An Instrument Approach to Airway Management

David P. Thomson, MS, MD, MPA,[1] Darren Braude, MD, MPH,[2] Kevin High, RN, MPH,[3] and Rachel Miller-Tester, MS, NREMT-P[4]

Abstract

Aviation terminology and thought processes are commonly applied to medicine. We further propose the adaptation of instrument flight terminology to emergency airway management including the aviation approach plate visual aid and replacement of the term "failed airway" with "missed airway,"

Introduction

Since the publication of *To Err Is Human*,[1] medical providers have been aware of the use of aviation concepts for patient safety. In his 2003 article, Richard Levitan[2] looked at the safety of rapid sequence intubation (RSI) using the analogy of skydiving. More recently, Atul Gawande[3] has publicized the importance of using checklists, a basic aviation technology, to improve safety in medicine, particularly during surgery. In this article, we propose to use another aviation concept—the instrument landing approach—as a process to improve the safety and reliability of emergency airway management.

Discussion

Travelers today expect that the airlines will take off and land in all but the absolute worst weather. Most of these travelers are familiar with the large travel cases in which commercial airline pilots carry their navigational charts. Among these charts are instrument approach plates (Figure1)—specialized navigational charts used to land safely in adverse weather. These approach plates not only provide the pilot a detailed map of how to get to the runway but they also provide guidance for the pilot should he or she miss the approach and have to abort the landing attempt.

Unlike the pilot who "goes missed" when he or she does not visualize the runway, the emergency airway provider (EAP) who does not visualize critical airway landmarks often describes this experience negatively as a "failed airway." This description has been enshrined in the literature by several authors.[4-7] The term "failed airway" is a negative phrase in a neurolinguistic sense. Emergency providers, just like pilots, would like to believe they have "the right stuff."[8] Those same providers also believe, in the words of mission controller Gene Kranz, "Failure is not an option."[9] Although perseverance in the face of adversity is usually considered a positive attribute, when carried too far it can have tragic consequences.[10] The terminology of "failed airway" is familiar to all EAPs who use pharmacologically assisted intubation in their practice. There are various definitions of a failed airway, but several suggest that this occurs when critical oxygenation cannot be maintained or an experienced operator cannot perform endotracheal intubation within a variable number of attempts.[11-13] Walls and Murphy[4] define a failed airway as occurring when the chosen "method is not going to succeed, requiring the immediate initiation of a rescue sequence." Franklin and Murphy[14] state that "EMS [emergency medical services] providers . . . should also have at least one alternative airway device at their immediate disposal." Most of these situations can be successfully managed, at least temporarily, with an extraglottic airway (EGA). However, there are common barriers to placing an EGA that include but are not limited to perceived value of intubation over an EGA, pressure from colleagues/other providers, and the notion that an unsuccessful intubation is a failure. This is despite a growing body of literature that indicates that persisting in intubation can be detrimental to patient outcome because of time delays,[15] hypoxemia,[16] cardiopulmonary resuscitation disruption,[17] and other problems.[18] The literature also points to the high complication rate associated with repeated intubation attempts.[19,20] There is also a substantial body of literature showing the effectiveness of EGAs in the emergency setting and in providing airway protection.[21-23]

Cricothyrotomy is another alternative airway but one that may be used reluctantly by the EAP even though hesitation in the face of a patient with life-threatening obstruction can have dramatic consequences. It has been argued that the unwillingness of his physicians to perform a surgical airway

