

Endotracheal Intubation

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Knowledge Objectives

1. Discuss the indications, contraindications, technique, and complications of endotracheal intubation. (p 2)
2. Explain how to perform direct laryngoscopy, including how to find the visual landmarks. (pp 4-9)
3. Discuss how to confirm correct placement of an endotracheal tube, including the use of capnography. (pp 9, 12)
4. Describe how to secure an endotracheal tube with tape. (p 14)
5. Describe how to secure an endotracheal tube with a commercial device. (p 14)
6. Discuss the indications, contraindications, technique, and complications of extubation. (p 17)

Skills Objectives

1. Demonstrate endotracheal tube insertion. (pp 9-11, Skill Drill 1)
2. Demonstrate how to confirm correct placement of an endotracheal tube. (pp 9-12)
3. Demonstrate end-tidal carbon dioxide detection. (p 9)
4. Demonstrate how to perform capnography. (pp 12-13, Skill Drill 2)
5. Demonstrate how to secure an endotracheal tube with tape. (pp 14, 15, Skill Drill 3)
6. Demonstrate how to secure an endotracheal tube with a commercial device. (pp 14, 16, Skill Drill 4)
7. Demonstrate how to perform extubation. (pp 17-18, Skill Drill 5)

Introduction

For patients unable to maintain their own airway, endotracheal intubation provides not only airway management, but also a medication route for several prehospital drugs. The endotracheal (ET) tube can also be used for deep tracheal suctioning when needed.

Table 1 Endotracheal Intubation

Indications	<ul style="list-style-type: none"> ■ Present or impending respiratory failure ■ Apnea ■ Hypoxia ■ Poor respiratory effort ■ Suppression or absence of gag reflex ■ Inability of patient to protect own airway
Contraindications	<ul style="list-style-type: none"> ■ None in emergency situations ■ Caution in unsuppressed gag reflex
Advantages	<ul style="list-style-type: none"> ■ Provides a secure airway ■ Protects against aspiration ■ Provides a route for certain medications (as a last resort; absorption of medications is unpredictable at best) ■ Direct visualization of anatomy and tube placement ■ Ideal method for confirming placement ■ May be performed in breathing or apneic patients
Disadvantages	<ul style="list-style-type: none"> ■ Requires special equipment and training ■ Bypasses physiologic function of upper airway <ul style="list-style-type: none"> ■ Warming ■ Filtering ■ Humidifying
Complications	<ul style="list-style-type: none"> ■ Bleeding ■ Hypoxia ■ Laryngeal swelling and trauma ■ Laryngospasm ■ Vocal cord damage ■ Dental trauma ■ Mucosal necrosis ■ Barotrauma ■ Misplacement <ul style="list-style-type: none"> ■ Right mainstem bronchus ■ Esophagus



Figure 1 Endotracheal intubation.

Endotracheal intubation involves placing a tube through the glottic opening and sealing the tube with a cuff inflated against the wall of the trachea. Endotracheal intubation provides an airtight seal between the patient's lungs and the ventilation device. A sealed cuff placed below the level of the vocal cords is the only form of definitive airway management. A solid understanding of the basics of endotracheal intubation is needed when making urgent decisions about when and how to intubate a patient. **Table 1** lists indications, contraindications, advantages, disadvantages, and complications of endotracheal intubation.

By definition, **endotracheal intubation** means simply placing a tube into the trachea (**Figure 1**). In common usage, however, this term is used in a variety of contexts. For the purposes of this chapter, the phrase endotracheal intubation means the process of placing a tube into the trachea. It is a common error to consider the term endotracheal intubation as synonymous with **direct laryngoscopy**, the most common method of putting a tube in the trachea. Direct laryngoscopy is only one of many techniques used to place a tube into the trachea. The tube is passed into the trachea to provide externally controlled breathing through a bag-mask device or other ventilation device.

Equipment

Endotracheal (ET) tubes range in size from 2.5 to 9.0 mm for the inside diameter, and the length ranges from 12 to 32 cm (**Figure 2**). Sizes ranging from 5.0 to 9.0 mm are cuffed to make an airtight seal with the tracheal wall. They have a proximal end 15/22-mm adapter that allows for ventilation with a standard device. There is also an inflation port with a pilot balloon at the proximal end. The distal cuff is inflated

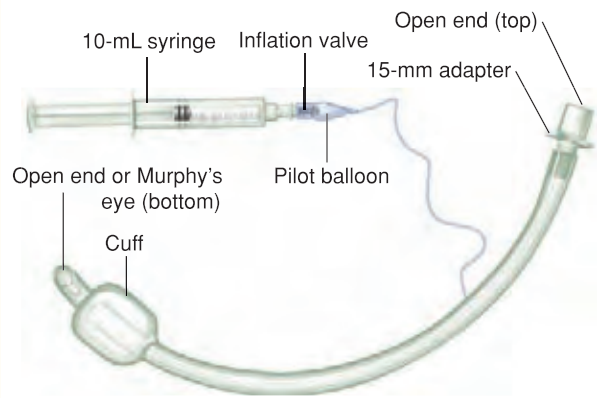


Figure 2 Endotracheal tube.

with a syringe attached to a one-way valve. The pilot balloon indicates whether the cuff is inflated or deflated once the distal end of the tube is inserted into the patient's airway. Centimeter markings along the length of the tube provide a measurement of the depth of the tube. The distal end has a beveled tip to facilitate insertion.

Tubes ranging from 2.5 to 5.0 mm are used in pediatric patients and are generally uncuffed. The narrowest portion of the pediatric airway is the cricoid ring. In children the cricoid ring is funnel-shaped and forms an anatomic seal with the ET tube, eliminating the need for a cuff. The proximal end still has a 15/22-mm adapter for use with standard ventilating devices. The distal end has a beveled tip with distal end depth markings. Because there is no balloon cuff, there is no pilot balloon.

