CE

2.1
ANCC CONTACT HOURS

By Linda Heltemes, CRNA, MS

While airway management is routinely performed in the surgical setting, it's never taken lightly. For patients with a difficult airway, the end result can be catastrophic. The difficult airway is a commonly documented cause of adverse outcomes in anesthesia, including hypoxic brain injury and death.[1]

In most cases, the anesthesia provider initially ventilates an apneic patient using a face mask, and then inserts an airway device—often times, either a tracheal tube (TT) or a laryngeal mask airway (LMA). In the broadest sense, a difficult airway is clinically identified by two undesirable scenarios—difficulty administering ventilation via face mask and a difficult tracheal intubation.[1] These scenarios may be present alone or in combination.

Even with airways that aren't by definition "difficult," there's always the potential for a challenge. A variety of factors can impact the effectiveness of airway management. (See *Factors that promote effective airway management.*) In particular, the skill level and experience of the practitioner managing the airway greatly impacts the outcome.[1] Another major factor is the availability of skilled assistance from other team members.[1] Every instance of patient care that requires establishment of an airway is a critical event and warrants the attention and focus of the healthcare team. While airway management is a complex topic, this article is intended to provide a general discussion of some primary elements to consider during management of the difficult airway in the surgical setting.

An unexpected outcome

The OR nurse should be familiar with and know the location of the emergency airway equipment and be prepared to assist the anesthesia provider during the management of a patient with a difficult airway. Consider the following scenario in the OR: You're

Managing the difficult airway

the circulating nurse and your patient, a 35-year-old man with no prior surgical history, is undergoing a nonemergent cholecystectomy. His medical history includes only hypertension. You're beside the patient during induction of general anesthesia. After preoxygenation, the certified registered nurse anesthetist (CRNA) administers I.V. fentanyl and propofol. As the patient's eyelids begin to close, you watch his chest rise and fall. When he becomes apneic, the CRNA effectively seals the patient's face mask and squeezes the oxygen reservoir bag, delivering two breaths. She administers an I.V. dose of succinylcholine to paralyze the patient and facilitate intubation. You hear the familiar beep of the pulse oximeter in the background.

When the oximetry tone changes, though, you glance at the patient monitor and notice his oxygen saturation level has decreased from 99% to 92%. The CRNA repositions the patient's chin and jaw, as well as the face mask, but she's unable to ventilate. The tone of the pulse oximeter rises sharply as the patient's oxygen saturation level continues to drop. The CRNA inserts an oral airway, but is still unable to effectively ventilate the patient. On the anesthesia cart, you see an 8.0 endotracheal tube and a laryngoscope handle with #3 Macintosh blade attached. As the CRNA reaches for the laryngoscope, you note the patient has produced a moderate amount of oral secretions. You have an oral cannula and tubing readily available and attached to a suction device; you turn on the suction. The patient's oxygen saturation has dropped to 82%. After orally suctioning the patient, the CRNA inserts the laryngoscope blade into his mouth. "I can't see anything," she says. With her right hand, she externally manipulates the larynx. "I can see the cords now," she says. "Will you hold this position?" You take over external laryngeal manipulation and the CRNA

Factors that promote effective airway management[1]

Skill and experience level of practitioner providing airway management	*Neck mobility.* The need to avoid manipulating a potentially unstable cervical spine increases the difficulty of airway management. Likewise, Halo fixation without elective tracheostomy is associated with a high risk for emergent/semi-emergent intubation, as well as mortality related to airway complications.
Availability of skilled assistance	*Effective preoxygenation.* Inadequate or ineffective preoxygenation increases the risk for hypoxia if there's a delay in securing the airway.
Patient positioning	*Proper choice of equipment.* This includes correct size of laryngoscope blade and correct size of endotracheal tube.
Properly functioning equipment (for example laryngoscopes, laryngoscope blades)	*Immediate availability of airway adjuncts.* These include oral and nasal airways.

