

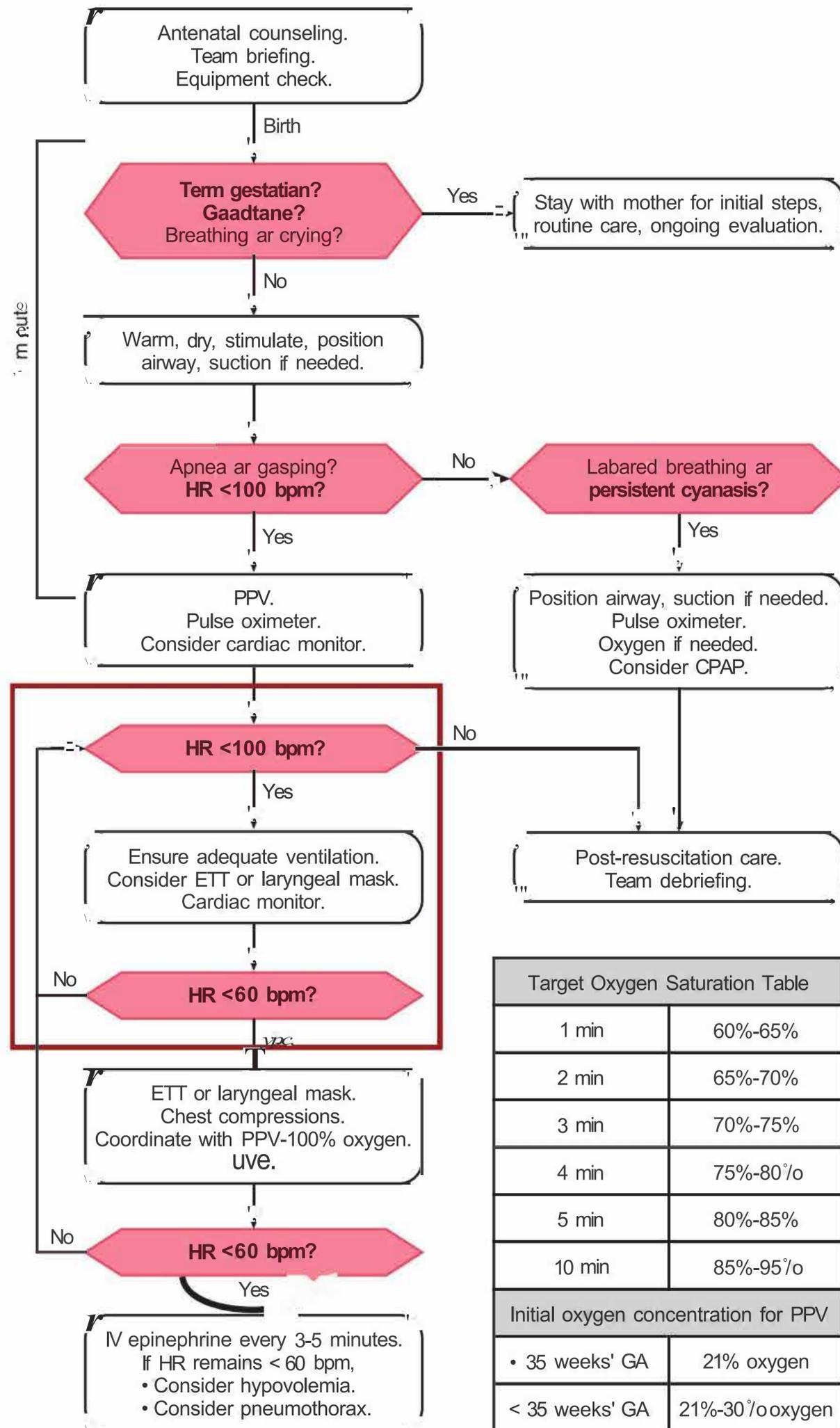
Endotracheal Intubation

What you will learn

- The indications for endotracheal intubation during resuscitation
- How to select and prepare the equipment for endotracheal intubation
- How to assist with endotracheal intubation
- How to use a laryngoscope to insert an endotracheal tube
- How to determine if the endotracheal tube is in the trachea
- How to use an endotracheal tube to suction thick secretions from the trachea

5





| Target Oxygen Saturation Table | |
|--------------------------------------|----------------|
| 1 min | 60%-65% |
| 2 min | 65%-70% |
| 3 min | 70%-75% |
| 4 min | 75%-80% |
| 5 min | 80%-85% |
| 10 min | 85%-95% |
| Initial oxygen concentration for PPV | |
| • 35 weeks' GA | 21% oxygen |
| < 35 weeks' GA | 21%-30% oxygen |

Key Points

- Insertion of an endotracheal tube (intubation) is strongly recommended if the baby's heart rate remains less than 100 bpm and is not increasing after positive-pressure ventilation (PPV) with a face mask or laryngeal mask.
- f) Insertion of an endotracheal tube is strongly recommended before starting chest compressions. If intubation is not successful or feasible, and the baby weighs more than approximately 2 kg, a laryngeal mask may be used.
- 8 An endotracheal tube should be inserted for direct tracheal suction if the trachea is obstructed by thick secretions, for surfactant administration, and for stabilization of a newborn with a suspected diaphragmatic hernia.
- 8 If PPV is prolonged, an endotracheal tube may be considered to improve the efficacy and ease of assisted ventilation.
- A person with intubation skills should be in the hospital and available to be called for immediate assistance if needed. If the need for intubation is anticipated, this person should be present in the delivery room at the time of birth. It is not sufficient to have someone on call at home or in a remote area of the hospital.
- The appropriate laryngoscope blade for a term newborn is size No. 1. The correct blade for a preterm newborn is size No. 0 (size No. 00 *optional* for extremely preterm newborn).
- The intubation procedure ideally should be completed within 30 seconds. Effective teamwork is required to perform this procedure quickly.
- Demonstrating exhaled carbon dioxide (CO₂) and observing a rapidly increasing heart rate are the primary methods of confirming endotracheal tube insertion within the trachea.
- f) Endotracheal tube insertion depth can be estimated using the nasal-tragus length (NTL) or the baby's gestational age; however, the depth estimate should be confirmed by auscultating equal breath sounds. If the tube is to remain in place, obtain a chest x-ray for final confirmation.

- 4D) If a correctly inserted endotracheal tube does not result in PPV with chest movement, suspect airway obstruction and suction the trachea with a suction catheter or tracheal aspirator.
- G, If a baby's condition worsens after endotracheal intubation, the tube may have become **displaced or obstructed**, or there may be a **pneumothorax** or PPV **equipment** failure (*DOPE* mnemonic).
- O Avoid repeated unsuccessful attempts at endotracheal intubation. For babies who weigh more than approximately 2 kg, a laryngeal mask may provide a rescue airway when PPV with a face mask fails to achieve effective ventilation and intubation is unsuccessful or not feasible.

Case: Resuscitation with positive-pressure ventilation using an endotracheal tube

Your team is called to attend the birth for a woman at 37 weeks' gestation whose labor is complicated by maternal fever and fetal tachycardia. The amniotic fluid is clear. You complete a pre-resuscitation briefing and prepare your supplies and equipment. After the vaginal birth, the obstetrician dries and stimulates the baby, but the baby remains limp and apneic. The umbilical cord is clamped and cut and the baby is moved to the radiant warmer. You position and suction the mouth and nose while providing brief additional stimulation, but the baby is still not breathing. You start positive-pressure ventilation (PPV) while another team member places a pulse oximeter sensor on the baby's right hand and another documents the events as they occur. The baby's heart rate is 50 beats per minute (bpm) and not increasing. You observe that the chest is not moving with PPV breaths and begin the ventilation corrective steps. After the first 5 corrective steps, the chest is still not moving and the heart rate has not improved. A carbon dioxide (CO₂) detector placed between the PPV device and mask remains purple with assisted breaths. You decide to insert an endotracheal tube to improve the effectiveness of PPV.

Leads are placed on the chest and attached to a cardiac monitor. An assistant holds a 3.5-mm endotracheal tube, provides cricoid pressure, and monitors the procedure time while a qualified provider uses a size 1 laryngoscope to insert the endotracheal tube. A CO₂ detector is placed on the tube, PPV is resumed, and the detector turns yellow, indicating that the tube is in the trachea and the lungs are being ventilated. The baby's chest is moving and the heart rate rapidly

increases. Based on the nasal-tragus length (NTL) measurement, the endotracheal tube is held with the 8-cm marking adjacent to the lip. Breath sounds are equal in both axillae, the tube is secured, and PPV continues. You adjust the oxygen concentration based on pulse oximetry. The baby still has poor tone and irregular respiratory effort. You quickly update the parents and transfer the baby to the nursery for a chest x-ray and post-resuscitation care. Shortly afterward, your resuscitation team conducts a debriefing to discuss preparation, teamwork, and communication.