1. Department of Emergency Medicine, East Carolina University, Greenville, NC

2. Department of Emergency Medicine, University of New Mexico, Albuquerque, NM

3. Department of Emergency Medicine/Emergency Services, Vanderbilt University, Medical Center, Nashville, TN

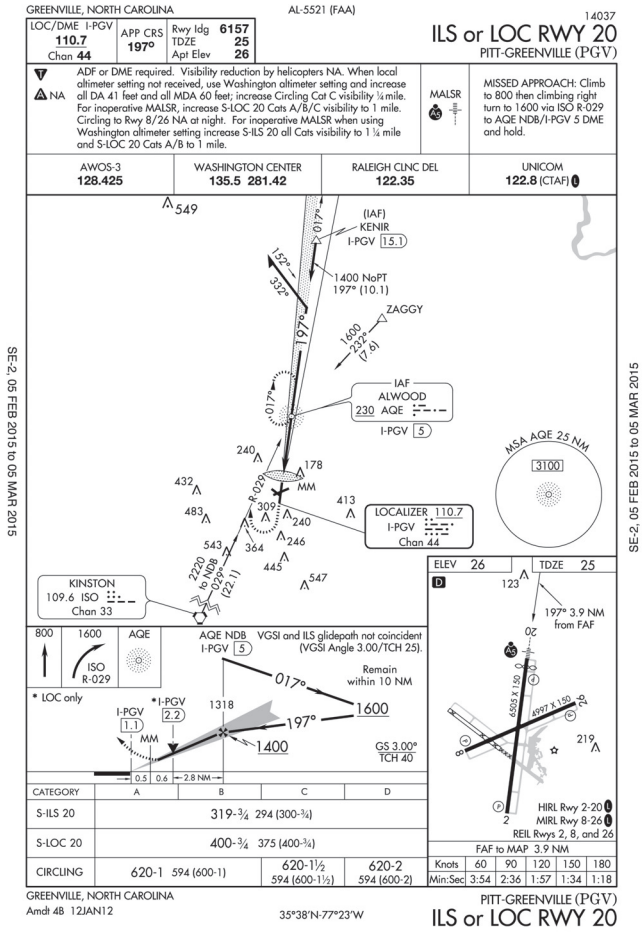
4. IFR Global, Inc., Murfreesboro, TN.

Address for correspondence:
David P. Thomson, MS, MD, MPA, Department of Emergency Medicine, Brody School of Medicine, East Carolina University, 3 ED Tower Vidant Medical Center, Greenville, NC 27834-4354, Thomsonda@ecu.edu

1067-991X/$36.00

http://dx.doi.org/10.1016/j.amj.2014.12.011

Figure 1. Typical pilot's instrument approach plate.



contributed to George Washington's death (although over 2 L of bloodletting certainly played a role).[24] Finucane et al[6] argue that psychological preparation is a key component in successful airway management, especially if unusual or unforeseen events occur. Levitan and Asken[25] note, ". . . how much the individual's mindset is critical to successful performance in a crisis."

Taking all this into consideration, we propose that the very negative terminology of "failed airway" may contribute to this resistance and therefore suggest a different terminology based on the aviation analogy of an instrument approach and landing (Figure 2).

The instrument approach begins with an assessment of the weather. This is analogous to assessment of the patient's airway for difficulty in intubation (LEMONS [Look externally, Evaluate 3-3-2 rule, Mallampati score, Obstruction, Neck mobility, Saturations[22]]), bag valve mask ventilation, EGA use, and surgical airway access. In the event of weather clearly below minimums, the instrument pilot proceeds directly to an alternate airport. This is the equivalent of an EAP delaying until additional help arrives and/or moving directly to an alternate airway management approach including continuous positive airway pressure/bilevel positive airway pressure, nasal intubation, awake intubation, rapid sequence airway, surgical airway, and so on. If the assessed "weather" is potentially favorable, the instrument pilot or EAP will make an attempt. This attempt should be performed extremely cautiously and carefully as if it is the only attempt you will get (ie, it should be an "optimal approach").

An optimal first intubation attempt has several potential components. First is preparation based on an appropriate checklist. This should include having all supplies ready, an appropriate tube/stylet shape, and proper patient positioning.[2] For a patient without cervical spine immobilization, this usually means a sniffing or ramped position with the goal of placing the ear canal at the same level as the sternal notch and the patient's facial plane parallel with the ceiling.[2] If cervical precautions must be maintained, then the front of the collar should be removed and in-line immobilization performed by an assistant.[26] Second is the appropriate management of neck pressure. In the event that airway landmarks cannot be visualized, cricoid pressure should be reduced and external laryngeal manipulation (also known as bimanual laryngoscopy) performed.[2] Any intubation attempt without the use of external laryngeal manipulation should not be considered an optimal attempt. The evidence would also suggest that video laryngoscopy will increase the chances of first pass success in the setting of a difficult airway or speed the time to intubation but whether this should be part of every first attempt remains controversial because this technology is not universally available.[26,27] Finally, a gum elastic bougie (also known as an endotracheal tube introducer) should be readily available during direct laryngoscopy and used if a Cormack-Lehane Class 3 airway (epiglottis only) is encountered. Alternatively, the EAP can forego a stylet entirely and make routine use of a bougie during direct laryngoscopy. Some EAPs and EMS agencies have adopted this approach based on the simple premise "if it's good for a difficult airway it's good for an easy airway." Although there are no empiric data yet that show this approach improves outcomes, it does guarantee that EAPs will be familiar with the device when they really need it. The same can be said for using video laryngoscopy, when available, on routine intubations as well as difficult ones. In the aviation world, this is similar to a pilot being familiar with his or her avionics and autopilot and using them even in optimal weather conditions.[28]

If the instrument pilot reaches the designated altitude without any sight of the runway, the approach is considered "missed." The terminology is notably not "failed." Some approaches are to a point on the chart; others are for a given number of minutes after a checkpoint. Similarly, in airway management, if an EAP reaches the designated cutoff in time or oxygen saturation without any sight of suitable landmarks, he or she should declare a "missed airway" rather than a failed airway. For the instrument pilot who feels that a missed approach is a failure, the result is often his or her own death.[29] For the EAP who feels that a missed airway is a failure, the result may be the patient's death.