Preexisting temporary factors associated with challenges to airway management[1]

- Airway swelling
- Pharyngeal abscess
- Limited mouth opening due to modifiable pathology (for example, recent jaw injury)
- Difficulty swallowing (dysphagia)
- Voice abnormality, such as hoarseness (dysphonia)
- Dyspnea
- Stridor

inserts the TT. Your patient's oxygen saturation is 75% and he's cyanotic. The CRNA inflates the TT cuff and auscultates breath sounds. An end-tidal CO_2 waveform appears on the patient monitor. "Breath sounds are equal bilaterally," the CRNA says. "You can release pressure now. Thank you for all the help." The CRNA secures the TT with tape. With continued ventilation, the patient's oxygen saturation level quickly climbs to 98% and his color returns to normal.

Defining the difficult airway

By definition, a difficult airway is apparent in a patient by the CRNA's inability to effectively provide ventilation by way of face mask, perform tracheal intubation, or both.[2]

Difficult mask ventilation (DMV) is characterized by the inability of an unassisted anesthesia provider to maintain a patient's oxygen saturation level at greater than 92%; or by the inability to prevent or reverse signs of inadequate ventilation while providing positive-pressure ventilation during general anesthesia.[1] In one study of 1,502 patients, 5% (75) were found to demonstrate DMV. Two later studies found the rate of DMV to be approximately 8% and 2%.[1]

Difficult tracheal intubation (DTI) involves scenarios in which multiple attempts at intubation occur in either the presence or absence of tracheal pathology.[1] The incidence of DTI is estimated to range between 1.5% to 8.5% of patients.[1]

Predicting the difficult airway

In general, a history of previous airway management difficulty is an important predictor of future difficulty in this area, unless the challenges to airway management were related to temporary factors.[1] Certain preexisting factors may contribute to increased DMV or DTI. Among other etiologies, these factors can be related to pathologic conditions of the pharynx, neck, or mediastinum.[1] (See *Preexisting temporary factors associated with challenges to airway management.*)

Predicting the potential for either DMV or DTI involves the consideration of multiple factors. (See *Predicting the difficult airway: DMV and DTI.*) It's worth noting that some research suggests that commonly used forms of assessment, such as the Mallampati test, as well as some generally accepted physical indicators, lack the sensitivity to predict DTI.[1] For example, while decreased neck mobility may be present in a patient who's difficult to intubate, this attribute isn't valuable for use in preoperative prediction of DTI. Likewise, a history of obstructive sleep apnea is also not a sensitive predictor of DTI.[1] (See *Ineffective sole indicators of DTI.*)

Though potentially useful, preoperative evaluation isn't always a guaranteed predictor of difficulty with airway management. In one review of anesthesia literature, researchers found that 1 in 10,000 patients will have an unpredicted difficult airway.[3] With all patients, the practice of thorough airway evaluation can help sharpen the focus on potential strategies for airway management should problems arise.[1]

Predicting the difficult airway: DMV and DTI[1,3]

Predictors of DMV	Predictors of DTI
Over age 55	Disease processes of the larynx or pharynx (neoplasm)
Body mass index over 26 kg/m^2	Thyroid mass
Edentulousness (absence of natural teeth)	Acromegaly (chronic metabolic condition characterized by elongation and enlargement of the bones of the face, jaw, and extremities)
History of snoring	Large or poorly compliant tongue
Presence of a beard (can interfere with sealing the mask against the face)	Decreased compliance of submental (situated under the chin) tissue
Limited protrusion of the lower jaw	Limited protrusion of the lower jaw

Patient care

For patients in whom a difficult airway is known or suspected, the American Society of Anesthesiologists (ASA) recommends that the anesthesia provider take certain preparatory steps to ensure the best possible patient outcome. (See *ASA recommendations for patients with known or suspected difficult airway*.) Included among the preparatory steps is preoxygenation, which involves the administration of 100% oxygen via face mask to the spontaneously breathing patient before sedation or anesthetic induction.[2]

At the cellular level, preoxygenation allows for denitrogenation, or the replacement of the lung's nitrogen volume with oxygen.[4] During induction of general anesthesia, standard care includes inducing unconsciousness, as well as the administration of a muscle relaxant for paralysis, if necessary. Once anesthetized and apneic, the patient requires artificial ventilation. In a patient who's difficult to ventilate, the oxygen saturation level can fall rapidly. Preoxygenation takes into consideration a potential delay in securing the patient's airway, and reduces the risk of oxygen desaturation during the apneic period.