Selecting the proper tube size is important. When the tube selected is too small for the patient, it increases the resistance to flow and, therefore, difficulty in ventilating. When the tube selected is too large, it can be difficult to insert and can cause trauma. The average-sized adult female uses a 7.0- to 8.0-mm tube. An average-sized adult male uses a 7.5- to 8.5-mm tube.

A number of anatomic clues can help determine the proper tube size for adults and children. First, the internal diameter of the nostril is a good approximation of the diameter of the glottic opening. The diameter of the little finger or the size of the thumbnail is also a good approximation of airway size.

There are many types of laryngoscope blades, each with its own advantages and disadvantages, depending on personal preferences. The two most common blades are the straight (Miller) and the curved (Macintosh) blades **Figure 3**. Many other blade designs are manufactured for specialty purposes, with the Wisconsin blade having gained much popularity, especially for use in intubating children. Various

blade designs have been shown to be effective, although the curved and straight blades are the most commonly used and readily available. In most emergency situations, it is unlikely that you will have immediate access to other blades.

Blade choice is mainly a matter of personal preference and is more related to experience than to functional differences. Nevertheless, the two blades are used differently. The straight blade is narrow and has a curved channel. Its tip is rounded and is designed to lift the epiglottis to provide the laryngoscopic view. The curved blade has a broad flange that is used to move the tongue out of the way. The tip of the curved blade is flat and broader and is designed to fit into the vallecula.

Because of the hypopiglottic ligament, upward pressure in the vallecula moves the epiglottis, providing the laryngoscopic view.

Blade sizes range from 0 to 4. Infants and children use sizes 0, 1, and 2, whereas 3 and 4 are considered adult sizes. In most adults of average size, a size 3 straight or curved blade provides the best visualization. For pediatric patients, blade sizes are often recommended based on patient age or height. Most providers choose the blade for adults based on experience and the size of the patient (size 3 for average-sized adults and size 4 for larger persons).

Two other pieces of equipment have specific uses. The first is the stylet. It is common, especially in emergency situations, to be unable to obtain a full view of the glottic opening. The stylet enables you to guide the tip of the tube over the arytenoid cartilage, even if you cannot see the entire glottic opening. The second is the Magill forceps. Magill forceps have two uses in the emergency setting. First, they are used



A



B

Figure 3 **A.** A straight (Miller) blade. **B.** A laryngoscope and an assortment of curved (Macintosh) blades.

to remove obstructions from the airway under direct visualization. If you see a solid obstruction in the airway, hold the Magill forceps in your right hand and remove the obstruction. The Magill forceps can also be used to guide the tip of the ET tube through the glottic opening if you are unable to get the proper angle with simple manipulation of the tube.

■ Orotracheal Intubation by Direct Laryngoscopy

Orotracheal intubation by direct laryngoscopy involves inserting an ET tube through the mouth and into the trachea while visualizing the glottic opening with a laryngoscope; it is by far the most common method of performing endotracheal intubation in the emergency setting.

It is important to always prepare and check the equipment before beginning the intubation attempt [Table 2](#). However, it is easy to become complacent with this step. With practice, you will find that most intubations are relatively easy and uncomplicated and you will most likely not use all of the extra equipment that you assembled for the intubation attempt. Unfortunately, this usual experience may lull you into a false sense of security. When you do encounter

a difficult airway in a patient, you need to have the necessary extra equipment immediately available. Remember that you are preparing for possible difficulty, even though you hope that you have none. Therefore, it is best to have the extra equipment assembled because in a small percentage of cases you will be glad to have it when you need it.

■ Standard Precautions

Intubation is a procedure that may expose you to body fluids; therefore, proper precautions should be taken. In addition to gloves, you should wear a mask and eye shield because your face will be relatively close to the patient's mouth and nose. The mask and eye shield will protect you if the patient vomits. Masks with eye protection included are inexpensive, easy to put on, and unobtrusive. They should be considered mandatory parts of your airway kit.

■ Preoxygenation

The importance of preoxygenation cannot be overstated. During an intubation attempt, the patient will undergo a period of forced apnea. The goal is to prevent hypoxia from occurring during this period in which the patient is not breathing or being ventilated. In general, patients in stable

Table 2 Preparing Equipment for Intubation

Equipment	What to Check, Prepare, and Assemble
Ventilation equipment	Have an assistant ventilate the patient while you are assembling, checking, and preparing your equipment. Check to make sure that the patient is being ventilated with 100% oxygen and that the pulse oximeter is reading 96% to 100%.
Endotracheal tube, stylet, 10-mL syringe (or appropriate size for the type of tube you are using), water-soluble lubricant	Select the proper size endotracheal tube (7.0 to 8.0 for adult female; 7.5 to 8.5 for adult male). Inject 10 mL of air into the cuff, and check that it holds air. Check to make sure that the 15/22-mm adapter is firmly inserted into the tube. Insert the stylet, and be sure that the tip is proximal to Murphy's eye . Bend it to be sure that the stylet does not protrude. Bend the tube/stylet into a hockey stick configuration. Increase the angle of the bend if you anticipate a difficult intubation.
Laryngoscope handle and blades	It is best to have an assortment of blades available because some patients are easier to intubate with one than another. Check the blade that you plan to use. Be sure that it is free from any nicks in the metal (which could easily cause a laceration). Check the bulb to be sure that the light is "bright, white, steady, and tight." The light should be bright enough that it is uncomfortable to look directly at it. It should be white, not yellow or dim. The light should not flicker, especially as the blade is moved on the handle. Most important, the bulb must be tightly screwed into the handle to prevent its loss in the airway.
Magill forceps	Have available to guide the tip of the tube into the trachea or to remove foreign body airway obstructions.
Suction	You will not need it in most patients, but when you need it, you need it fast!
Towels	Needed to position the patient's head.
Confirmation devices	Stethoscope and an end-tidal carbon dioxide detector or an esophageal detector device.
ET tube securing device	Have the appropriate device (eg, tape or a commercial ET tube securing device) ready before you start.

condition can undergo 2 to 3 minutes of apnea provided they are adequately preoxygenated.