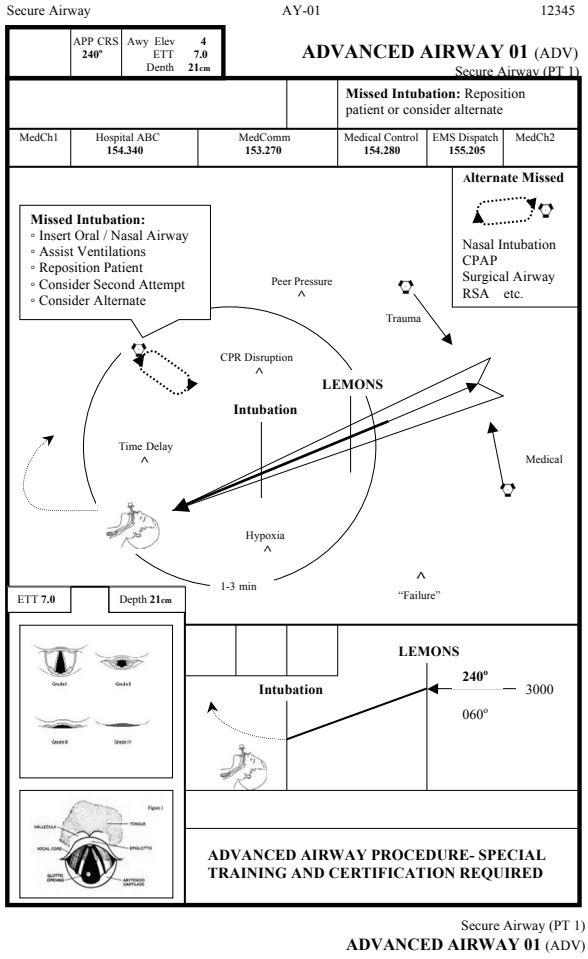
Once a "missed approach" is declared, a pilot will proceed to a holding point and circle while options are considered.

Was the approach flown at the right speed? Did the approach proceed to the minimal altitude or was it too high? Has the weather changed? Similarly, the EAP needs to go to a holding point (ie, provide bag valve mask ventilation if the patient is hypoxemic) and reevaluate. For example, if the "weather" has deteriorated, you cannot maintain critical oxygenation, or there is nothing to realistically change, proceed directly to an alternate airport and place an EGA. If the "weather" has not changed and there is something you believe you can change to make another attempt successful (eg, better positioning, change of blades, change of device, change of intubator, addition of external manipulation, and so on), then proceed.[30] The EAP should keep in mind, however, that more aviation crashes occur on the second attempt. Likewise, there are more airway complications with second and subsequent attempts.[19,20] This is a dangerous time for an instrument pilot and a dangerous time for the patient. Changing to a more experienced intubator cannot be underestimated, especially in academic centers; if a copilot missed an approach, the passengers would expect the pilot to make the second attempt.

If the second attempt again results in a missed approach, proceed directly to an alternate airport. An instrument pilot should never make a third attempt (this would be reckless), yet the evidence would say that many EAPs make third, fourth, and more attempts. Einstein reportedly said that insanity was doing the same thing over and over again and expecting different results.[31] Success rates are well-known to drop with each successive attempt; there is a reason you missed the first and second approach, especially if you used an optimal first attempt.[18] Successive attempts result in an increased risk of hypoxemia, elevated intracranial pressure, patient awareness from waning sedation, airway trauma, and prolonged scene times for EMS airways.[32] This means that an EAP should anticipate no more than 2 attempts at "landing"(ie, intubation) and the distinct possibility of 0 or 1 attempt if your goal is to avoid crashing.