Ineffective sole indicators of DTI[1,4]

- The Mallampati Test is used to grade the patient based on structures visible upon examination of the oropharynx with maximal opening of the patient's mouth. This assessment notes the degree to which the base of the tongue obscures the pharyngeal structures. Findings range from Mallampati I (entire uvula fully visible) to Mallampati IV (only hard palate visible). Research suggests this test alone is insufficient for predicting DTI.
- Male sex
- Increased age
- History of obstructive sleep apnea
- Temporomandibular joint pathology
- Abnormal upper teeth
- Short thyromental distance (distance from the thyroid notch to the tip of the chin)

Difficult airway algorithm

In 2003, the ASA updated The Difficult Airway Algorithm, which is intended to facilitate management of the difficult airway, as well as to reduce the likelihood of adverse outcomes.[2] These guidelines provide a step-by-step approach to airway management in a flowchart format (see *The difficult airway algorithm*).

The ASA difficult airway algorithm begins with assessing the likelihood of encountering a difficult airway, as well as evaluating the impact of difficulty with airway management.[2] Once a patient is apneic, even before attempting to secure the airway, it may be difficult to ventilate the patient via face mask. In those cases, establishing a secure airway becomes even more urgent.

The ASA advises creating at least one portable storage unit containing equipment for use in management of the difficult airway.[2] (See *ASA recommended contents of portable unit for use in difficult airway management.*) In addition to the items listed, oral suction equipment should be readily available.

ASA recommendations for patients with known or suspected difficult airway[2]

- Inform the patient (or person legally responsible for the patient) of associated risks and procedures related to management of the difficult airway.
- Identify at least one individual who's readily and immediately available to assist the anesthesia provider with the airway management process.
- Whenever possible, preoxygenate the patient via face mask before initiating airway management.
- Utilize opportunities to administer supplemental oxygen during management of the difficult airway.

Included among the variety of approaches to airway management are emergency invasive airway access devices. (See *Overview of emergency airway access devices.*) While it's important to be familiar with all modalities of airway management, this article will focus on the basics of three primary approaches: tracheal intubation of the anesthetized patient, tracheal intubation of the conscious patient, and LMA insertion. Following the ASA algorithm, in cases where attempts at tracheal intubation fail and face mask ventilation is inadequate, insertion of an LMA may be considered.[2]

Approaches to airway management

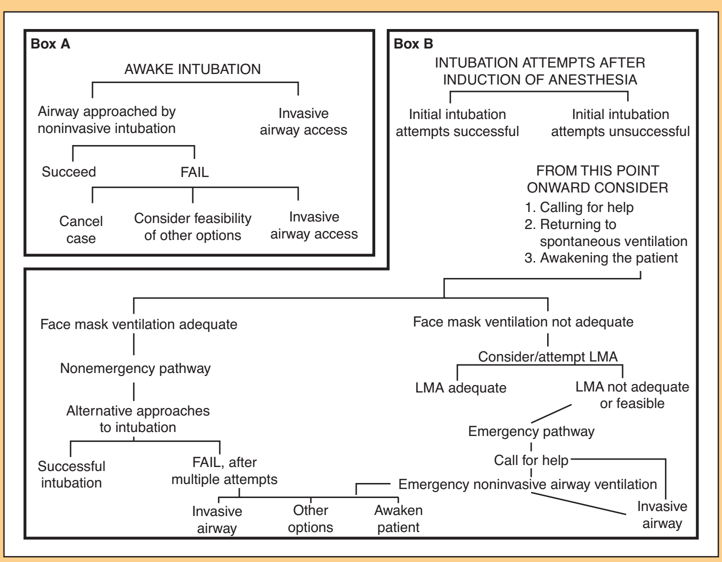
Tracheal intubation of the anesthetized patient

Most often, oral tracheal intubation is accomplished using direct visualization of the vocal cords (See *Structures seen during direct laryngoscopy*). With this approach, a lighted laryngoscope blade is inserted into the right side of the mouth, and the tongue is displaced to the left. Generally, one of two types of laryngoscope blades is used during oral tracheal intubation: the Macintosh (aka "Mac") or the Miller. The tip of the Macintosh (curved) blade is advanced into the vallecula, which is a grooved space just anterior to the epiglottis. The tip of the Miller (straight) blade is positioned directly beneath the epiglottis. In an uncomplicated intubation, when the vocal cords are visualized, the TT is advanced past the cords at a depth of at least 2 cm.[4] The cuff on the distal end of the TT is then inflated, which creates a seal in the trachea and reduces the risk of aspiration of gastric contents into the lungs.