What is an endotracheal tube?

An endotracheal tube (Figure 5.1) is a thin tube that is inserted through the glottis, between the vocal cords, and advanced into the trachea. Although digital intubation using only the operator's finger has been described, endotracheal intubation typically requires the use of a lighted instrument (laryngoscope [Figure 5.2]) to visualize the larynx and guide the insertion of the tube between the vocal cords.

When should insertion of an endotracheal tube be considered?

- Insertion of an endotracheal tube (intubation) is strongly recommended if the baby's heart rate remains less than 100 bpm and is not increasing after PPV with a face mask or laryngeal mask.
- Insertion of an endotracheal tube is strongly recommended before starting chest compressions. If intubation is not successful or

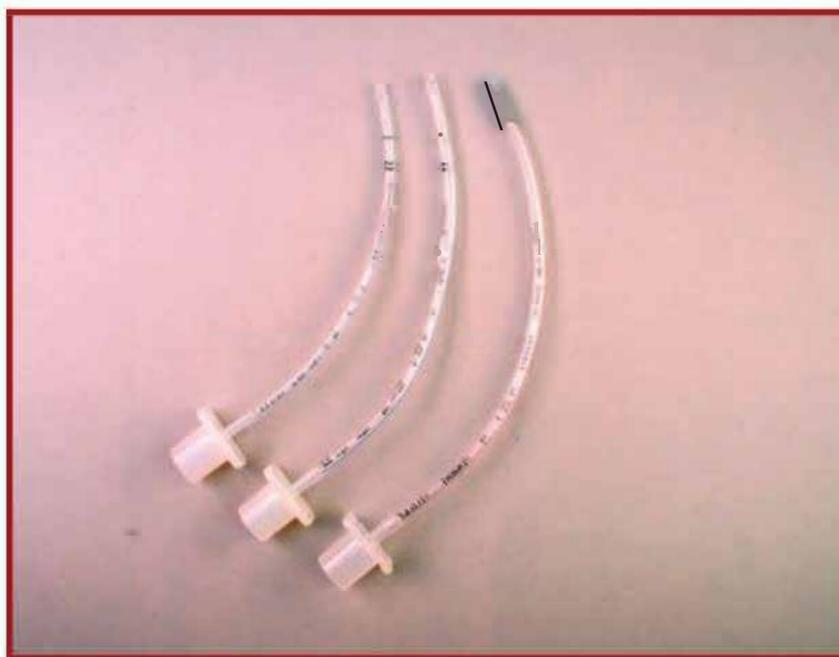


Figure 5.1. Endotracheal tubes (size 2.5, 3.0, 3.5)



Figure 5.2. Laryngoscope

feasible, and the baby weighs more than approximately 2 kg, a laryngeal mask may be used.

- Ventilation through an endotracheal tube for 30 seconds may improve ventilation efficacy and prevent the need to proceed to chest compressions.
- If chest compressions are needed, ventilation through an endotracheal tube may improve coordination with compressions.
- Intubation allows the compressor to give compressions from the head of the bed.
- An endotracheal tube should be inserted for direct tracheal suction if the trachea is obstructed by thick secretions, for surfactant administration, and for stabilization of a newborn with a suspected diaphragmatic hernia.
- If PPV is prolonged, an endotracheal tube may be considered to improve the efficacy and ease of assisted ventilation.

When endotracheal intubation is needed, it must be performed without significant delay. A person with intubation skills should be available to be called for immediate assistance if needed. If the need for intubation is anticipated, this person should be present in the delivery room at the time of birth.

What are the important anatomic landmarks in the neonatal airway?

The anatomic landmarks are labeled in Figures 5.3 and 5.4.

- O **Esophagus:** The passageway extending from the throat to the stomach
- 8 **Epiglottis:** The lid-like structure overhanging the glottis
- E) **Vallecula:** The pouch formed by the base of the tongue and the epiglottis
- C) **Larynx:** Portion of the airway connecting the pharynx and trachea
- O **Glottis:** The opening of the larynx leading to the trachea, flanked by the vocal cords
- O **Vocal cords:** Mucous membrane-covered ligaments on both sides of the glottis
- O **Trachea:** Portion of the airway extending from the larynx to the carina

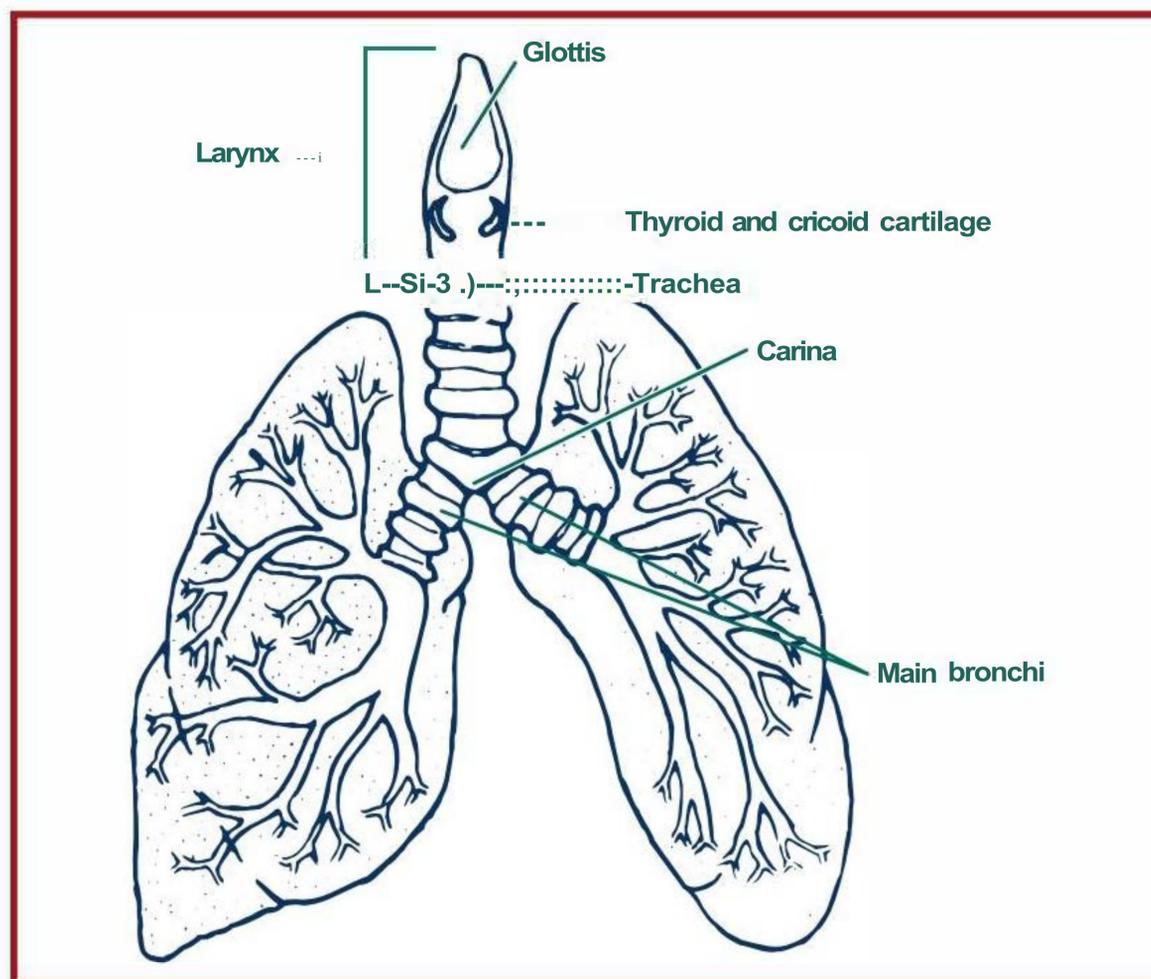


Figure 5.3. Airway anatomy

- O) **Thyroid and cricoid cartilage:** Lower portion of the cartilage protecting the larynx
- O) **Carina:** Where the trachea branches into the 2 main bronchi
- E) **Main bronchi:** The 2 air passageways leading from the trachea to the lungs