Although in aviation it has been said, "Any landing you walk away from is a good one,"[33] you cannot say that any intubation the patient lives through is a good one. The contribution of hypoxemia and hypercapnia or hypocapnia to morbidity and mortality in head and spinal cord injury, for example, suggests that a patient may be successfully intubated yet suffer worse outcomes than unintubated controls.[34-38] Kerrey et al,[39] in reviewing videos of pediatric resuscitation efforts, noted that 61% of their patients had an adverse event during RSI, with 31% experiencing more than 1 adverse event. They note that they are attempting to develop a standardized RSI protocol. The American Society of Anesthesiologists Practice Guidelines encourages the use of a "preformulated strategy."[12] An article in *Anaesthesia* from 2009 describes the use of a flowchart for adult patients who cannot be intubated, recommending this systematized approach because of the rare but critical nature of these events.[40] A group from Montpellier, France concluded that there was a need for systematic protocols for intubation in the intensive care unit as a way to better address the high risk of complications.[41] An article from Davis et al[42] noted that when outcomes are analyzed with respect to the Trauma and Injury Severity Score, "Early intubation, especially in the hands of air medical crews, can be life saving, with more critically injured patients having a greater likelihood of unexpected survival with ETI." This suggests that highly trained providers following closely supervised protocols can make a difference with airway management.

Figure 2. Airway management approach plate.



Conclusion

Like our colleagues in aviation, the EAP must put safety first, although in this case it is the safety of the patient alone and the EAP has no personal stake in avoiding a crash. On the contrary, the goals of the EAP and the patient actually may be at odds; the former wants to avoid failure, whereas the latter wants to walk away unharmed.

Assessing the "weather" and deciding not to intubate is the better part of valor in some cases. Declaring a "missed approach" and placing an EGA is not a sign of failure but rather a sign of provider and technical maturity, prioritizing long-term patient outcome above all else. We have learned a

great deal in medicine from our aviation colleagues. The use of an "instrument approach" to airway management is just 1 more example of this cross-pollination.