Many patients requiring intubation are physiologically compromised. To prepare them for the apnea that occurs during intubation, they must be preoxygenated and the amount of time between breaths significantly limited.

Pulse oximetry has dramatically changed how patients are monitored before and during intubation. Pulse oximetry is performed by placing the probe of the pulse oximeter on the patient's finger. Ideally, the patient should have an oxygen saturation of 100% for 2 to 3 minutes before intubation, and it should never fall below 95% during an intubation attempt. Because the patient's baseline level before the crisis is unknown, you cannot rely entirely on the pulse oximeter reading, but nevertheless, it provides you with important trending information.

The consequences of brief periods of hypoxia can be disastrous. Do not rely too heavily on the pulse oximeter reading because it may be falsely high, even if the patient is profoundly hypoxic. Although some of the sequelae of hypoxia are dramatic and immediate, most are subtle and occur gradually. Some of the poor neurologic outcomes following aggressive airway management result from intubation-induced hypoxia. These incidents can be avoided by providing adequate preintubation hyperoxygenation.

■ Position the Patient

Proper positioning of the patient is one of the main keys to successful laryngoscopy. To properly position a patient before performing intubation by direct laryngoscopy, you need to have knowledge of basic airway anatomy. There are three axes of the airway: the oral plane, the pharyngeal plane, and the tracheal plane. Ordinarily these axes are at sharp angles, facilitating the entry of food into the esophagus and reducing the likelihood of food entering the airway. Although this is an obvious advantage for everyday life, the angles of these three axes make intubation difficult

Figure 4

Safety

Intubation is a procedure that may expose you to body fluids; therefore, proper precautions should be taken. In addition to gloves, you should wear a mask and eye shield because your face will be relatively close to the patient's mouth and nose. The mask and eye shield help protect you if the patient vomits.

To facilitate visualization of the airway, you want to align the three axes to the extent possible. This is achieved by placing the patient in the “sniffing” position. The sniffing position is so named because this is the position of the head when intentionally sniffing. The position involves approximately a

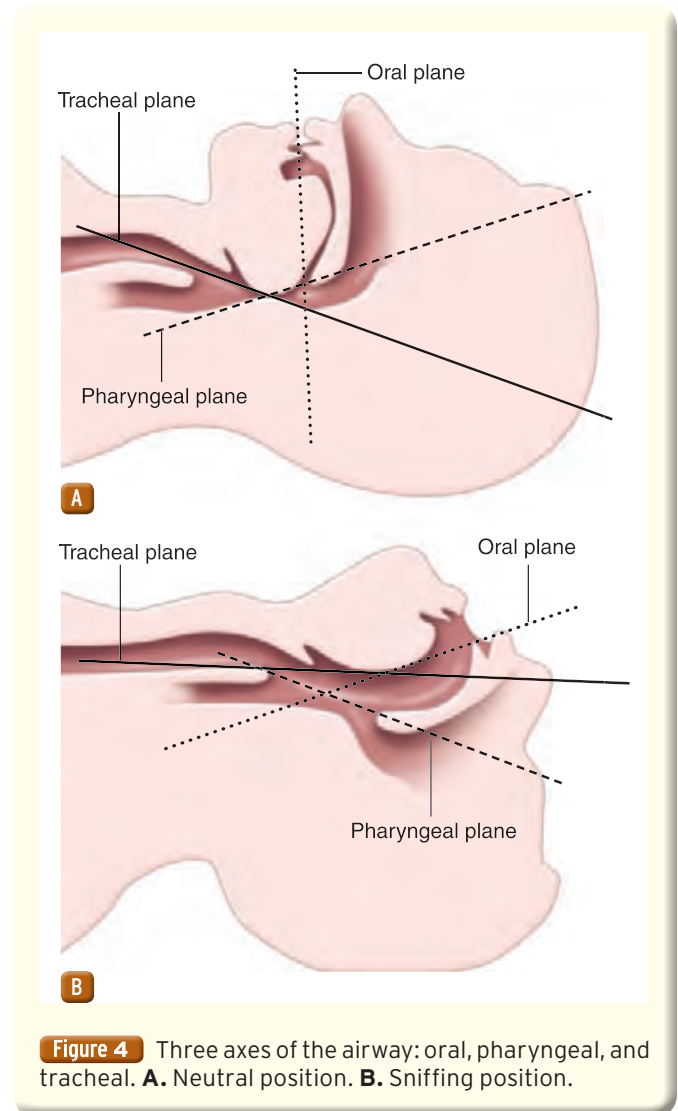


Figure 4 Three axes of the airway: oral, pharyngeal, and tracheal. **A.** Neutral position. **B.** Sniffing position.

20° extension of the **atlanto-occipital joint** and 30° flexion of the neck at C6 and C7.

In most supine patients, the sniffing position is achieved by extension of the head and elevation of the occiput 2.5 to 5 cm. The most practical guide to the amount of occipital elevation necessary in a given patient is to elevate the head until the ear is at the level of the sternum. Elevation of the head is best achieved with folded towels positioned under the head and/or neck (**Figure 5**). The advantage of using towels is that the thickness can easily be adjusted by changing the number of folds. In obese patients, however, padding under the head alone may not result in the sniffing position. You may need to pad also under the shoulders, neck, and head. When in doubt as to whether the patient is in a true sniffing position, looking at the person from the side usually provides the best view for evaluating the adequacy of the head tilt.