In the patient with an unanticipated difficult airway, hypoxemia, hypercarbia, and hemodynamic instability can rapidly ensue. In all cases, adequate preparation

The difficult airway algorithm

Below is the ASA recommendations for management of the difficult airway. The anesthesia provider will (1) assess the patient and determine the likelihood and clinical impact of airway management problems, (2) initiate attempts to deliver supplemental oxygen throughout the process of managing the difficult airway, and (3) develop primary strategies and consider alternative basic airway management strategies.



Source: Barash PG, Cullen BF, Stoelting RK. *Handbook of Clinical Anesthesia.* 5th Ed. Philadelphia, Lippincott Williams & Wilkins, 2006: 1034.

of the patient, staff, and equipment are critical to provide effective airway management.[1] Unlike the LMA, tracheal intubation requires advanced skill level.

When visualization of the vocal cords is difficult, another member of the OR team may be asked to apply pressure to the cricoid cartilage, which can improve the view of the vocal cords. Applying pressure to the cricoid cartilage also compresses the esophagus, which can prevent passive regurgitation, but isn't intended to prevent complications due to active vomiting. For the purposes of improving visualization of the vocal cords, current studies suggest application of cricoid pressure may not be the most effective strategy.[1]

Likewise, the application of backward, upward, and rightward pressure, or BURP maneuver, on the cricoid cartilage by a team member may help to improve visualization of the vocal cords.[1] However, research has shown that cricoid pressure and the BURP maneuver may impair visualization of the vocal cords as often as 30% of the time when performed

ASA recommended contents of portable unit for use in difficult airway management[2]

- Laryngoscope blades of varying sizes and styles; may include rigid fiberoptic laryngoscope
- Tracheal tubes of assorted sizes
- Tracheal tube guides, including stylets, tracheal tube changers, light wands, and Magill's forceps (used to manipulate the distal tip of the tracheal tube)
- LMAs of various sizes and styles (may include "intubating LMAs")
- Equipment used for flexible fiberoptic intubation
- Emergency invasive airway equipment (cricothyrotomy supplies)
- Emergency noninvasive airway equipment (esophageal tracheal Combitube, hollow jet ventilation stylet, transtracheal jet ventilator)
- Retrograde intubation equipment
- Exhaled CO_2 detector

Overview of emergency airway access devices[2,4,5]

Esophageal-tracheal Combitube	Usually inserted blindly (without visualization of the vocal cords), this device consists of two fused tubes. The longer blue-colored tube has an occluded distal tip, as well as side perforations that allow gas to exit. The shorter, clear tube has an open tip, and no perforations. Inserted blindly, the distal lumen of the Combitube will lie in the esophagus in 95% of cases. In this position, ventilation through the blue tube will force gas through the side perforations, and into the lungs. The shorter, clear tube can then be used for gastric decompression. Alternatively, if the distal portion of the Combitube enters the trachea, ventilation via the clear tube will force gas into the trachea.
Flexible FOB	FOB may be especially useful when direct visualization of the vocal cords is undesirable or impossible. Such situations include poor range of motion of the temporomandibular joint, unstable cervical spine, and certain congenital or acquired airway anomalies. The FOB contains two main bundles of fibers, each consisting of 10,000 to 15,000 individual fibers. One bundle transmits light from a light source, while the other bundle provides a high-resolution image. The FOB allows for indirect visualization of the vocal cords, especially in the unique situations described above, as well as with awake intubation.
Tracheotomy	Accomplished by making an incision into the trachea through the neck, below the level of the vocal cords. Sometimes utilized to gain airway access in cases of tumor, edema of the glottis, or when foreign body obstruction is present.
Cricothyrotomy	Insertion of a large-bore I.V. catheter or commercially available cannula through the cricothyroid membrane and into the trachea. Once the needle is removed, ventilation is achieved by forcing gas through the remaining cannula. Devices used for ventilation include transtracheal jet ventilators, as this equipment provides a driving force high enough to generate sufficient gas flow. Cricothyrotomy is generally contraindicated in children under age 10.