References

1. Kohn LT, Corrigan JM, Donaldson MS. *To Err is Human: Building a Safer Health System*. Washington, DC: Institute of Medicine; 1999.
2. Levitan RM. Patient safety in emergency airway management and rapid sequence intubation: metaphorical lessons from skydiving. *Ann Emerg Med*. 2003;42:81-87.
3. Gawande A. *The Checklist Manifesto—How to Get Things Right*. New York, NY: Metropolitan Books/Henry Holt and Company; 2009.
4. Walls RM, Murphy MF. Identification of the difficult and failed airway. In: Walls RM, Murphy MF, eds. *Manual of Emergency Airway Management*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2012.
5. Kovacs G, Law JA. *Airway Management in Emergencies*. Shelton, CT: Peoples Medical Publishing House-USA; 2011.
6. Finucane BT, Tsui BCH, Santora AH. *Principles of Airway Management*. New York, NY: Springer; 2011.
7. Hung O, Murphy MF. *Management of the Difficult and Failed Airway*. New York, NY: McGraw Hill Medical; 2012.
8. Wolfe T. *The Right Stuff*. New York, NY: Farrar, Straus, and Giroux; 1979.
9. Kranz G. *Failure is not an option: Mission control from Mercury to Apollo 13 and beyond*. New York, NY: Berkeley Books; 2001.
10. Helmreich RL, Merritt AC. *Culture at Work in Aviation and Medicine: National, Organizational, and Professional Influences*. Aldershot, UK: Ashgate Publishing Limited ; 2001.
11. Mace SE. Challenges and advances in intubation: airway evaluation and controversies with intubation. *Emerg Med Clin North Am*. 2008;26:977-1000.
12. Caplan RA. Practice guidelines for management of the difficult airway. *Anesthesiology*. 2003;98:1269-1277.
13. Reardon RF, McGill JW. Tracheal intubation. *Clinical Procedures in Emergency Medicine*. 5th ed. Philadelphia, PA: Saunders; 2010.
14. Franklin KM, Murphy MF. Alternative devices for EMS airway management. In: Walls RM, Murphy MF, eds. *Manual of Emergency Airway Management*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins.
15. Abo BN, Hostler D, Wang HE. Does the type of out-of-hospital airway interfere with other cardiopulmonary resuscitation tasks? *Resuscitation*. 2007;72:234-239.
16. Dunford JV, Davis DP, Ochs M, et al. Incidence of transient hypoxia and pulse rate reactivity during paramedic rapid sequence intubation. *Ann Emerg Med*. 2003;42:721-728.
17. Wang HE, Simeone SJ, Weaver MD, Callaway CW. Interruptions in cardiopulmonary resuscitation from paramedic endotracheal intubation. *Ann Emerg Med*. 2009;54:645-652.
18. Wang HE, Yealy DM. Out-of-hospital endotracheal intubation: where are we? *Ann Emerg Med*. 2006;47:532-541.
19. Mort TC. Emergency tracheal intubation: complications associated with repeated laryngoscopic attempts. *Anesth Analg*. 2004;99:607-13.
20. Sakles JC, Chiu S, Mosier J, Walker C, Stolz U. Importance of first pass success when performing orotracheal intubation in the emergency department. *Acad Emerg Med*. 2013;20:71-78.
21. Wang HE, Thomson DP. Airway management. In: Cone DC, O'Connor RE, Fowler RL, eds. *Emergency Medical Services: Clinical Practice and Systems Oversight*. Dubuque, IA: Kendall/Hunt Publishing Company; 2009.
22. Khazin V, Ezri T, Yishai R, et al. Gastroesophageal regurgitation during anesthesia and controlled ventilation with six airway devices. *J Clin Anesth*. 2008;20:508-513.
23. Bercker S, Schmidbauer W, Volk T, et al. A comparson of seal in seven supraglottic airway devices using a cadaver model of elevated esophageal pressure. *Anesth Analg*. 2008;106:445-448.
24. Moren DM. Death of a president. *N Engl J Med*. 1999;341:1845-1850.
25. Levitan RM, Asken M. The conspiracy of stress: part 1. *ACEP Now*. 2014;33:23.
26. Gibbs MA, Gonzalez MG, Walls M. The trauma patient. In: Walls RM, Murphy MF, eds. *Manual of Emergency Airway Management*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2012.
27. Vu M, Vu EN, Tallon JM, Thompson J, Law JA. Airway management in trauma, and the traumatized airway. In: Kovacs G, Law JA, eds. *Airway Management in Emergencies*. 2nd ed. Shelton, CT: People's Medical Publishing House-USA; 2011.
28. King J, King M. *Cleared for Approach: Your andbook for Your Instrument Rating*. San Diego, CA: Cessna Pilot Center; 2000.
29. Landsberg B. A miss is as good as a mile. *AOPA Air Safety Foundation*. June 1993. Available at: http://www.aopa.org/asf/asfarticles/sp9306.html. Accessed June 1, 2010.
30. Reardon RF, Carleton SC, Brown CA. Direct laryngoscopy. In: Walls RM, Murphy MF, eds. *Manual of Emergency Airway Management*. 4th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2012.
31. Brainy Quote. Insanity: doing the same thing over and over again and expecting different results. Albert Einstein. *Brainy Quote*. Available at: http://www.brainyquote.com/quotes/quotes/a/alberteins133991.html. Accessed June 15, 2013.
32. Cobas MA, De la Peña MA, Manning R, Candiotti K, Varon AJ. Prehospital intubations and mortality: A level 1 trauma center perspective. *Anesth Analg*. 2009;109:489-493.
33. Massie GR. Any landing. In: English D, ed. *Slipping the Surly Bonds: Great Quotations on Flight*. New York, NY: McGraw-Hill; 1998.
34. Stiell IG, Nesbitt LP, Pickett W, et al. The OPALS major trauma study: impact of advanced life-support on survival and morbidity. *CMAJ*. 2008;178:9.
35. Davis DP. Research: Should Invasive airway management be done in the field? *CMAJI*. 2008;178:9.
36. von Elm E, Schoettker P, Henzi I, Osterwalder J, Walder B. Pre-hospital tracheal intubation in patients with traumatic brain injury: systematic review of current evidence. *Br J Anesth*. 2009;103:371-386.
37. Davis DP, Heister R, Poste JC, Hoyt DB, Ochs M, Dunford JV. Ventilation patterns in patients with severe traumatic brain injury following paramedic rapid sequence intubation. *Neurocrit Care*. 2005;2:165-171.
38. Davis DP, Dunford JV, Poste JC, et al. The impact of hypoxia and hyperventilation on outcome after paramedic rapid sequence intubation of severely head-injured patients. *J Trauma*. 2004;57:1-10.
39. Kerrey BT, Rinderknecht AS, Geis GL, Nigrovic LE, Mittiga MR. Rapid sequence intubation for pediatric emergency patients: higher frequency of failed attempts and adverse effects found by video review. *Ann Emerg Med*. 2012;60:251-259.
40. Heard AMB, Green RJ, Eakins P. The formulation and introduction of a 'can't intubate, can't ventilate' algorithm into clincal practice. *Anaesthesia*. 2009;64:601-608.
41. Jaber S, Amraoui J, Lefrant JY, et al. Clinical practice and risk factors for immediate complications of endotracheal intubation in the intensive care unit: a prospective, multiple-center study. *Crit Care Med*. 2006;34:2355-2361.
42. Davis DP, Peay J, Sise MJ, et al. Prehospital airway and ventilation management: a trauma score and injury severity score-based analysis. *J Trauma*. 2010;69:294-301.