After the patient is in the sniffing position, have the assistant stop ventilating. The intubation attempt should take no more than 30 seconds. The attempt should be stopped at 30 seconds, if the oxygen saturation falls significantly, or if the patient's heart rate or rhythm changes dramatically.



Figure 5 Head elevation is best achieved with folded towels positioned under the head and/or neck.



Figure 7 Place the side of your right-hand thumb just below the bottom lip and push the mouth open, or scissor your thumb and forefinger between the molars.

If you abort an intubation attempt, simply reoxygenate the patient for 2 to 3 minutes with 100% oxygen and try again. Repeated attempts do not harm the patient, but prolonged attempts do.

■ Blade Insertion

The tongue is a sticky, amorphous structure that is a major hindrance to visualizing the airway. The proper use of the laryngoscope blade is critical to controlling the tongue; this is difficult to simulate in practice with manikins. Nevertheless, you need to develop excellent technique in manikins to help avoid difficulties in patients.

Position yourself at the top of the patient's head. If the patient is on a gurney, you can squat to put your head at the level of the patient's face. If the patient is on the floor or ground, you may need to kneel and lean forward or lie down on the floor to get into the proper position **Figure 6**.



Figure 6 If the patient is on the floor or ground, you may need to kneel and lean forward or lie down on the floor to get into the proper position.

All laryngoscope handles and blades are held in the left hand. Some custom-made or specialty blades can be held in the right hand, but these are rare in emergency settings. Hold the laryngoscope in your left hand and the prepared, lubricated tube like a pencil in your right hand.

Grasp the laryngoscope with your left hand and hold it as low down on the handle as possible. If the patient's mouth is not open, the easiest technique is to place the side of your right-hand thumb just below the bottom lip and push the mouth open, or "scissor" your thumb and forefinger between the molars **Figure 7**.

Regardless of the blade being used, it should be inserted into the right side of the patient's mouth. Use the flange of the blade to sweep the tongue to the left side of the mouth while the blade is moved into the midline. Moving the tongue from right to left is a critical step. If you simply insert the blade in the midline, the tongue will hang over both sides of the blade and you will see only the tongue **Figure 8**.



Figure 8 The tongue is a sticky, amorphous structure that can be a major hindrance to visualizing the airway. Proper use of the laryngoscope is critical to controlling the tongue.



Figure 9 Prying against the upper teeth with the laryngoscope can result in breaking and potential aspiration of the teeth. Do not do it!

If you are using a straight blade, insert the tip of the blade all the way to the posterior pharyngeal wall and then lift the jaw. If you are using a curved blade, insert the tip into the vallecula. With both types of blades, the goal is to lift the jaw. The most common beginning error is to pull the jaw back using the patient's teeth as a leverage point **Figure 9**. This can break the teeth, and it does not provide a view of the glottis. Lifting the patient's jaw is accomplished by keeping your left wrist straight, elbow bent, and back straight **Figure 10**. The correct motion is similar to holding a wine glass and offering a toast.

■ Visualization of the Glottic Opening

As you look down the blade, you should start to see some familiar airway landmarks. Identifying the epiglottis or the arytenoid cartilage is very important at this point. Identifying these structures enables you to make small adjustments



Figure 10 Keep your back and your left arm straight as you pull upward. This allows you to use the strength of your shoulders to lift the patient's jaw.

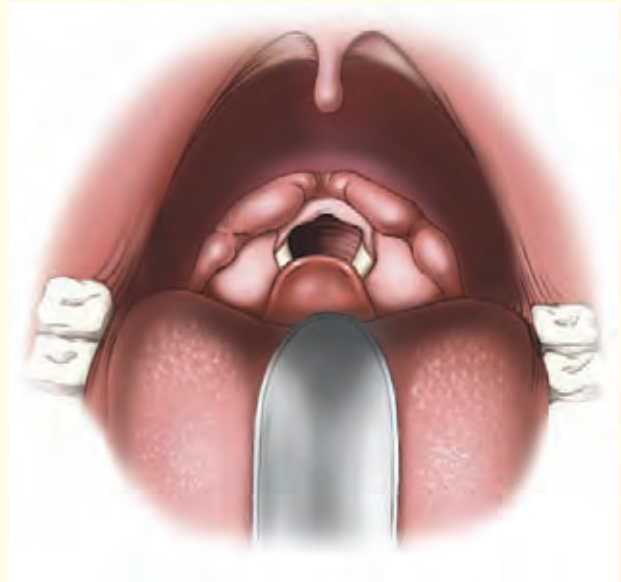


Figure 11 Laryngoscopic view of the vocal cords (white fibrous bands).

in the position of the blade to aid in visualization of the glottic opening. If you are not able to identify any familiar structures, it is generally fruitless to continue, and it may be better to start over. With the curved blade, it is best to walk the blade down the tongue because you know that the vallecula and the epiglottis lie at the base of the tongue. With the straight blade, insert the blade straight back until the tip touches the posterior pharyngeal wall. This is the proper depth of insertion.

As you continue to work the tip of the blade into the proper position (lifting the epiglottis or in the vallecula), the glottic opening should come into view as you lift. Do not be concerned if you do not have a full view of the glottic opening. The vocal cords are the white fibrous bands that lie vertically within the glottic opening; they should be slightly open **Figure 11**.