by an assistant.[1] For improving visualization of the vocal cords, bimanual laryngoscopy (external laryngeal manipulation) has been found to be superior to both cricoid pressure and the BURP maneuver.[1]

Bimanual laryngoscopy requires the practitioner performing intubation to externally manipulate the larynx by placing the right hand on the patient's neck while maneuvering the laryngoscope blade using the left hand. Once optimal visualization is achieved, another member of the team takes over the external laryngeal manipulation and maintains pressure at that location, allowing the practitioner performing the intubation to insert the TT with the right hand (See *Bimanual laryngoscopy*).[1]

Verification of TT placement includes confirmation of end-tidal CO_2, as well as auscultation of bilateral breath sounds. Once placement is confirmed, the TT is secured with tape or a device specifically designed for this purpose.

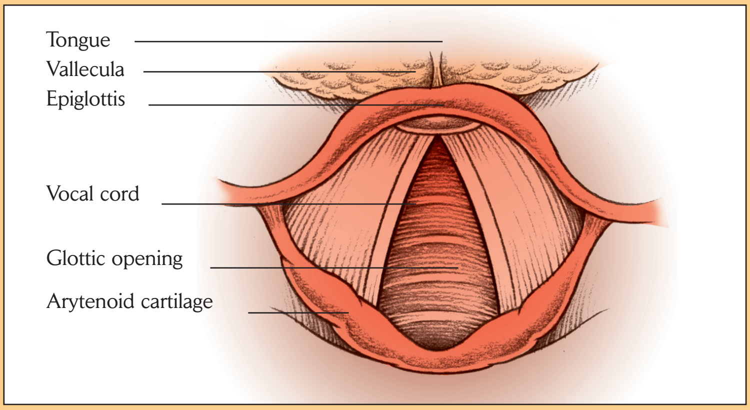
Tracheal intubation of the conscious patient

Awake intubation is indicated when thorough airway assessment or known patient history suggests the inability to safely control ventilation and oxygenation without the risk of pulmonary aspiration.[4] One of the most undesirable airway-related scenarios involves patients who are both difficult to ventilate via face mask and difficult to intubate. For these patients, awake intubation may also be an appropriate option.[2] As noted, when attempts at tracheal intubation are unsuccessful, insertion of an LMA may be appropriate.[2] However, because the LMA doesn't definitively protect the airway from aspiration of gastric contents, tracheal intubation may be preferable over LMA insertion.[1]

In order to effectively accomplish awake intubation, the patient should be advised of the rationale for the procedure, as well as the steps involved. Whenever possible, medications should be administered to reduce patient anxiety. Additionally, medication such as glycopyrrolate (Robinul) may be administered to

Structures seen during direct laryngoscopy

Locating anatomic structures with a laryngoscope is key to successful intubation. This illustration shows the anatomic structures of the larynx.

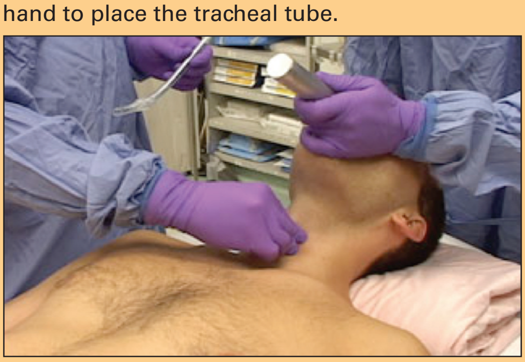


Source: *Mastering ACLS*, 2nd ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2006:23.

Bimanual laryngoscopy

Direction on neck is opposite direction of lift on the laryngoscope.

An assistant then maintains pressure at this location, freeing the laryngoscopist's right hand to place the tracheal tube.