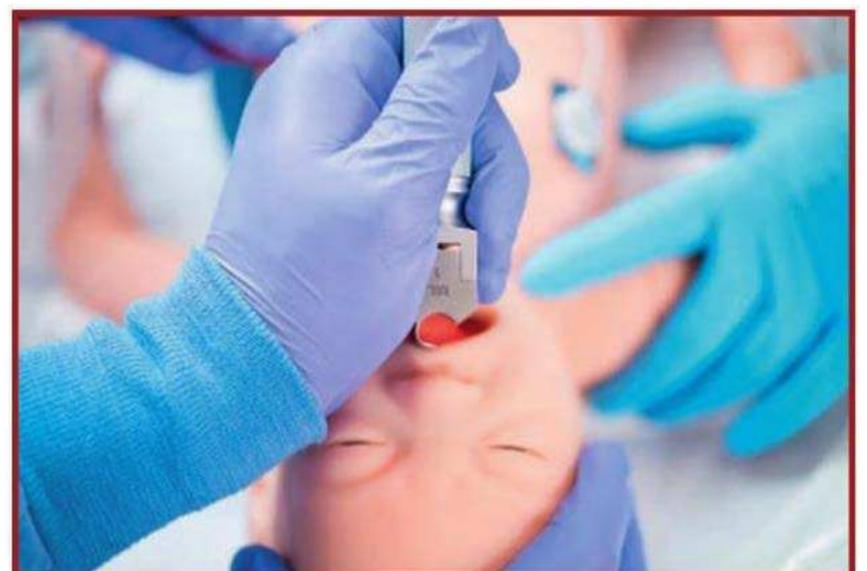
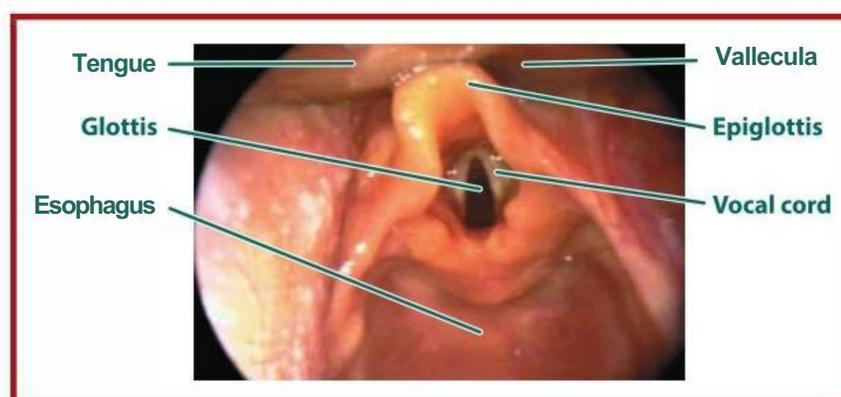


Figure 5.4. Laryngoscopic view of vocal cords and surrounding structures

What supplies and equipment should be available for intubation?

Intubation supplies and equipment should be kept together and readily accessible. It is important to anticipate the need for intubation and prepare the supplies and equipment before a high-risk delivery.

Each delivery room, nursery, and emergency department should have at least 1 complete set of the following items (Figure 5.5):

- O Laryngoscope handle•
 - If the handle uses replaceable batteries and bulbs, an extra set should be available.
- 8 Laryngoscope blades (straight Miller)*
 - No. 1 (term newborn)
 - No. 0 (preterm newborn)
 - No. 00 (*optional for extremely preterm newborn*)
- E) Endotracheal tubes with inside diameters of 2.5, 3.0, and 3.5 mm
 - Size 2.0 mm, size 4.0 mm, and tubes with inflatable cuffs are available and may be considered for specific indications but are not routinely used during neonatal resuscitation.
- 8 Stylet (*optional*) that fits into the endotracheal tube
- O CO₂ detector
- O Suction setup with suction catheters: size 10F or larger (for suctioning the pharynx), size 8F, and either size 5F or 6F (for suctioning endotracheal tubes of various sizes that become obstructed with secretions during resuscitation)
- O Waterproof adhesive tape (1/2 or 3/4 inch), or other tube-securing device
- O Measuring tape and/or endotracheal tube insertion depth table (Table 5-4)
- f) Scissors to cut tape

*A video laryngoscope with an integrated camera that displays a magnified view of the airway structures on a video screen is an option.

- CD) Tracheal aspirator
- fD Stethoscope (with neonatal head)
- 0 Positive-pressure ventilation device (bag or T-piece resuscitator) and tubing for blended air and oxygen
- G, Pulse oximeter, sensor, and cover
- 4D Laryngeal mask (size 1) as a rescue airway
 - 5-mL syringe if using a laryngeal mask with an inflatable rim

Intubation should be performed as a clean procedure. All supplies should be protected from contamination by being opened, assembled, and placed back in their packaging until just before use. The laryngoscope blades and handle should be cleaned, following your hospital's procedures, after each use.

When intubation becomes necessary, a cardiac monitor is recommended for the most accurate assessment of the baby's heart rate. During resuscitation, auscultation can be difficult and pulse oximetry may not reliably detect the baby's pulse. A cardiac monitor is a valuable tool at this point in resuscitation because an increasing heart rate is a critical indicator for proper endotracheal tube insertion and because your decision to proceed with chest compressions after intubation depends on accurate assessment of the heart rate.



Figure 5.5. Neonatal airway supplies and equipment. (Supplies removed from packaging for demonstration purposes.)

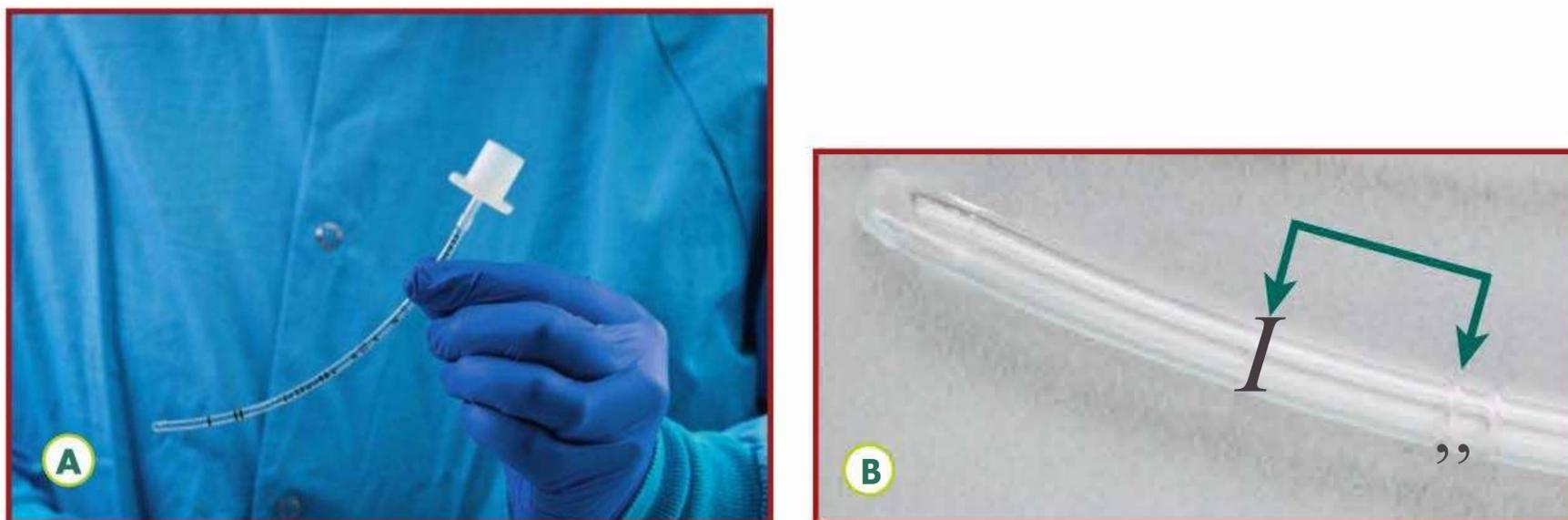


Figure 5.6. Neonatal endotracheal tube with a uniform diameter (A). This tube has a vocal cord guide that is used to approximate the insertion depth (B). The tube is inserted so that the vocal cords are positioned in the space between the double line and single line (indicated by the arrows). The vocal cord guide is only an approximation and may not reliably predict the correct insertion depth.

What type of endotracheal tube should be used?

The endotracheal tube should have a uniform diameter throughout the length of the tube (Figure 5.6A). Tapered tubes are not recommended for neonatal resuscitation. Endotracheal tubes have centimeter markings along the side measuring the distance to the tip of the tube. Many tubes will also have lines or markings (Figure 5.6B) near the tip that are intended to be a vocal cord guide. When the tube is inserted so that vocal cords are positioned between the 2 sets of lines, the tip of the tube is expected to be above the carina; however, the location and design of the lines varies considerably between manufacturers. *The vocal cord guide is only an approximation and may not reliably indicate the correct insertion depth.*

How do you prepare the endotracheal tube?

Select the correct size.

Endotracheal tubes are described by the size of their internal diameter (mm ID). The appropriate endotracheal tube diameter is estimated from the baby's weight or gestational age. Table 5-1 gives the recommended endotracheal tube size for various weight and gestational-age categories. Using a tube that is too small increases the resistance to air flow and the chance that it will become obstructed by secretions. Using a tube that is too large may traumatize the airway. Size 2.0 mm, size 4.0 mm, and tubes with inflatable cuffs are available and may be considered for specific indications but are not routinely used during neonatal resuscitation.