Words of Wisdom

When the angle of the pharynx and the larynx is particularly acute, it is often difficult to see the entire glottic opening. You can do two things to increase the percentage of the glottic opening that you can see. You can use **cricoid pressure** (also called the **Sellick maneuver**) or the BURP maneuver. (Per the American Heart Association, cricoid pressure should not be used to prevent or treat gastric distention; however, it is still an acceptable method of improving the view during intubation.)

Cricoid pressure moves the airway structures more posteriorly. If applied by an assistant during direct laryngoscopy, it reduces the acuity of the angle between the pharynx and larynx and can improve the laryngoscopic view **Figure 12**.



Figure 12 Cricoid pressure (also called the Sellick maneuver).

The **BURP maneuver** is an acronym for Backward, Upward, Rightward Pressure. If you are having difficulty seeing the glottic opening, take your right hand and locate the lower third of the thyroid cartilage. By applying backward, upward, and rightward pressure, you can often move the larynx into view **Figure 13**. Unfortunately, sometimes when you let go to pass the tube with your right hand, you will lose the view. If possible, once you have visualized the glottic opening, have an assistant hold the larynx in position as you pass the tube. The BURP maneuver can also be applied to the cricoid ring or the hyoid bone.

The **gum bougie** is an ingenious device that can make intubation possible in some difficult situations, especially when you have limited glottic visualization. The gum bougie is a flexible device that is roughly a centimeter in diameter **Figure 14**. It is rigid enough to be easily directed through the glottic opening, but flexible enough so that it does not cause damage to the tracheal walls. There is a slight angle at its distal tip.

The gum bougie is inserted through the glottic opening under direct visualization. Because it is much smaller than



Figure 13 The BURP maneuver—displacing the larynx back, up, and to the right—may help visualize the vocal cords.



Figure 14 The gum bougie device.

Source: Courtesy of Marianne Gausche-Hill, MD, FACEP, FAAP

an ET tube, it is useful if you cannot obtain a full glottic view. The angle at its distal tip facilitates entry into the airway and enables you to “feel” the ridges of the tracheal wall. Once the gum bougie is placed deeply into the trachea, it becomes a guide for the ET tube. Simply slide the tube over the device and into the trachea. Remove the gum bougie, ventilate, and confirm placement.

■ Tube Insertion

Once you have visualized the glottic opening, the next step is to insert the ET tube. When you find the glottic opening, do not take your eyes off it. Losing sight of the glottic opening is a major cause of failed intubation. Have the tube ready in your right hand so that you can advance it immediately on identification of the vocal cords.

A major mistake beginners make is to try to pass the tube down the barrel of the blade. The laryngoscope blade is not designed as a guide for the tube; it is a tool used only to visualize the glottic opening. Placing the tube down the blade obscures your view of the glottic opening **Figure 15**. Pass the tube as far to the right as possible and at an angle that lets you watch the tip as you insert it through the vocal cords. Continue to insert the tube until the proximal end of the cuff is 1 to 2 cm past the vocal cords. If you take your eyes off the tip of the tube, even for a second, you significantly increase the likelihood of allowing the tube to slip into the esophagus.



Figure 15 Do not place the tube down the blade; this obscures your view of the glottic opening.

■ Ventilate

After watching the tube pass between the patient's vocal cords, gently remove the blade, hold the tube with your right hand, and carefully remove the stylet. Fill the tube cuff with just enough air to stop the leaking sound around the tube and then detach the syringe from the inflation port. Have your assistant attach the ventilation device to the tube with an end-tidal carbon dioxide detector (note, if you are using an esophageal detection device, it is important to use it before the first breath is taken). As the first breaths are delivered, watch the patient's chest rise.

You should now listen to breath sounds as another way to confirm the tube location. You should listen to both lungs at both the apices and bases and to the stomach over the epigastrium. If the tube is properly positioned in the trachea, you will hear equal breath sounds bilaterally and a quiet epigastrium. Gurgling over the stomach suggests esophageal placement, and the tube should be immediately removed and the patient ventilated. Unilateral breath sounds generally indicate a mainstem intubation. Place your stethoscope over the quiet side of the chest and slowly withdraw the tube until you hear breath sounds return.

Ventilation should continue as indicated according to the patient's size and clinical condition. It is prudent to slightly hyperventilate the patient for 30 seconds to 1 minute immediately after intubation to eliminate any accumulated carbon dioxide.

A summary of the steps of orotracheal intubation by direct laryngoscopy is listed here, and the steps are shown in **Skill Drill 1**:

1. Use standard precautions (gloves and face shield).
2. Preoxygenate the patient whenever possible with a bag-mask device and 100% oxygen **Step 1**.
3. Check, prepare, and assemble your equipment **Step 2**.
4. Place the patient's head in the sniffing position **Step 3**.
5. Insert the blade into the right side of the patient's mouth, and displace the tongue to the left **Step 4**.
6. Gently lift the long axis of the laryngoscope handle until you can visualize the glottic opening and the vocal cords **Step 5**.
7. Insert the ET tube through the right corner of the mouth, and place it between the vocal cords **Step 6**.
8. Remove the laryngoscope from the patient's mouth **Step 7**.
9. Remove the stylet from the ET tube **Step 8**.
10. Inflate the distal cuff of the ET tube with 5 to 10 mL of air, and detach the syringe **Step 9**.
11. Attach the end-tidal carbon dioxide detector to the ET tube **Step 10**.
12. Attach the bag-valve device, ventilate, and auscultate over the apices and bases of both lungs and over the epigastrium **Step 11**.

13. Secure the ET tube **Step 12**.

14. Place a bite block in the patient's mouth **Step 13**.

■ Confirm Placement

Watching the ET tube pass between the vocal cords is your first method of confirming tube placement. You must continue the process of gathering information to assess the location of the tube. Remember that a misplaced tube that goes undetected is a fatal error. You must incorporate multiple assessment findings into the determination of where the tube is located. If the tube must be repositioned or moved, be sure to remove the air from the cuff first.