Source: http://www.airwaycam.com/bimanual.aspx. Used with permission.

reduce oral secretions.[4] Local anesthetics are used to decrease airway sensitivity to the procedure. Methods of local anesthetic administration include topical (with a cotton-tipped applicator or aerosol spray) and transtracheal injection (for a nerve block).[4]

Following local anesthesia, a fiberoptic bronchoscope (FOB) is inserted through a TT, and then passed through either the mouth or nose. For oral intubation, a hollow bite block is inserted into the mouth, and the FOB is passed through the bite block. If the TT is passed nasally, vasoconstrictive medication is instilled into each nostril to reduce bleeding from potential trauma.[5] Using the FOB for indirect visualization, the TT is advanced through the vocal cords. The cuff on the distal end of the TT is then inflated, creating a seal in the trachea and reducing the risk of pulmonary aspiration of gastric contents. Correct placement of the TT is verified by way of confirmation of end-tidal CO_2, as well as through auscultation of bilateral breath sounds. The TT is then secured with tape or a device specifically designed for this purpose. Once the airway is secured, the patient can be safely anesthetized.

Because the patient is awake and spontaneously breathing, It's not necessary to rush when performing this procedure.[5] If ventilation or oxygenation becomes inadequate, the FOB is removed, and the patient is ventilated via face mask.[5]

Successful awake intubation requires advanced skill. This procedure also carries additional risks for injuring the patient. The FOB should only be advanced when a lumen is visible.[5] If only the wall of the TT or a mucus membrane is visible, blindly advancing the FOB may result in tissue injury or perforation.

Insertion of the laryngeal mask airway

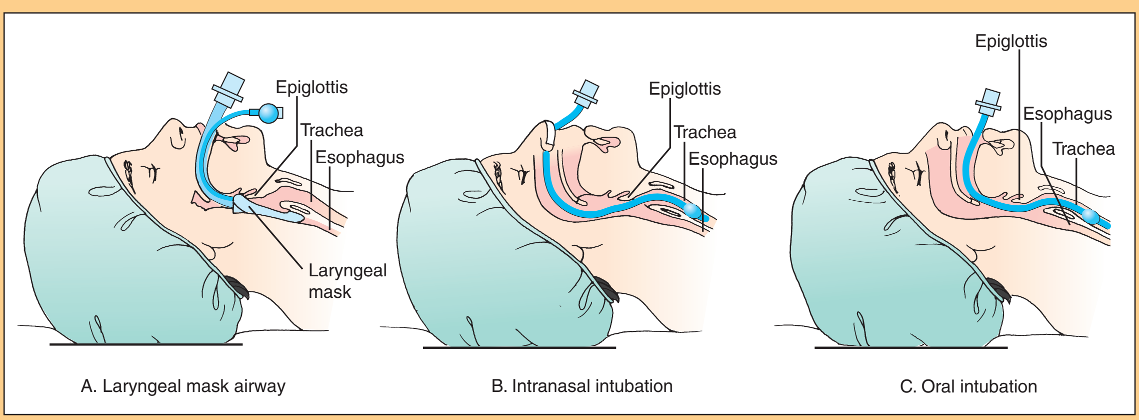
Since it was introduced in 1988, the LMA has become commonly used in the anesthesia setting. Several types of LMAs are now available for use; however, the classic design involves a small, mask-like device mounted on a hollow tube. The LMA is placed by blindly inserting the mask-like portion into the lower pharynx so that it's seated over the laryngeal inlet.[1] Inflation of the mask-like portion with air may be necessary to create a seal within the hypopharynx and allow for adequate ventilation (See *Laryngeal mask airway and endotracheal intubation*).

LMA insertion can be effectively accomplished by personnel with limited advanced airway skills.[1] Studies evaluating usage of the LMA in cardiac arrest scenarios suggest this device is superior to bag mask ventilation.[1] It's estimated that 1 in 10,000 patients can't be ventilated by face mask and are also unable to be intubated by traditional means. In comparison, approximately 1 in 800,000 patients can't be successfully managed using an LMA.[4]

One significant disadvantage of the LMA involves the risk for pulmonary aspiration of gastric contents; however, some researchers suggest this risk may be

Laryngeal mask airway and endotracheal intubation

The illustrations below show the laryngeal mask airway in place and intranasal and oral endotracheal intubation.