Table 5-1. Endotracheal Tube Size for Babies of Various Weights and Gestational Ages

| Weight | Gestational Age | Endotracheal Tube Size |
|-------------------|-----------------------|------------------------|
| Below 1 kg | Below 28 weeks | 2.5 mm ID |
| 1-2 kg | 28-34 weeks | 3.0 mm ID |
| Greater than 2 kg | Greater than 34 weeks | 3.5 mm ID |

Consider using a stylet.

Many operators find it helpful to use a stylet with the endotracheal tube to provide additional rigidity and curvature (Figure 5.7A). Use of a stylet is optional and depends on the operator's preference. When inserting a stylet, it is important to ensure that the tip is not protruding from either the end or side hole of the endotracheal tube (Figure 5.7B). If the tip protrudes, it may cause trauma to the tissues. The stylet should be secured with a plug, or bent at the top, so that it cannot advance farther into the tube during the insertion procedure. It is important to ensure that the stylet is easily removable from the endotracheal tube because aggressive attempts to remove the stylet after intubation can accidentally displace the tube.

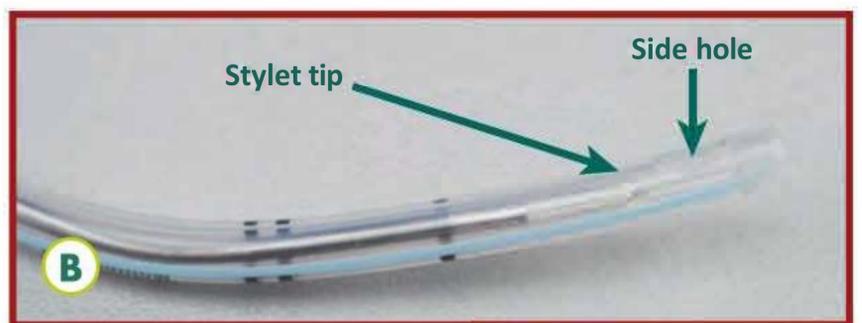


Figure 5.7. Optional stylet for increasing endotracheal tube stiffness and maintaining curvature during intubation

How do you prepare the laryngoscope and other equipment you will need?

The following steps describe how to prepare the equipment used for intubation:

- O If not already done, attach cardiac monitor leads for accurate assessment of the baby's heart rate.
- f) Select the appropriate laryngoscope blade and attach it to the handle.
 - a. Use a No. 1 blade for term newborns.
 - b. Use a No. 0 blade for preterm newborns. Some operators may prefer to use a No. 00 blade for extremely preterm newborns.
- E) Turn on the light by clicking the blade into the open position to verify that the batteries and light are working. If the light is dim or flickers, tighten or replace the bulb, insert a new battery, or replace



the laryngoscope. If you are using a light-bulb laryngoscope, close the laryngoscope until ready for use to avoid overheating the light bulb and blade.

- 8 Prepare the suction equipment.
 - a. Occlude the end of the suction tubing to ensure that the suction is set to 80 to 100 mm Hg.
 - b. Connect a size 10F (or larger) suction catheter to remove secretions from the mouth and pharynx.
 - c. Smaller suction catheters (size 8F and size SF or 6F) should be available for removing secretions from an obstructed endotracheal tube, if necessary, after insertion. Appropriate catheter sizes are listed in Table 5-2.
 - d. A tracheal aspirator can be attached to the endotracheal tube to directly suction meconium or thick secretions that obstruct the trachea. Some endotracheal tubes have an integrated suction port that can be attached directly to suction tubing and do not require use of a tracheal aspirator.
- 0 Prepare a PPV device with a mask to ventilate the baby, if necessary, between intubation attempts. Check the operation of the device as described in Lesson 4.
- 0 Place a CO₂ detector, stethoscope, measuring tape or insertion depth table, waterproof adhesive tape (1/2 or 3/4 inch) and scissors, or other tube-securing device within reach.

Table 5-2. Suction Catheter Size for Endotracheal Tubes of Various Inner Diameters

| Endotracheal Tube Size | Catheter Size |
|------------------------|---------------|
| 2.5 mm ID | 5F or 6F |
| 3.0 mm ID | 6F or 8F |
| 3.5 mm ID | 8F |

How should you position the newborn for intubation?

Place the baby's head in the midline, the neck slightly extended in the sniffing position, and the body straight. It may be helpful to place a small roll under the baby's shoulders to maintain slight neck extension. This position aligns the trachea for optimal viewing by allowing a straight line of sight into the glottis once the laryngoscope has been properly inserted. A team member should help to maintain good positioning throughout the procedure.

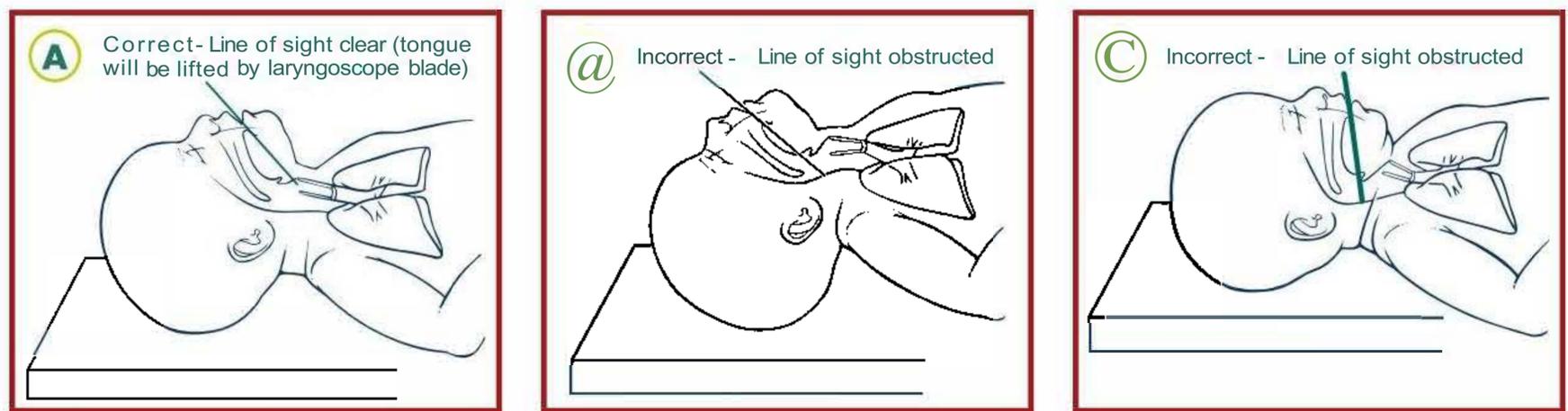


Figure 5.8. Correct (A) and incorrect (B and C) positioning for intubation

Both overextension and flexion of the neck will obstruct your view of the airway. If the shoulder roll is too large or the neck is overextended, the glottis will be raised above your line of sight. If the neck is flexed toward the chest, you will be viewing the posterior pharynx and will not be able to visualize the glottis (Figure 5.8).

Adjust the height of the bed, if possible, so that the baby's head is level with the operator's upper abdomen or lower chest to bring the head closer to the operator's eye level and improve the view of the airway.

How do you hold the laryngoscope?

Always hold the laryngoscope in your **left** hand with your thumb resting on the upper surface of the laryngoscope handle and the blade pointing away from you (Figure 5.9). The laryngoscope is designed to be held in the left hand by both right- and left-handed users. If held in the right hand, your view through the open, curved portion of the blade will be obstructed.



Figure 5.9. Hold the laryngoscope in your left hand.

How do you perform the intubation procedure?

The steps for endotracheal intubation are briefly described as follows; however, proficiency requires considerable supervision and practice. Even if you are not performing the procedure, it is helpful to understand the steps so you can effectively assist the operator.

Get ready to insert the laryngoscope.

- o) Correctly position the baby. If possible, adjust the height of the bed as needed. You may stabilize the baby's head with your right hand (Figure 5.10) while a team member ensures that the baby's whole body is lying straight and the head is in the sniffing position.
- f) Use your right index finger or thumb to gently open the baby's mouth.



Figure 5.10. Stabilize the baby's head with your right hand.



Figure 5.10. Positioning the baby for intubation

Insert the laryngoscope and identify key landmarks.