After visualizing the tube passing through the glottis, note the depth of the markings on the tube. The average depth in adult males is 22 cm at the teeth, and the average depth in adult females is 21 cm at the teeth. Look for condensation in the tube. Condensation indicates correct placement in the trachea.

Auscultation over the lungs and epigastric area is the next step. Air entry into the stomach indicates esophageal placement, mandating immediate removal of the tube. Equal breath sounds should be heard over the apices of each lung and equal breath sounds and expansion over the bilateral bases. Unequal or absent breath sounds over the lung fields indicate esophageal placement, right mainstem placement, pneumothorax, or bronchial obstruction.

Palpation of the balloon cuff at the sternal notch by compressing the pilot balloon is another indication of correct placement. Pulse oximetry provides a measurement of oxygenation as long as other factors do not interfere with peripheral circulation. Carbon dioxide detectors (end-tidal carbon dioxide) may also be used. They detect the presence of carbon dioxide in expired air. These detectors may be colorimetric, digital, or digital/waveform. A capnographer attaches in between the ET tube and bag-mask device; it contains colorimetric paper, which should turn yellow during exhalation, indicating proper tube placement **Figure 16**.



Figure 16 Colorimetric capnographers.

Source: Courtesy of Marianne Gausche-Hill, MD, FACEP, FAAP

Skill Drill

1

Intubation of the Trachea Using Direct Laryngoscopy



Step 1 Use standard precautions (gloves and face shield). Preoxygenate the patient whenever possible with a bag-mask device and 100% oxygen.



Step 2 Check, prepare, and assemble your equipment.



Step 3 Place the patient's head in the sniffing position.



Step 4 Insert the blade into the right side of the patient's mouth, and displace the tongue to the left.



Step 5 Gently lift the long axis of the laryngoscope handle until you can visualize the glottic opening and the vocal cords.



Step 6 Insert the ET tube through the right corner of the mouth, and visualize its entry between the vocal cords.



Step 7 Remove the laryngoscope from the patient's mouth.



Step 8 Remove the stylet from the ET tube.



Step 9 Inflate the distal cuff of the ET tube with 5 to 10 mL of air, and detach the syringe from the inflation port.

Skill Drill

1

Intubation of the Trachea Using Direct Laryngoscopy (*continued*)



Step 10 Attach the end-tidal carbon dioxide detector to the ET tube.



Step 11 Attach the bag-valve device, ventilate, and auscultate over the apices and bases of both lungs and over the epigastrium.



Step 12 Secure the ET tube.



Step 13 Place a bite block in the patient's mouth.



Figure 17 A capnometer.

Source: Courtesy of Marianne Gausche-Hill, MD, FACEP, FAAP

A **capnometer** performs the same function; however, instead of using colorimetric paper, it attaches in the same way as a **capnograph**, but provides an LED readout of the patient's exhaled carbon dioxide, again indicating correct ET tube placement **Figure 17**. Because carbon dioxide is not present in the esophagus, use of carbon dioxide detectors is yet another method of determining correct tube placement. The steps are as follows **Skill Drill 2**.

1. Detach the ventilation device from the ET tube **Step 1**.
2. Attach an in-line capnograph or capnometer to the proximal adapter of the ET tube **Step 2**.
3. Reattach the ventilation device to the ET tube, and resume ventilations **Step 3**.
4. Monitor the capnograph or capnometer for appropriate reading (appropriate color change or digital reading) **Step 4**.

The **esophageal detector device (EDD)** is yet another method of confirming proper ET tube placement. The EDD is a bulb or syringe with a 15/22-mm adapter. With the syringe model, the syringe is attached to the end of the ET tube and the plunger is withdrawn, creating negative pressure **Figure 18**. If the tube is in the trachea (which has rigid, noncollapsible walls), air is easily drawn into the syringe and the plunger does not move when released. Unlike the trachea, however, the esophagus is a flaccid, easily collapsible tube. Thus, if the tube is in the esophagus, a vacuum is created as the EDD's plunger is withdrawn, and the plunger moves back toward zero when released.

With the bulb model, the bulb is squeezed and then attached to the end of the ET tube. If it remains collapsed or inflates slowly, the esophageal wall has occluded the distal tip of the tube, indicating that esophageal intubation has likely occurred. If the bulb briskly expands, the tube is properly positioned in the trachea **Figure 19**.

The final determination of correct tube placement is bag-mask ventilation compliance. The bag should be easy to compress with corresponding chest expansion. Increased



Figure 18 With the esophageal detector device syringe, the ability to freely withdraw air indicates placement of the tube in the trachea.

Source: Courtesy of Marianne Gausche-Hill, MD, FACEP, FAAP

resistance to bag-mask compliance may indicate gastric distention, esophageal placement, or tension pneumothorax.

After confirming proper tube placement, note and mark the ET tube with an ink line or piece of tape at the point where it emerges from the patient's mouth; this will enable medical personnel involved in the subsequent care of the patient to determine whether the tube has slipped in or out. The average depth for adult patients is 21 to 25 cm.

Evidence of a misplaced tube, regardless of when it was last checked, must be reconfirmed. Reconfirmation should also be performed after any major move and after any manipulation of the neck. Manipulation of the neck may displace the tube up to 5 cm.



Figure 19 If the ET tube is in the trachea, the esophageal detector device bulb should briskly fill with air.

Source: Courtesy of Marianne Gausche-Hill, MD, FACEP, FAAP

Skill Drill

2

Using Colorimetric Capnography for Carbon Dioxide Detection



Step 1 Detach the ventilation device from the ET tube.



