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The Unanticipated Difficult Airway: A Dynamic and Dangerous Scenario

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Stem Case and Key Questions Content

A 49 year old female with past medical history significant for obesity (BMI 33), obstructive sleep apnea, menorrhagia, and anemia presents for laparoscopic assisted vaginal hysterectomy. Her functional capacity is greater than 4 metabolic equivalents. She exercises regularly and has never used tobacco. Her review of systems is negative, and she further denied any acid reflux, chest pain, daytime somnolence, or recent upper respiratory illness. Her preoperative vital signs include: height 65 inches, weight 200 lbs (90 kg), heart rate 70, blood pressure 130/82 mmHg, temperature 36.6 degrees Celsius, and oxygen saturation of 97% on room air. Her pertinent preoperative labs include: hemoglobin 9.2, hematocrit 28, creatinine 1.0, and potassium 3.9. Preoperative physical exam is grossly unremarkable.

1. How might this patient's history and review of systems influence your perioperative airway plan?

The patient's airway exam is as follows: Mallampati II, mouth opening >6 cm, normal upper lip bite test, thyromental distance three finger breadths, and slight limitation cervical extension to only 70 degrees, interincisior distance 4 cm, and neck circumference of 16 inches.

2. Which aspects of the above mentioned airway evaluation most likely predict difficult mask ventilation?
3. Which aspects of the above mentioned airway evaluation tools most likely predict difficult intubation?
4. Based on your perioperative airway evaluation, develop and describe your airway management plan.
5. Would you employ the use of "ramp positioning" for airway management in the operating room? Describe the benefits and risks of this positioning technique.

The patient is lying supine on the OR table. A "ramp" has been placed under the patient using blankets to optimize positioning for airway management. Standard monitors are placed and pre-induction vital signs are normal. After smooth induction of general anesthesia with intravenous lidocaine, fentanyl, and propofol, the nurse anesthetist is unable to get a good seal of the mask to the patient's face. An oral airway is placed and mask ventilation is now easy. Rocuronium is administered. The nurse anesthetist attempts direct laryngoscopy with a Miller 3 blade and verbalizes that she has a grade 4 Cormack view.

6. Assuming the intubation attempt was atraumatic, lasted only 5 seconds, and the oxygen saturation remains 100%, how would you proceed?

Mask ventilation is resumed by the nurse anesthetist using an oral airway. The oxygen saturation remains 100%. Direct laryngoscopy now attempted by the anesthesiologist using a Mac 3 blade. He/she verbalizes that they have a grade 3 Cormack view and they make one attempt to place an endotracheal tube without success. The oxygen saturation falls to 88% within 30 seconds. Mask ventilation is resumed by the nurse anesthetist, who verbalizes that mask ventilation is becoming “a little difficult.” A two provider mask ventilation technique improves the oxygen saturation to 100%.

7. Describe the different Cormack views.
8. Why did the oxygen saturation fall so rapidly?
9. According to the American Society of Anesthesiologists’ Difficult Airway Algorithm, what would be an appropriate next step in management?

The anesthesiologist places a video laryngoscope in the patient’s mouth and obtains a grade 2 Cormack view of the vocal cords. The anesthesiologist attempts to place a (malleable) styletted endotracheal tube without success. The nurse anesthetist applies external laryngeal pressure, but despite this maneuver, the tube will not pass through the vocal cords. The oxygen saturation is 85%, the blood pressure is 190/110 mmHg, and the heart rate is 112 beats per minute.

10. What is/are the etiology/etiologies of this patient’s hypoxia?
11. According to the American Society of Anesthesiologists’ Difficult Airway Algorithm, what would be an appropriate next step in management?
12. Is a surgical airway indicated at this point in the scenario? Would you consult a surgical colleague?

Two provider mask ventilation with oral airway is resumed, and capnography reveals an obstructed exhalation pattern. The oxygen saturation slowly improves to 93% over one minute of two provider mask ventilation. The oropharynx is suctioned and additional propofol is administered. The anesthesiologist would like to attempt a combined technique: use the video laryngoscope to obtain the initial view of the cords and a fiberoptic scope to guide the tube into the trachea. The nurse anesthetist places the video laryngoscope back in the patient’s mouth and obtains a grade 2 view of the cords. The anesthesiologist places an endotracheal tube over a fiberoptic scope and then places the fiberoptic scope into the patient’s mouth. Three unsuccessful attempts are made to maneuver the fiberoptic scope toward the vocal cords, and the oxygen saturation falls to 64%. Attempts to bag mask ventilate with an oral airway are unsuccessful, and the oxygen saturation remains in the low 60’s.