- 8 Insert the laryngoscope blade in the midline and gently slide it over the tongue through the oropharynx until the tip lies in the space between the base of the tongue and the epiglottis. This space is called the vallecula (Figure 5.11). In extremely preterm newborns,

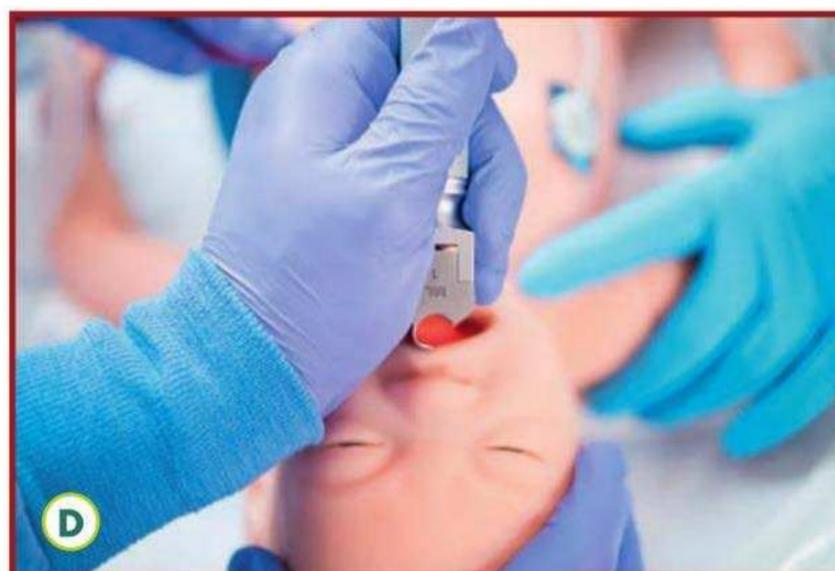
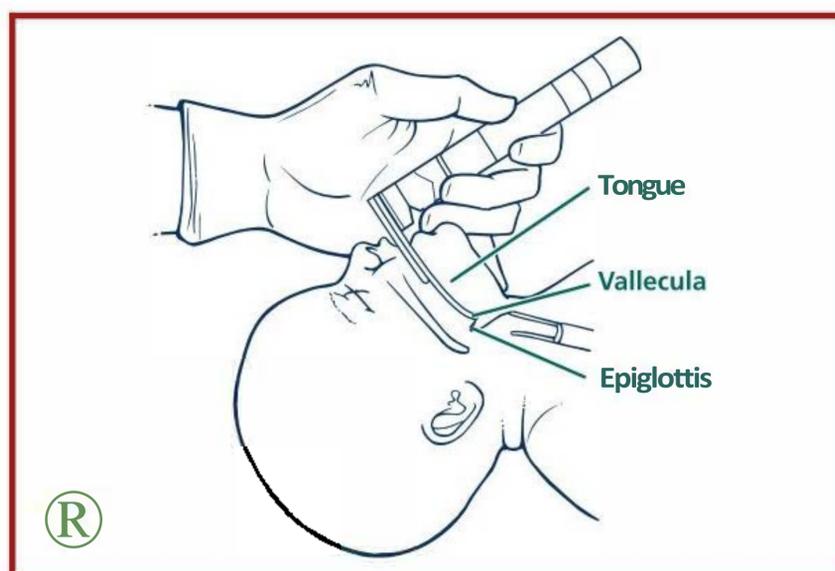
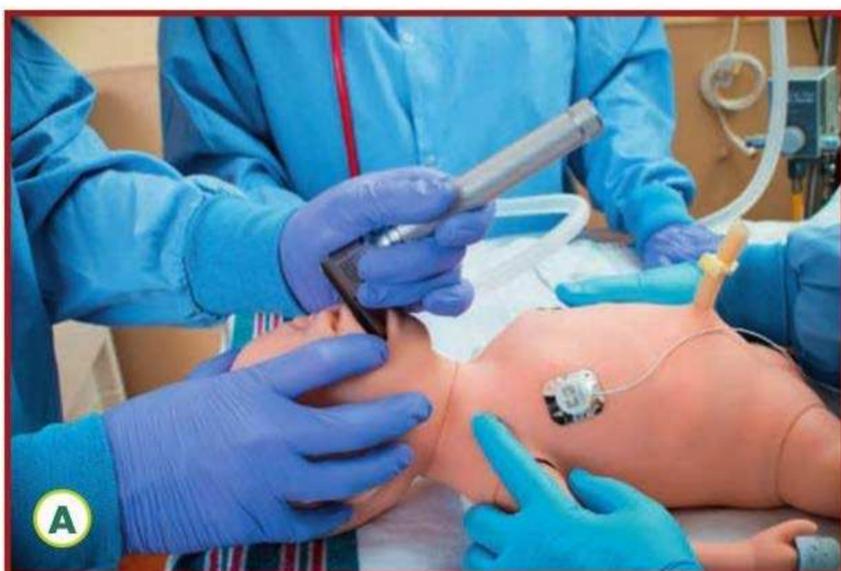


Figure 5.11. Insert the laryngoscope blade in the midline (A) and advance until the tip lies in the vallecula (B). Hold the laryngoscope in the midline (C) to identify landmarks through the open, curved portion of the laryngoscope blade (D).

the vallecula may be very small and you may need to gently place the laryngoscope tip directly under the epiglottis.

- 9 Lift the entire laryngoscope in the direction that the handle is pointing, opening the mouth and moving the tongue out of the way to expose the glottis. You may need to tilt the tip of the blade very slightly to lift the epiglottis and see the glottis and vocal cords.

When first learning the procedure, operators tend to bend their wrist, pulling the top of the handle toward themselves in a "rocking" motion against the baby's upper gum. This will not produce the desired view and may injure the baby's lips and gums (Figure 5.12).

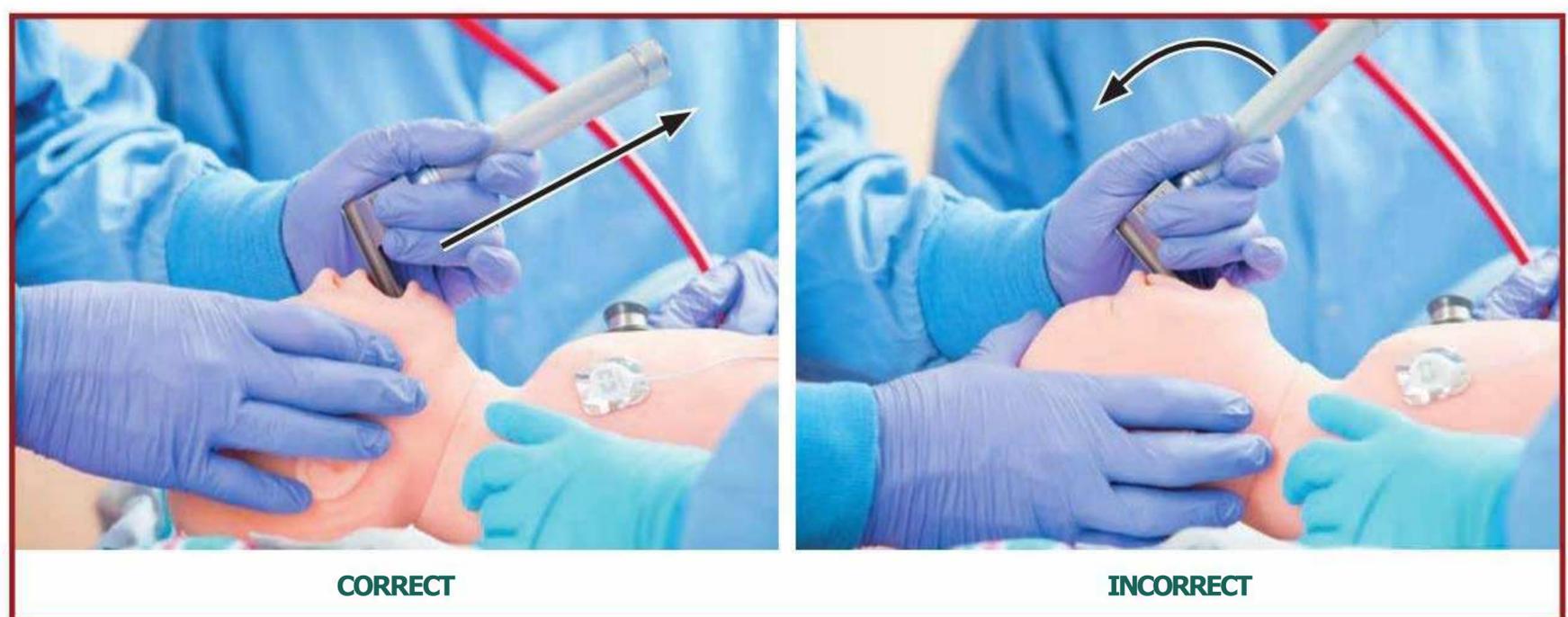


Figure 5.12. Correct (left) and incorrect (right) method for lifting the laryngoscope to expose the larynx. Lift the laryngoscope in the direction that the handle is pointed; do not rotate or "rock" the handle against the baby's upper gum.

Note: This lesson describes placing the tip of the blade in the vallecula to lift the epiglottis. In some cases, where the vallecula is small or the epiglottis is large and floppy, it may be necessary to use the blade tip to *gently* lift the epiglottis directly.