Step 2 Attach an in-line capnographer or capnometer to the proximal adapter of the ET tube.



Step 3 Reattach the ventilation device to the ET tube, and resume ventilations.



Step 4 Monitor the capnographer or capnometer for appropriate reading (appropriate color change or digital reading).

■ Corrective Measures

If the ET tube is confirmed to be in the esophagus, it must be removed immediately. Be ready to vigorously suction as needed. The likelihood of emesis is increased, especially if gastric distention is present. Ideally, you should preoxygenate

the patient before reintubation. The misplaced tube may be removed before or after proper tracheal placement is confirmed. Leaving the first tube in place may serve as a guide or block for the second tube. If the tube is removed before reintubation, make sure you are ready to perform diligent and vigorous airway suctioning.

If breath sounds are heard only on the right side, the tube may be advanced too far into the right mainstem bronchus. Follow these steps to reposition the tube:

- Deflate the balloon cuff.
- While ventilation continues, SLOWLY retract the tube while simultaneously listening for breath sounds over the left side of the chest.
- STOP as soon as breath sounds are heard in the left side of the chest.
- Note the tube depth.
- Reinflate the balloon cuff.
- Secure the tube.
- Resume ventilations.

Misplacement of an ET tube can be fatal if not corrected. It is imperative that you frequently check tube placement and quickly remedy any misplacement.

■ Securing the Tube

The last, and very important step, is to secure the tube. *Never take your hand off the ET tube before it has been secured with tape or a commercial device!* Inadvertent extubation caused by the patient or someone else is common and very traumatic to the patient. A second intubation would not be as easy as the first because of swelling and possible bleeding. It is disheartening to accomplish a difficult intubation and then find that the tube has been accidentally dislodged. Be sure to secure the tube well to prevent this from happening. Also, it is a good idea to support the tube manually while you ventilate the patient to avoid a sudden jolt from the bag-mask device that could pull the tube from the trachea.

Many commercial tube holders are available that have varying degrees of efficiency. If one is available in your facility, become familiar with its use. You should know how to secure a tube using tape, because it is almost always available.

The steps for securing an ET tube with tape are listed here and shown in **Skill Drill 3**:

1. Note the centimeter marking on the tube at the level of the patient's teeth **Step 1**.
2. Remove the bag-valve device from the ET tube **Step 2**.
3. Move the ET tube to the corner of the patient's mouth **Step 3**.
4. Encircle the ET tube with tape, and secure the tape to the patient's maxilla (using tincture of benzoin to facilitate tape adhesion) **Step 4**.
5. Reattach the bag-valve device, and auscultate again over the apices and bases of the lungs and over the epigastrium **Step 5**.

The steps for securing an ET tube with a commercial device are listed here and shown in **Skill Drill 4**:

1. Note the centimeter marking on the tube at the level of the patient's teeth **Step 1**.
2. Remove the bag-valve device from the ET tube **Step 2**.

3. Position the ET tube in the center of the patient's mouth **Step 3**.
4. Place the commercial device over the ET tube and secure **Step 4**.
5. Reattach the bag-valve device, and auscultate again over the apices and bases of the lungs and over the epigastrium **Step 5**.

After the tube is secured, be sure that a bite block or oral airway is inserted into the patient's mouth. If the patient bites the tube or has a seizure, there is a risk of occluding the airway. A rigid device that will not damage the teeth but that is hard enough to prevent biting the tube should be placed in the mouth. Finally, it is important to limit head movement in the intubated patient. With a firmly secured tube, the tip can move as much as 5 cm during head flexion and extension. If you are going to move the patient, consider placing the patient on a rigid board and using a cervical collar and/or head immobilization device to reduce the likelihood of tube dislodgment during head movement.

Words of Wisdom

Following endotracheal intubation, thick pulmonary secretions or other fluids may occlude the ET tube, preventing effective ventilation. This situation requires tracheobronchial suctioning of an intubated patient, which is covered in Chapter 10, *Airway Management*.

Words of Wisdom

When determining the length of a suction catheter for endotracheal intubation, measure from the center of the lips to the earlobe to the xiphoid process **Figure 20**.



Figure 20 When determining the length of a suction catheter for endotracheal suction, measure from the center of the lips to the earlobe to the xiphoid process.

Skill Drill

3

Securing an Endotracheal Tube With Tape



Step 1 Note the centimeter marking on the tube at the level of the patient's teeth.



Step 2 Remove the bag-valve device from the ET tube.



Step 3 Move the ET tube to the corner of the patient's mouth.



Step 4 Encircle the ET tube with tape, and secure the tape to the patient's maxilla (using tincture of benzoin to facilitate tape adhesion).



Step 5 Reattach the bag-valve device, and auscultate again over the apices and bases of the lungs and over the epigastrium.

Skill Drill

4

Securing an Endotracheal Tube With a Commercial Device



Step 1 Note the centimeter marking on the tube at the level of the patient's teeth.



Step 2 Remove the bag-valve device from the ET tube.



Step 3 Position the ET tube in the center of the patient's mouth.



Step 4 Place the commercial device over the ET tube and secure.



Step 5 Reattach the bag-valve device, and auscultate again over the apices and bases of the lungs and over the epigastrium.

Field Extubation

Extubation is the process of removing the tube from an intubated patient. In the critical care environment, the decision to extubate a patient is very complicated and depends on many factors. It may take days or weeks to wean a patient off of a ventilator and be confident that the person will be able to ventilate and maintain his or her own airway. The decision to extubate the critical care patient is beyond the scope of this chapter.