Source: Smeltzer SC, Bare BG, Hinkle JL, Cheever KH. *Brunner & Suddarth's Textbook of Medical-Surgical Nursing.* 11th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2008:511.

overestimated.[1] Certain styles of LMA allow for the insertion of a gastric tube to evacuate stomach contents. Another potential concern involves inadequate ventilation, which may occur due to ineffective sealing of the device in the hypopharynx. Ventilation with pressures of greater than 30 cm H_2O can increase gas leakage from around the device, as well as the portion of gas entering the esophagus.[1] In turn, gastric inflation can increase the risk of reflux and subsequent pulmonary aspiration.

Postoperative considerations

During patient follow-up, the anesthesia provider assesses for potential complications related to difficult airway management, including aspiration, tracheal and esophageal perforation, pneumothorax, edema, and bleeding.[2]

The patient should be advised of signs and symptoms that may precede potentially life-threatening complications (for example, pain or swelling of the face and neck, sore throat, subcutaneous emphysema, chest pain, and difficulty swallowing).[2] In addition, the anesthesia provider should thoroughly document the presence and nature of the airway difficulty encountered. Documentation should differentiate between all modalities of airway management used (for example, face-mask ventilation, LMA insertion, and tracheal intubation). Likewise, documentation should describe the degree to which each intervention was beneficial or detrimental to the process of difficult airway management. Thorough documentation can be useful in facilitating and guiding future patient care.[2] **OR**

REFERENCES

1. Lavery GG, McCloskey BV. The difficult airway in adult critical care. *Crit Care Med.* 2008;36(7):2163-2173.

2. American Society of Anesthesiologists. Special article: practice guidelines for management of the difficult airway. *Anesthesiology.* 2003;98(5):1269-1277.

3. Birnbaumer DM, Pollack Jr. CV. Troubleshooting and managing the difficult airway. *Semin Respir Crit Care Med.* 2002;23(1):3-9.

4. Barash PG, Cullen BF, Stoelting RK. Handbook of clinical anesthesia. 5th ed. Lippincott Williams & Wilkins: Philadelphia, Pa.; 2006:341-356.

5. Morgan GE, Mikhail MS, Murray MJ. *Clinical Anesthesiology*. 4th ed. McGraw-Hill: New York; 2006:91-116.

Linda Heltemes is a CRNA at Valley Anesthesia Associates, and president of Summit Communications, LLC, Fargo, N.D.

The author has disclosed that she has no significant relationship with or financial interest in any commercial companies that pertain to this educational activity.

CE Connection

Earn CE credit online:
Go to http://www.nursingcenter.com/CE/ORnurse and receive a certificate *within minutes*.

INSTRUCTIONS

Managing the difficult airway

TEST INSTRUCTIONS

- To take the test online, go to our secure Web site at **http://www.nursingcenter.com/ORnurse**.
- On the print form, record your answers in the test answer section of the CE enrollment form on page 23. Each question has only one correct answer. You may make copies of these forms.
- Complete the registration information and course evaluation. Mail the completed form and registration fee of $21.95 to: Lippincott Williams & Wilkins, CE Group, 2710 Yorktowne Blvd., Brick, NJ 08723. We will mail your certificate in 4 to 6 weeks. For faster service, include a fax number and we will fax your certificate within 2 business days of receiving your enrollment form.
- You will receive your CE certificate of earned contact hours and an answer key to review your results. There is no minimum passing grade.
- Registration deadline is October 31, 2011.

DISCOUNTS and CUSTOMER SERVICE

- Send two or more tests in any nursing journal published by Lippincott Williams & Wilkins together and deduct $0.95 from the price of each test.
- We also offer CE accounts for hospitals and other health care facilities on nursingcenter.com. Call 1-800-787-8985 for details.

PROVIDER ACCREDITATION

Lippincott Williams & Wilkins, publisher of *OR Nurse 2009* journal, will award 2.1 contact hours for this continuing nursing education activity.

Lippincott Williams & Wilkins is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

Lippincott Williams & Wilkins is also an approved provider of continuing nursing education by the District of Columbia and Florida #FBN2454. LWW home study activities are classified for Texas nursing continuing education requirements as Type I. This activity is also provider approved by the California Board of Registered Nursing, Provider Number CEP 11749 for 2.1 contact hours.

Your certificate is valid in all states.

The ANCC's accreditation status of Lippincott Williams & Wilkins Department of Continuing Education refers only to its continuing nursing educational activities only and does not imply Commission Accreditation approval or endorsement of any commercial product.