- 0 The vocal cords and glottis appear at the very top of your view as you look down the laryngoscope. An assistant can help bring the glottis into view by using their thumb and first finger to provide gentle pressure on the baby's thyroid and cricoid cartilage (Figure 5.13). They should direct the pressure downward and toward the baby's right ear.
- 0 Identify the key landmarks (Figure 5.14). If the tip of the blade is correctly positioned in the vallecula, you should see the epiglottis hanging

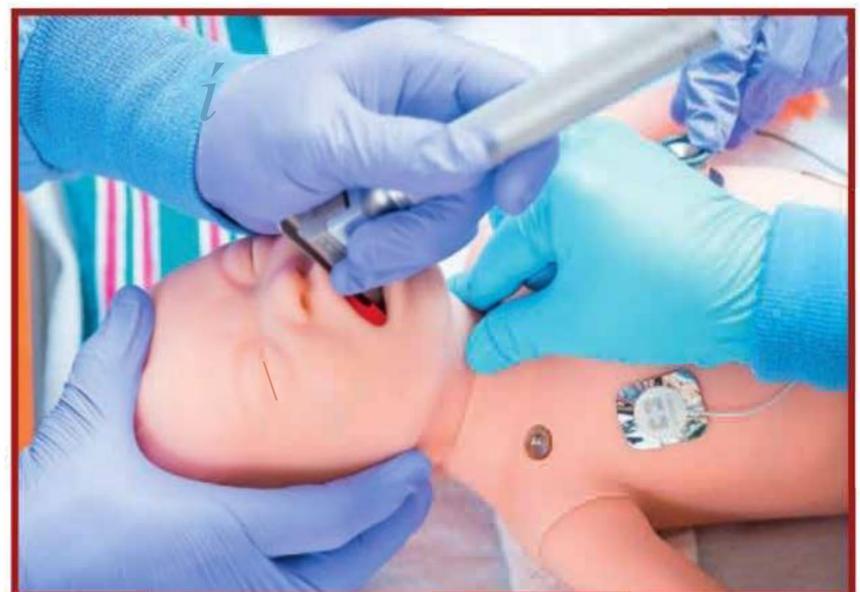


Figure 5.13. Thyroid and cricoid pressure provided by an assistant may improve visualization of the vocal cords and glottis. Press downward and toward the baby's right ear.

down from the top and the vocal cords directly below. The vocal cords appear as thin vertical stripes in the shape of an inverted letter «y»

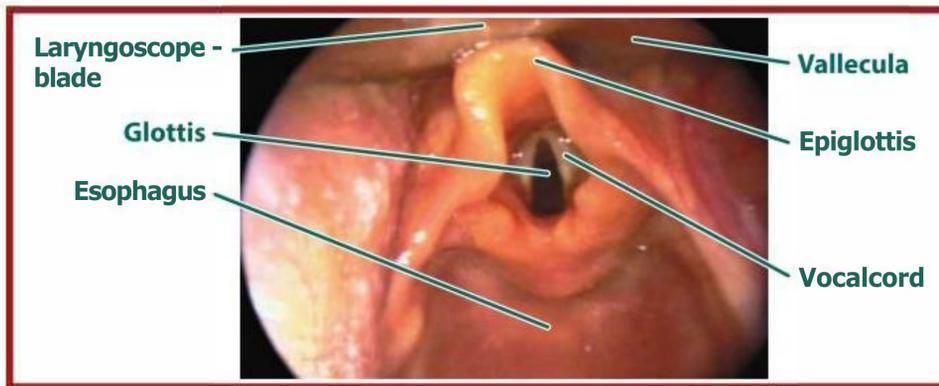
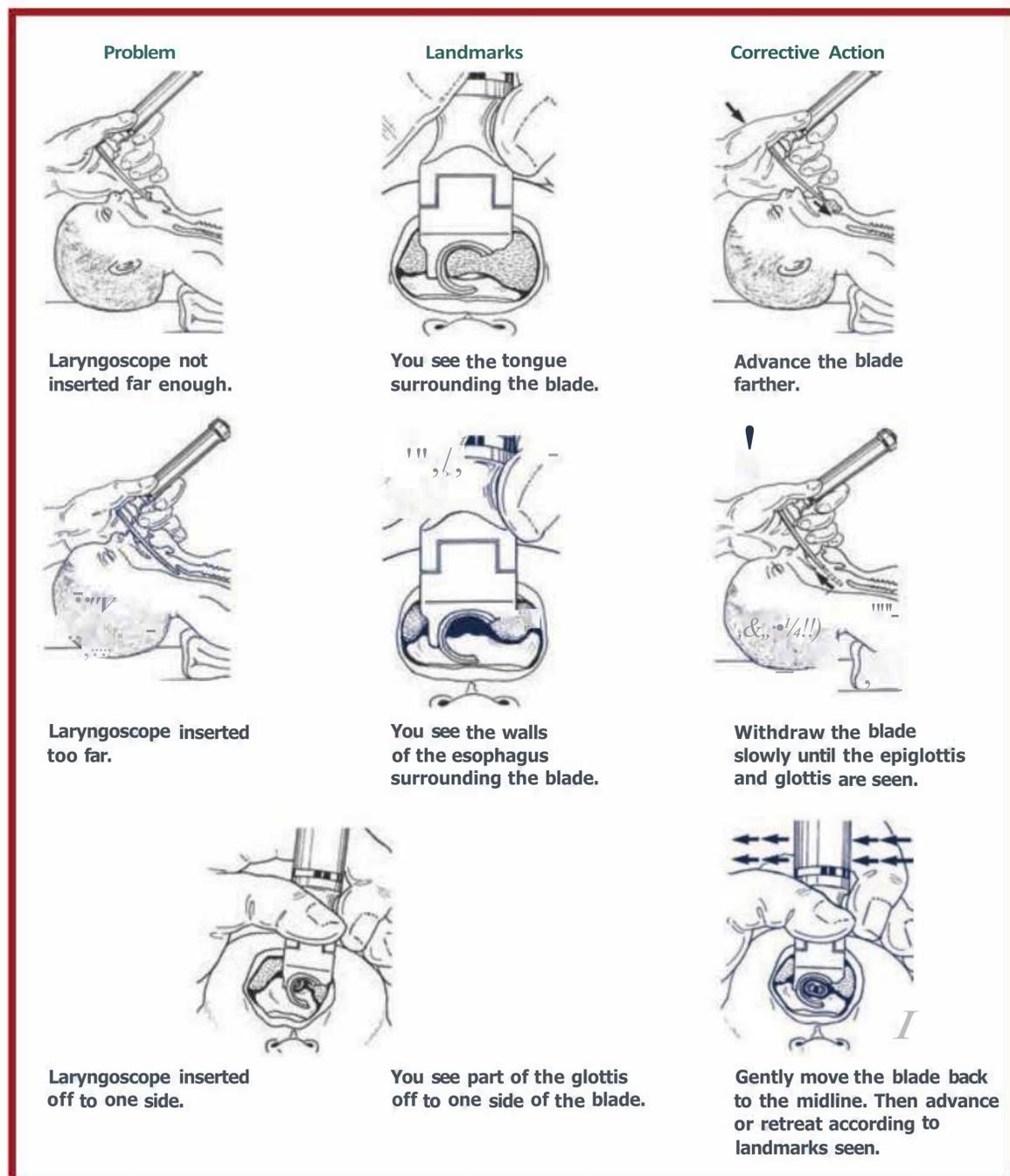


Figure 5.14. Key landmarks. The baby is lying supine. The laryngoscope blade is at the top of the photo, holding the tongue up and out of the way.

If these structures are not immediately visible, adjust the blade until the structures come into view. You may need to insert or withdraw the blade slowly to see the vocal cords (Figure 5.15).

Figure 5.15. Corrective actions for poor visualization of landmarks during laryngoscopy



If the blade is not inserted far enough, you will see the base of the tongue and posterior pharynx (Figure 5.16). Advance the blade slightly until the epiglottis comes into view.

If the blade is inserted too far, you will see only the esophagus (Figure 5.17) and will need to withdraw the blade slightly until the epiglottis drops down from above.



Figure 5.16. Laryngoscope not inserted far enough. Tongue and posterior pharynx obscure view.



Figure 5.17. Laryngoscope inserted too far. Only the esophagus is visible.



Figure 5.18. Suctioning secretions during laryngoscopy

If the anatomic landmarks are obstructed by secretions, use a size 10F or 12F catheter to remove secretions from the mouth and pharynx (Figure 5.18).

Insert the endotracheal tube.

- Once you have identified the vocal cords, hold the laryngoscope steady and maintain your view of the vocal cords, while an assistant places the endotracheal tube in your right hand. Insert the tube into the right side of the baby's mouth, outside the blade, with the concave curve in the horizontal plane (Figure 5.19). Do not insert the tube through the laryngoscope's open channel. This will obstruct your view of the vocal cords.