13. How many intubations attempts have occurred since the start of this complicated scenario? Why is this significant?
14. According to the American Society of Anesthesiologists’ Difficult Airway Algorithm, what would be an appropriate next step in management?
15. Is a surgical airway indicated at this point in the scenario?

A laryngeal mask airway is placed by the anesthesiologist and the bag is squeezed multiple times by the nurse anesthetist. There is no chest rise and there is an absent end tidal CO2 tracing. The oxygen saturation remains critically low at 60% and the heart rate is 50 beats per minute.

16. Would you attempt to intubate through the laryngeal mask airway? Why or why not?
17. Would you perform a needle cricothyrotomy or a surgical cricothyrotomy? Describe how to perform your chosen technique.
18. What are the risks, benefits, and alternatives to a needle versus knife technique?

Model Discussion Content

Introduction

Multiple attempts at airway manipulation can rapidly deteriorate into a “cannot ventilate and cannot intubate” scenario, sometimes leading to anoxic brain injury or death. Failure to recognize and act upon a “cannot ventilate and cannot intubate” scenario is an example of a cognitive error (1). The purpose of this PBLD is to (i) review the comprehensive preoperative airway exam, (ii) navigate the American Society of Anesthesiologists’ Difficult Airway Algorithm using a dynamic stem scenario, and (iii) review the indications, benefits, and risks of needle cricothyrotomy and surgical cricothyrotomy.

Objective 1: Review the comprehensive preoperative airway exam and identify known risk factors for anticipated difficult mask ventilation and difficult intubation.
A comprehensive pre-anesthetic airway evaluation includes a focused airway history, physical examination, and review of airway imaging (if applicable). A focused airway history includes patient interview (e.g., “did you have an excessively sore throat after a previous anesthetic?”) and review of previous anesthetic records. Physical examination serves to identify known anatomic features of possible difficult airway. Anatomic features of difficult airway include: Mallampati class greater than 2, short/thick neck, decreased cervical range of motion, prominent “overbite,” highly arched or narrow palate, non-compliant submandibular space, short interincisor distance (less than 3 cm), and short thyromental distance (less than three ordinary finger breadths) (2). The ASA Guidelines do not specify which of these known anatomic features apply specifically to difficulties in mask ventilation, intubation, or both. For example, a short thyromental distance is often associated difficult laryngoscopic view (3), but may have little influence on ability to mask ventilate. Alternatively, a Mallampati class of 3 may be more predictive of difficult mask ventilation and not always predictive of difficult intubation. The predictive value of multiple features of the airway examination versus single features in predicting the presence of a difficult airway has not been fully investigated (2). With that said, it is important to formulate an airway plan based not only on the presence of airway features, but also upon a detailed airway history, clinical experience, and availability of airway adjuncts and resources.

Objective 2: Apply the American Society of Anesthesiologists’ Difficult Airway Algorithm to a dynamic scenario.

The ASA emphasizes the importance of perioperative airway planning in the first three steps of the “Difficult Airway Algorithm.” These first steps may be inadvertently overlooked, as the reader’s eye may be drawn towards the flow-chart section of this document. These steps are as follows:
1. Assess the likelihood and clinical impact of basic management problems: difficultly with patient cooperation or consent, difficult mask ventilation, difficult supraglottic airway placement, difficult laryngoscopy, difficult intubation, difficult surgical airway access (2).
2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of

difficult airway management (2).
3. Consider the relative merits and feasibility of basic management choices: awake intubation vs. intubation after induction of general anesthesia, non-invasive technique vs. invasive techniques for initial approach to intubation, video-assisted laryngoscopy as an initial approach to intubation, preservation vs. ablation of spontaneous ventilation (2).