In emergency medicine, extubation of patients is rarely performed. The major indication for extubation is when the patient's level of consciousness improves and he or she begins gagging on the tube. In general, it is better to sedate the patient than to remove the tube, but this may not be an option in some systems or in patients who are in hemodynamically unstable condition.

There are a number of risks in extubating patients in emergency situations. The most obvious is overestimating the ability of the patient to protect his or her own airway. Once you remove the tube, there is no guarantee that you will be able to replace it. Patients who are awake are at a high risk for laryngospasm on removal of an ET tube, and most patients experience some degree of upper airway swelling because of the trauma of having a tube in the throat. These two facts, complicated by the ever-present possibility of vomiting, make reintubation challenging and maybe impossible. These risks must be factored against the benefit of removing the tube.

Field extubation is indicated when the patient is able to protect and maintain the airway, the patient is not sedated, and you are confident that you will be able to ventilate and reintubate if necessary. Field extubation should never be

performed if there is a risk of continued or recurrent respiratory failure. Keep in mind that postextubation vomiting and laryngospasm are possible.

Field extubation is accomplished by first hyperoxygenating the patient. Discuss the procedure with the patient, and explain what you are going to do. If possible, it is best to have the patient sit up or lean slightly forward. Be sure to assemble and have available all equipment to suction, ventilate, and reintubate, if necessary. After you have confirmed that the patient remains responsive enough to protect his or her own airway, suction the oropharynx to remove any debris or secretions that may threaten the airway. Deflate the cuff on the ET tube at the beginning of an exhalation so that any accumulated secretions just above the cuff are not aspirated into the lungs. On the next exhalation, remove the tube in one steady motion, following the curvature of the airway. You may find it useful to hold a towel or emesis basin in front of the patient's mouth, in case the patient gags or vomits. The steps for performing extubation are summarized here and shown in **Skill Drill 5**:

1. Hyperoxygenate the patient **Step 1**.
2. Ensure that ventilation and suction equipment are immediately available **Step 2**.
3. Confirm patient responsiveness **Step 3**.
4. Lean the patient forward **Step 4**.
5. Suction the oropharynx **Step 5**.
6. Deflate the distal cuff of the ET tube **Step 6**.
7. Remove the ET tube during a cough or when the patient exhales **Step 7**. Following extubation, provide 100% oxygen via a nonrebreathing mask. Have suction immediately available. Monitor breathing and oxygenation carefully.

Skill Drill

5

Performing Extubation



Step 1 Hyperoxygenate the patient.



Step 2 Ensure that ventilation and suction equipment are immediately available.



Step 3 Confirm patient responsiveness.



Step 4 Lean the patient forward.



Step 5 Suction the oropharynx.



Step 6 Deflate the distal cuff of the ET tube.



Step 7 Remove any device or tape which was used to secure the ET tube. Then, remove the ET tube as the patient coughs or begins to exhale.

Prep Kit

■ Ready for Review

- Unresponsive patients or patients who cannot maintain their own airway should be considered candidates for endotracheal intubation, the insertion of an endotracheal tube into the trachea.
- In orotracheal intubation, the endotracheal tube is inserted into the trachea via the mouth.
- Once an endotracheal tube is inserted, you must confirm tube placement. Methods include auscultation over the lungs and the epigastric area, performing pulse oximetry, and using carbon dioxide detectors.
- Carbon dioxide detectors detect the presence of carbon dioxide in expired air. These may be colorimetric, digital, or digital/waveform.
- A capnograph attaches in between the endotracheal tube and bag-mask device; it contains colorimetric paper, which should turn yellow during exhalation, indicating proper tube placement. A capnometer performs the same function, but provides an LED readout of the patient's exhaled carbon dioxide.
- The final determination of correct tube placement is bag-mask ventilation compliance. The bag should be easy to compress with corresponding chest expansion.
- Extubation should not be performed in the prehospital setting unless the patient is unreasonably intolerant of the tube. It is generally best to sedate the intubated patient who is becoming intolerant of the endotracheal tube.

■ Vital Vocabulary

- atlanto-occipital joint** The joint formed at the articulation of the atlas of the vertebral column and the occipital bone of the skull.
- BURP maneuver** Acronym for **B**ackward, **U**pward, and **R**ightward **P**ressure.
- capnographer** A device used to confirm endotracheal tube placement that contains colorimetric paper, which should turn yellow during exhalation, indicating proper tube placement.
- capnometer** A device used to confirm endotracheal tube placement that provides an LED readout of the patient's exhaled carbon dioxide, indicating proper tube placement.
- cricoid pressure** The application of posterior pressure to the cricoid cartilage; used to improve the view during intubation; also called the Sellick maneuver.
- direct laryngoscopy** A technique to accomplish endotracheal intubation by visualizing the glottic opening with the aid of a laryngoscope.
- endotracheal intubation** Placement of a tube into the trachea.
- endotracheal (ET) tube** A tube designed to be placed into the trachea for the purpose of airway management, ventilatory control, and/or medication delivery.
- esophageal detector device (EDD)** Bulb or syringe that is attached to the proximal end of the endotracheal tube; a device used to confirm proper endotracheal tube placement.
- extubation** The process of removing the tube from an intubated patient.
- gum bougie** A device that is placed between the vocal cords under direct laryngoscopy. The endotracheal tube is then advanced over the gum bougie and into the trachea. This device is useful when you are unable to obtain a full view of the glottic opening.
- laryngospasm** The spasmodic contraction of the vocal cords, accompanied by an enfolding of the arytenoid and aryepiglottic folds.
- Murphy's eye** The opening on the side of the endotracheal tube at its distal end; prevents occlusion of the tube with secretions.
- Sellick maneuver** A technique in which pressure is applied on the cricoid cartilage; used to improve the view during intubation; also called cricoid pressure.

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