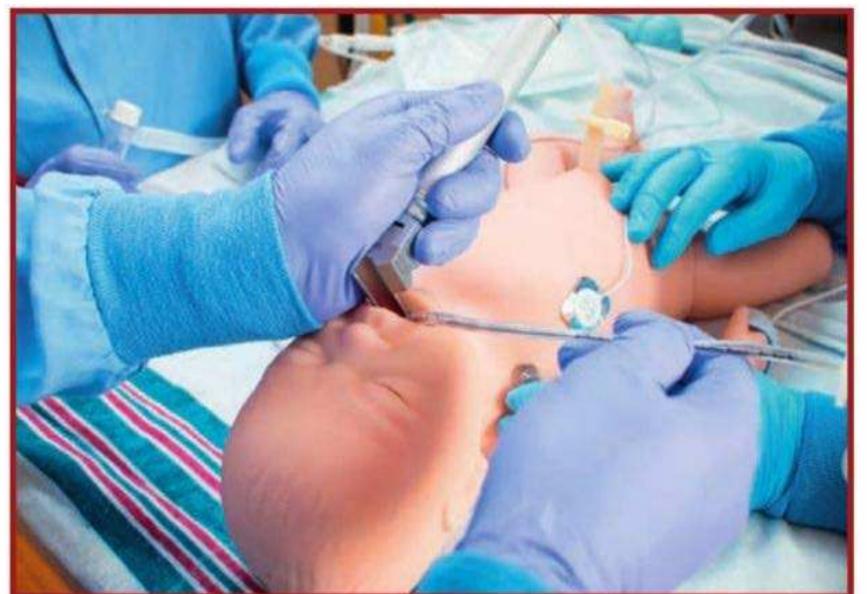


Figure 5.19. Insertion of the endotracheal tube into the right side of the mouth

Pass the tube along the right side of the baby's mouth toward the vocal cords. As the tip approaches the vocal cords, rotate the tube's curvature into the vertical plane so the tip is directed upward. When the vocal cords open, insert the tube until the vocal cords are positioned between the marked guide lines on the tube. If your assistant is providing gentle thyroid and cricoid pressure, they may feel the tube pass beneath their fingers. Note the centimeter depth marking on the outside of the tube that aligns with the baby's upper lip.

If the vocal cords are closed, wait for them to open. Do not touch the closed cords with the tip of the tube and never try to force the tube

between closed cords. If the cords do not open within 30 seconds, stop and resume ventilation with a mask until you are prepared to reattempt insertion.

Secure the endotracheal tube.

- 0 Use your right index finger to hold the tube securely against the baby's hard palate. *Carefully remove the laryngoscope* without displacing the tube (Figure 5.20). If a stylet was used, an assistant should remove it from the endotracheal tube-being sure that you are holding the tube in place (Figure 5.21). Although it is important to hold the tube firmly, be careful not to squeeze the tube so tightly that the stylet cannot be removed.



Figure 5.20. Stabilize the tube against the baby's palate or cheek while carefully removing the laryngoscope.



Figure 5.21. An assistant removes the optional stylet while the operator holds the tube in place.

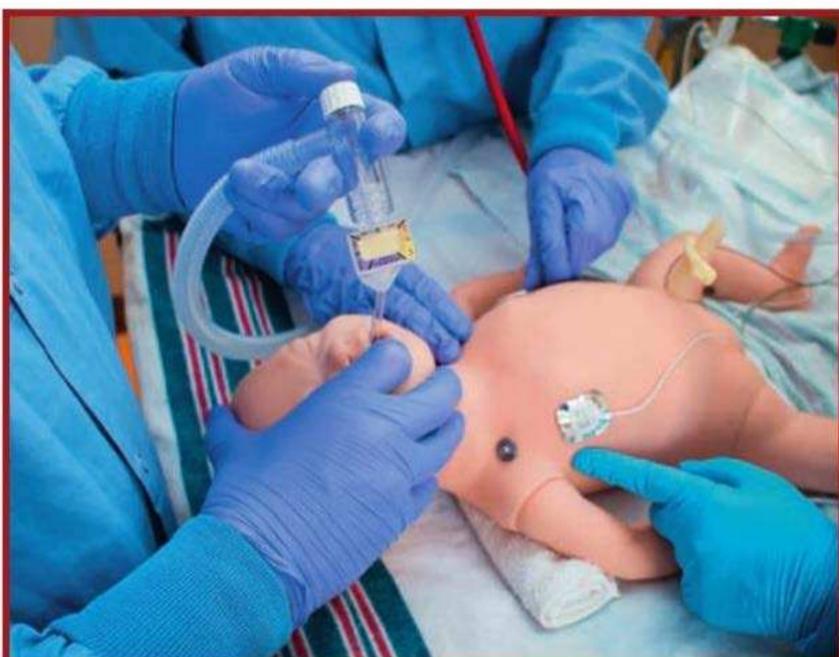


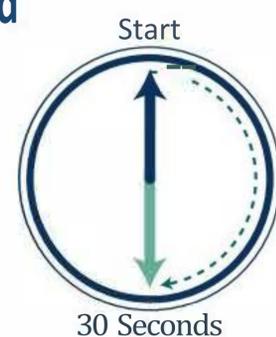
Figure 5.22. Attach a CO₂ detector and PPV device to the endotracheal tube and begin ventilation. Note the secure hand position used to hold the endotracheal tube in place.

Ventilate through the endotracheal tube.

- 0 An assistant should attach a CO₂ detector and PPV device to the endotracheal tube (Figure 5.22). Having the same person hold the endotracheal tube and the PPV device may help to avoid accidental extubation. Once the PPV device is attached, begin ventilation through the tube.

How much time should be allowed for an intubation attempt?

The steps of intubation should be completed within approximately **30 seconds**. Effective teamwork is required to perform this procedure



quickly. The baby is not being ventilated during the procedure, so rapid action is essential. If the baby's vital signs worsen during the procedure (severe bradycardia or decreased oxygen saturation), it is usually preferable to stop, resume PPV with a mask, and then try again.

Repeated attempts at intubation are not advised because you will increase the likelihood of soft-tissue trauma and make subsequent airway management more difficult. If the initial attempts are unsuccessful, evaluate other options, including using a video laryngoscope if available, requesting assistance from another provider with intubation expertise (eg, anesthesiologist, emergency department physician, respiratory care practitioner, neonatal nurse practitioner, physician's assistant), inserting a laryngeal mask, or continuing face-mask ventilation.

How do you confirm that the endotracheal tube is in the trachea?

The primary methods of confirming endotracheal tube insertion within the trachea are detecting exhaled CO_2 and a rapidly rising heart rate. As soon as you insert the endotracheal tube, connect a CO_2 detector (Figure 5.22) and confirm the presence of CO_2 during exhalation. If the tube is correctly inserted and you are providing effective ventilation through the tube, you should detect exhaled CO_2 within 8 to 10 positive-pressure breaths.

There are 2 types of CO_2 detectors available. Colorimetric devices change color in the presence of CO_2 (Figure 5.23). These are the most commonly used devices in the delivery room. Capnographs are electronic monitors that display the CO_2 concentration with each breath.

Can the tube be in the trachea even though O_2 is NOT detected?

Yes, there are limitations to the use of CO_2 detectors. If the tube is inserted in the trachea, but the lungs are not adequately ventilated, there may not be enough exhaled CO_2 to be detected. This may occur if the endotracheal tube or trachea are obstructed by secretions, you are not using enough ventilating pressure, or there are large bilateral pneumothoraces and the lungs are collapsed. In addition, babies with a very low heart rate or decreased cardiac function (low cardiac output) may not carry enough CO_2 to their lungs to be detected.

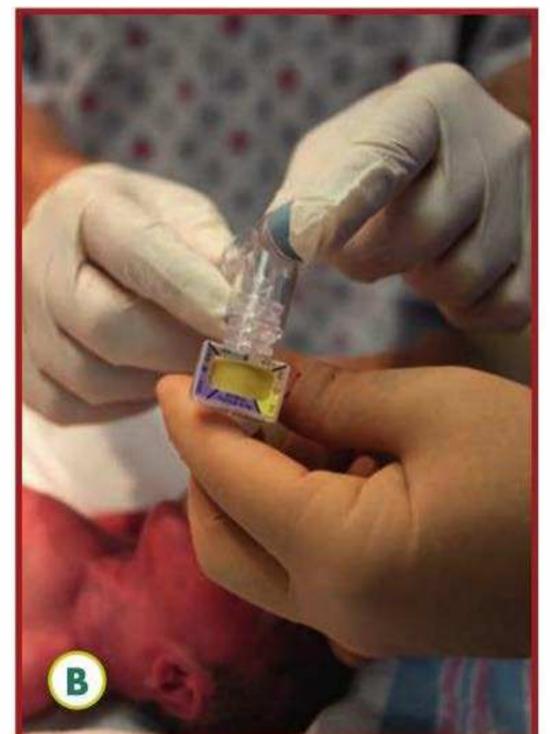


Figure 5.23. The colorimetric CO_2 detector is purple or blue before detecting exhaled CO_2 (A). The detector turns yellow in the presence of exhaled CO_2 (B).