The stem scenario describes a patient who is obese and has obstructive sleep apnea. Neither body mass index nor obstructive sleep apnea (regardless of severity) has been shown to be an independent predictor of difficult intubation (4). The patient's described airway exam does not include any of the described anatomic features of difficult airway. Given these absent features and negative airway history, most clinicians would agree that the patient would most likely be a relatively "easy" mask ventilation and intubation. Therefore, it is reasonable to induce general anesthesia and attempt standard laryngoscopy. Prior to induction, it is important to optimize the patient's positioning. The anatomic "sniffing" position serves to align the oral, pharyngeal, and laryngeal axes for optimal laryngoscopic view. For obese patients, obtaining a proper "sniffing position" requires alignment of the sternal notch with the external auditory meatus using head elevation (5). Head elevation may be achieved with stacked blankets or through the use of commercially available foam pillows.

On the first airway attempt in the scenario, the nurse anesthetist described a "grade 4 Cormack view." Cormack-Lehane views were provided in an effort to allow the participant to follow along with the scenario. Cormack-Lehane views are broadly used to describe laryngeal views on direct laryngoscopy; grades 1 and 2 are considered "easy intubations" while grades 3 and 4 are considered "difficult intubations." A grade 3 view describes a view of the epiglottis but not the cords, whereas a grade 4 view describes an inability to view both the vocal cords and epiglottis (6). A recent study by Krage et al questioned both clinicians' knowledge of this grading system as well as its reproducibility. In this study of 117 anesthesiologists and residents, only one in four clinicians were able to define all grades correctly on a standardized simulation mannequin and the reproducibility of the classification system was limited in this group (7). However, the Cormack-Lehane classification remains in widespread use for describing larygnoscopic views.
As the stem scenario unfolds, the participant is first lead down the "can ventilate, cannot intubate" pathway of the Difficult Airway Algorithm. In accordance with the Difficult Airway Algorithm, changing laryngoscopic blade and attempting a second direct laryngoscopy is a reasonable and acceptable next step in management. On this second attempt the oxygen saturation falls to 88% within 30 seconds. One can affirm from clinical experience that the oxygen saturation in an obese patient falls much more rapidly in this patient population. The physiologic explanation is that the shortened time to hypoxia in the obese patient is due to the closing capacity exceeding the functional residual capacity when anesthetized (8). In other words, the small airways in obese patients collapse/close much earlier and easier than normal patients due to limited baseline reserve capacity. Due to this restrictive physiology and early onset of hypoxia when apneic, it is imperative that the need to provide supplemental oxygen be on the forefront of airway management attempts (i.e., return to mask ventilation with or without airway adjuncts as soon as possible).

The next part of the stem scenario involves the use of video laryngoscopy. Video laryngoscopes have been shown to improve Cormack-Lehane view and achieve a higher intubation success rate in a shorter time when compared to standard direct laryngoscopy (9). Despite the use of video laryngoscopy, the Cormack-Lehane view remains unfavorable (grade 3). This may be due to a number of factors including suboptimal positioning, incorrect use of the video laryngoscope, airway edema, anterior larynx, or a combination thereof. The first attempt to intubate using the video laryngoscope is with a styletted endotracheal tube. A standard and widely used malleable intubating stylette was used in place of the rigid, shaped, non-disposable stylette that is provided by the manufacturer of the video laryngoscope. While this is practice is not endorsed by the manufacturer, many clinicians continue to use a malleable stylette in place of the rigid, shaped, non-disposable manufacturer stylette. During this intubation attempt, the patient again becomes hypoxic and is noted to be tachycardic and hypertensive as well. The etiology of the patient's hypoxia is most likely due to the above-described physiology (collapse of small airways due to restrictive physiology and limited reserve), but one should also consider aspiration and bronchospasm on the differential diagnosis of hypoxia. Bronchospasm and aspiration maybe precipitated by light anesthesia and multiple airway attempts. The tachycardia and hypertension are suggestive of light anesthesia, and supplemental IV anesthetic should be administered to prevent recall, aspiration, bronchospasm, and laryngospasm. Alternatively, the participant may elect to awaken the patient if the muscle relaxant (rocuronium) can be reversed. However, it is unlikely that the intubating dose of rocuronium will be completely reversible at this point in the scenario.

