated with survival. In addition, emergency airway management in the prehospital setting, emergency department, and intensive care units may differ, making studies harder to compare.

Our take-home message is more complex than “every effort should be made to secure the airway on the first, well-prepared intubation attempt”, although the mnemonic “the first shot is often the best shot” is very appealing. First, anticipating severe adverse events if the first intubation attempt fails is an important aspect of a “first-shot best shot” approach. Second, anesthesiology training improves first-pass success rates, although whether such training requires 150 successful intubations as in a German study or 3 years of clinical training as in a UK recommendation is unclear. Third, sufficient optimization of first-pass success rates is difficult to obtain and/or to maintain for many airway managers because of a lack of experience with the procedure. Fourth, there are insufficient data for determining whether more simulation will improve first-pass intubation rates. Finally, when managing an airway, each individual should assess the odds of initial success versus possible problems or complications and build in an appropriate margin for safety.

Figure 1. First-pass intubation success (FPS) of prehospital paramedics, prehospital physicians, and in-hospital physicians in emergency airway management. The calculation of SDs is not possible because of unavailability of raw data.

Figure 2. Overall pass intubation success (OPS) of prehospital paramedics, prehospital physicians, and in-hospital physicians in emergency airway management. The calculation of SDs is not possible because of unavailability of raw data.

Table 2. First-Pass Success and Other Variables of Emergency Airway Management

<table>
<thead>
<tr>
<th>Study design</th>
<th>n</th>
<th>FPS, n (%)</th>
<th>OPS, n (%)</th>
<th>Multiple intubation attempts, n (%)</th>
<th>Cormack/Lehane grade, n (%)</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>≥2</td>
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<td>≥3</td>
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<td></td>
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<td>1/2</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3/4</td>
<td></td>
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<td>In-hospital physicians</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sakles et al.3</td>
<td>1828</td>
<td>1333 (72.9)</td>
<td>NR</td>
<td>495 (37.1)</td>
<td>NR</td>
</tr>
<tr>
<td>Fogg et al.28</td>
<td>295</td>
<td>246 (83.4)</td>
<td>295 (100.0)</td>
<td>49 (16.6)</td>
<td>10 (3.4)</td>
</tr>
<tr>
<td>Varga et al.29</td>
<td>490</td>
<td>477 (97.3)</td>
<td>486 (99.2)</td>
<td>8 (1.6)</td>
<td>NR</td>
</tr>
<tr>
<td>Cho et al.27</td>
<td>10,942</td>
<td>8774 (80.2)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Griesdale et al.29</td>
<td>136</td>
<td>91 (66.9)</td>
<td>136 (100.0)</td>
<td>45 (33.1)</td>
<td>18 (13.2)</td>
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<td>Hirsch-Allen et al.31</td>
<td>191</td>
<td>116 (60.7)</td>
<td>191 (100.0)</td>
<td>75 (36.3)</td>
<td>30 (25.2)</td>
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<tr>
<td>Grissom et al.30</td>
<td>4282</td>
<td>3824 (89.3)</td>
<td>4281 (100.0)</td>
<td>458 (10.7)</td>
<td>NR</td>
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<tr>
<td>Total</td>
<td>18,164</td>
<td>14,861 (81.8)</td>
<td>5389 (99.9)</td>
<td>1130 (23.0)</td>
<td>58 (9.3)</td>
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<td>Prehospital physicians</td>
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<tr>
<td>Rognäs et al.19</td>
<td>683</td>
<td>530 (77.6)</td>
<td>681 (99.7)</td>
<td>153 (22.4)</td>
<td>NR</td>
</tr>
<tr>
<td>Harris and Lockey25</td>
<td>400</td>
<td>350 (87.5)</td>
<td>399 (99.8)</td>
<td>50 (12.5)</td>
<td>4 (1.0)</td>
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<td>Jabre et al.26</td>
<td>817</td>
<td>582 (71.2)</td>
<td>816 (99.9)</td>
<td>235 (28.8)</td>
<td>NR</td>
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<tr>
<td>Peters et al.22</td>
<td>732</td>
<td>619 (84.5)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
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<tr>
<td>Total</td>
<td>2632</td>
<td>2081 (79.1)</td>
<td>1896 (99.9)</td>
<td>438 (23.1)</td>
<td>4 (1.0)</td>
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<td>Prehospital paramedics</td>
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<td></td>
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<tr>
<td>Prekker et al.23</td>
<td>7521</td>
<td>5807 (77.2)</td>
<td>7425 (98.7)</td>
<td>1706 (22.7)</td>
<td>426 (5.7)</td>
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<tr>
<td>Diggs et al.27</td>
<td>74,993</td>
<td>63,956 (85.3)</td>
<td>8024 (10.7)</td>
<td>5004 (75.4)</td>
<td>1631 (24.6)</td>
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<tr>
<td>Peters et al.32</td>
<td>576</td>
<td>265 (46.4)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Warner et al.24</td>
<td>576</td>
<td>380 (66.0)</td>
<td>507 (88.0)</td>
<td>424 (92.2)</td>
<td>36 (7.8)</td>
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<tr>
<td>Total</td>
<td>83,661</td>
<td>6452 (74.4)</td>
<td>71,888 (86.5)</td>
<td>9730 (11.8)</td>
<td>1626 (20.0)</td>
</tr>
</tbody>
</table>

% = related to reported data; ED = Emergency Department; FPS = first-pass success; ICU = intensive care unit; OPS = overall pass success; NR = not reported.

*note that calculation of standard deviations is not possible due to unavailability of raw data.
REFERENCES


28. Fogg T, Annesley N, Hitos K, Vassiliadis J. Prospective observational study of the practice of endotracheal intubation in