The emphasis again turns to avoiding hypoxia and the active pursuit of supplemental oxygen strategies. The participant may consider placement of a laryngeal mask airway, which may or may not be easy or successful. A laryngeal mask airway may be difficult to place if patient is light on anesthetic, which could precipitate laryngospasm or aspiration. In the stem scenario, two-handed mask ventilation with an oral airway is attempted with limited success. It should be recognized that the scenario has deteriorated into the "cannot ventilate, cannot intubate" pathway of the Difficult Airway Algorithm. At this point in the scenario (or arguably earlier), the participant must call for additional experienced help. Additionally, a fiberoptic bronchoscope and/or difficult airway cart should be immediately available. The clinician should ask for equipment to perform a surgical airway, and may consider calling a surgical colleague for assistance.

The providers in the stem scenario elect to try one last attempt to intubate using a combined video laryngoscope and fiberoptic technique: guide the endotracheal tube into the trachea and use a Seldinger "tube over scope" technique to intubate. While this seems like an interesting approach and a solution to the anterior larynx described, additional time spent trying to place the fiberoptic scope into the trachea has led to significant clinical decompensation. This combined technique should not have been attempted, as the scenario is in the "cannot intubate, cannot ventilate" pathway. The options for airway management in the "cannot intubate, cannot ventilate" pathway include: percutaneous jet ventilation, intubating laryngeal mask airway, combined endotracheal esophageal tube (Combi-tube), or surgical airway (2). The stem scenario participants attempted to place a laryngeal mask airway and are faced with the inability to ventilate. In an analysis of the ASA Closed Claims Project database of 466 difficult intubation claims, the laryngeal mask airway was not an effective rescue technique in some cases in which multiple and prolonged attempts at intubation were made (10, 11).

Objective 3: Describe the indications, benefits, and risks of needle cricothyrotomy and surgical cricothyrotomy.
The choice of emergency airway technique should be based upon (i) clinician familiarity and confidence with technique and (ii) availability of resources/equipment to perform the technique.

A study by Hamaekers and Henderson found that most anesthesiologists feel more familiar with and more confident with needle cricothyrotomy (12). Despite this finding, Frerk and Cook showed a success rate of only 37% for narrow-bore, cannula-over-needle cricothyrotomy (13). The recommended length of the catheter used for this technique is at least 4 to 14 cm, which is an important consideration given this patients' obese body habitus (14). There are a number of commercially available cricothyrotomy kits, each with different catheter diameters and lengths. High pressure jet ventilation is utilized to provide oxygenation with narrow-bore, cannula-over-needle crythyrotomies. Some of the complications of needle cricothyrotomy and jet ventilation include false passage of the catheter into the subcutaneous tissues, pneumomediastinum, and barotrauma from inability to exhale (upper airway obstruction) or incorrect use of jet ventilation. Some of the commercially available kits for percutaneous needle cricothyrotomies include larger bore catheters with universal adapters for traditional oxygenation and ventilation using standard airway circuits.

In the same study by Frerk and Cook, the success rate for surgical cricothyrotomy was 100% (13). Surgical cricothyrotomy does not require a special kit, catheter, or adapter; it requires only a #10 blade scalpel and an endotracheal tube (ideally reinforced). There are four simple steps to performing a surgical cricothyrotomy: palpation of the cricothyroid membrane, vertical incision through the skin, horizontal incision through the cricothyroid membrane, and insertion of a small-caliber endotracheal tube. Insertion of the endotracheal tube can be facilitated using the tip of a Miller blade and surgical lubricant. The risks of surgical cricothyrotomy include injury to the thyroid gland or thyroid arteries and tracheal injury.

Conclusion: A brief discussion of cognitive errors
In the midst of this dynamic difficult airway scenario, a seemingly simple yet very intentionally asked question of the PBLD participants is "how many intubation attempts have been made?" The purpose of this question is to illustrate how clinicians may become fixated on task performance during a difficult airway scenario. The clinician may lose track of time, number of airway attempts, and perhaps the global deteriorating picture. This fixation on performance (e.g., "Just let me have one more try. I know I can get this!") has been described as a cognitive error (1). This delay in recognition and responsiveness to the emergent "cannot ventilate, cannot intubate" situation can lead to cardiopulmonary arrest, anoxic brain injury, and death. Cognitive errors may be due to a number of psychological and human factor barriers including overconfidence, anchoring (inability to shift attention), poor situation awareness, denial, fear of failure and/or litigation(1).

Situational awareness and avoiding cognitive errors during a difficult airway scenario is a critical to success. One must be able to recognize which part of the Difficult Airway Algorithm they are navigating, as well as be able to react to dynamic changes as they arise.

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