Can the O_2 detector change color when the tube is NOT in the trachea?

Although uncommon, it is possible for a colorimetric CO_2 device to change color even though the tube is not in the trachea (Table 5-3). If the detector has already changed color in the package and is yellow when you remove it, the device is defective and should not be used. If epinephrine, surfactant, or atropine are administered through the endotracheal tube and touch the paper inside the CO_2 detector, or if gastric secretions touch the paper, they may permanently change the screen yellow and make the detector unusable.

Table 5-3. Colorimetric CO_2 Detector Problems

| False Negative (Tube IS IN trachea but NO color change) | False Positive (Tube IS NOT in trachea but color changes) |
|---|---|
| <ul style="list-style-type: none"> • Inadequate ventilating pressure • Collapsed lungs • Bilateral pneumothoraces • Very low heart rate • Low cardiac output • Obstructed endotracheal tube | <ul style="list-style-type: none"> • Defective device changed color in package before use • Epinephrine, surfactant, atropine, or gastric secretion contamination |

What are other indicators that the tube is in the trachea?

Demonstrating *exhaled CO_2* and observing a *rapidly increasing heart rate* are the *primary methods* of confirming endotracheal tube insertion within the trachea.

If the tube is positioned correctly, you should also observe

- Audible and equal breath sounds near both axillae during PPV
- Symmetrical chest movement with each breath
- Little or no air leak from the mouth during PPV
- Decreased or absent air entry over the stomach

Be cautious when interpreting breath sounds in newborns because sounds are easily transmitted. When listening to breath sounds, use a small stethoscope and place it near the axilla. A large stethoscope, or one placed near the center of the chest, may transmit sounds from the esophagus or stomach.

What if you suspect that the tube is not in the trachea?

The tube is not likely to be in the trachea if the CO_2 detector does not show the presence of exhaled CO_2 within 8 to 10 breaths. An endotracheal tube inserted in the esophagus provides no ventilation to the baby's lungs, and continuing to use it only delays effective ventilation. In most cases, you should remove the tube, resume ventilation with a face mask, ensure that your equipment is properly prepared, ensure that the baby is optimally positioned, and repeat the procedure using a clean tube.

Remember that babies with a very low heart rate or decreased cardiac function may not carry enough CO_2 to their lungs to change the color on the CO_2 detector. If you believe that the tube is correctly inserted in the trachea despite the lack of exhaled CO_2 , you may choose to stabilize the tube, reinsert the laryngoscope, and attempt to confirm that the tube is passing between the vocal cords. This "second look" procedure can be difficult and may delay establishing effective ventilation if the tube is not correctly inserted. If the tube position is confirmed and the baby's heart rate does not improve with ventilation through the endotracheal tube, chest compressions are indicated. Once cardiac output is improved, CO_2 will be detected.

How deeply should the tube be inserted in the trachea?

The goal is to insert the endotracheal tube tip in the middle portion of the trachea. This generally requires inserting the tube so that the tip is only 1 to 2 centimeters below the vocal cords. It is important not to insert the tube too far so that the tip touches the carina or enters a main bronchus. Two methods may be used for estimating the insertion depth. Your team should determine which method is preferred in your practice setting.

The nasal-tragus length (NTL) is a method that has been validated in both full-term and preterm newborns. The NTL method uses a calculation based on the distance (cm) from the baby's nasal septum to the ear tragus (Figure 5.24). Use a measuring tape to measure the NTL. The estimated insertion depth (cm) is $\text{NTL} + 1 \text{ cm}$. Insert the endotracheal tube so that the marking on the tube corresponding to the estimated insertion depth is adjacent to the baby's lip.





Figure 5.24. Measuring the NTL. Measure from the middle of the nasal septum (arrow, A) to the ear tragus (arrow, B) and add 1 cm to the measurement.

Studies have shown that gestational age is also an accurate predictor of the correct insertion depth (Table 5-4) and has the advantage of being known before birth. This table could be placed near the radiant warmer or with your intubation supplies.

Table 5-4. Initial Endotracheal Tube Insertion Depth ("Tip to Lip") for Orotracheal Intubation

| Gestation | Endotracheal Tube Insertion Depth at Lips | Baby's Weight |
|-------------|---|---------------|
| 23-24 weeks | 5.5 cm | 0.5-0.6 kg |
| 25-26 weeks | 6.0 cm | 0.7-0.8 kg |
| 27-29 weeks | 6.5 cm | 0.9-1 kg |
| 30-32 weeks | 7.0 cm | 1.1-1.4 kg |
| 33-34 weeks | 7.5 cm | 1.5-1.8kg |
| 35-37 weeks | 8.0 cm | 1.9-2.4 kg |
| 38-40 weeks | 8.5 cm | 2.5-3.1 kg |
| 41-43 weeks | 9.0 cm | 3.2-4.2 kg |

Adapted from Kempley ST, Moreiras JW, Petrone FL. Endotracheal tube length for neonatal intubation. *Resuscitation*. 2008 ;77(3):369-373.

Remember that both of these methods are estimates of the correct endotracheal tube depth. After inserting the tube, use a stethoscope to listen for breath sounds in both axillae and over the stomach (Figure 5.25).

- If the tube is correctly positioned, the breath sounds should be equal on both sides.
- If the tube is in too far, the breath sounds may be decreased on one side.
 - Most often, if the tube is inserted too far, it will enter the right mainstem bronchus causing breath sounds to be louder on the right side and quieter on the left side. Slowly withdraw the tube while listening to the breath sounds on the quieter side.
 - When the tube is correctly positioned, the breath sounds should improve and become equal.



Figure 5.25. Listen for equal breath sounds in both axillae (A). Breath sounds should not be audible over the stomach (B).

If you plan to keep the tube in place, how do you secure it?

Several methods of securing the tube have been described. Either water-resistant tape or a device specifically designed to secure an endotracheal tube may be used.

One method is described as follows:

- o After you have correctly positioned the tube, note the centimeter marking on the side of the tube adjacent to the baby's upper lip (Figure 5.26).
- f) Cut a piece of 3/4- or 1/2-inch tape so that it is long enough to extend from one side of the baby's mouth, across the upper lip, and about 2 cm onto the opposite cheek (Figure 5.27).
- 8 Split the tape along half its length so that it appears like a pair of pants (Figure 5.27A).
- 8 Place the uncut section of tape on the baby's cheek so that the beginning of the split is close to the corner of the baby's mouth. Place the upper «leg» of tape across the baby's upper lip (Figure 5.27B).
- o Carefully wrap the lower «leg» around the tube (Figures 5.27C and 5.27D). Be sure that the desired centimeter marking remains next to the baby's upper lip. It is easy to inadvertently push the tube in farther than desired during the taping procedure.

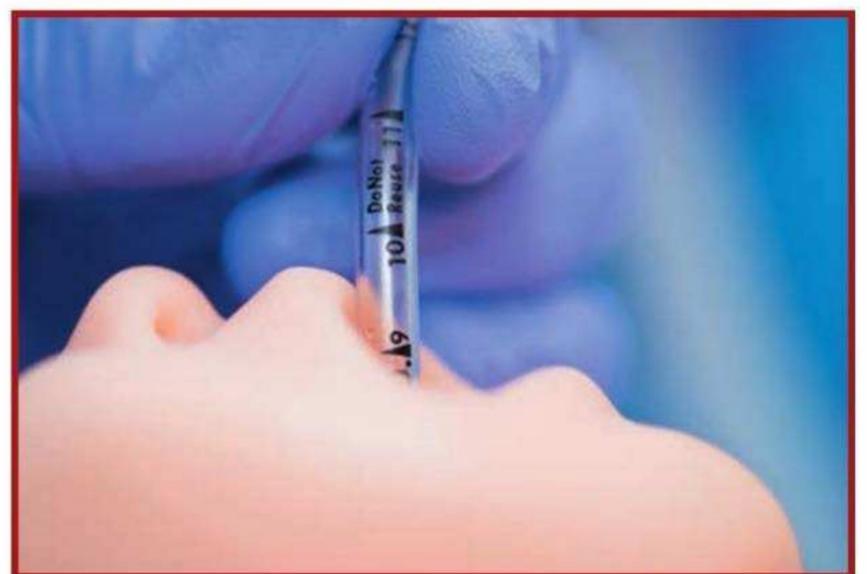


Figure 5.26. Note the marking adjacent to the upper lip.

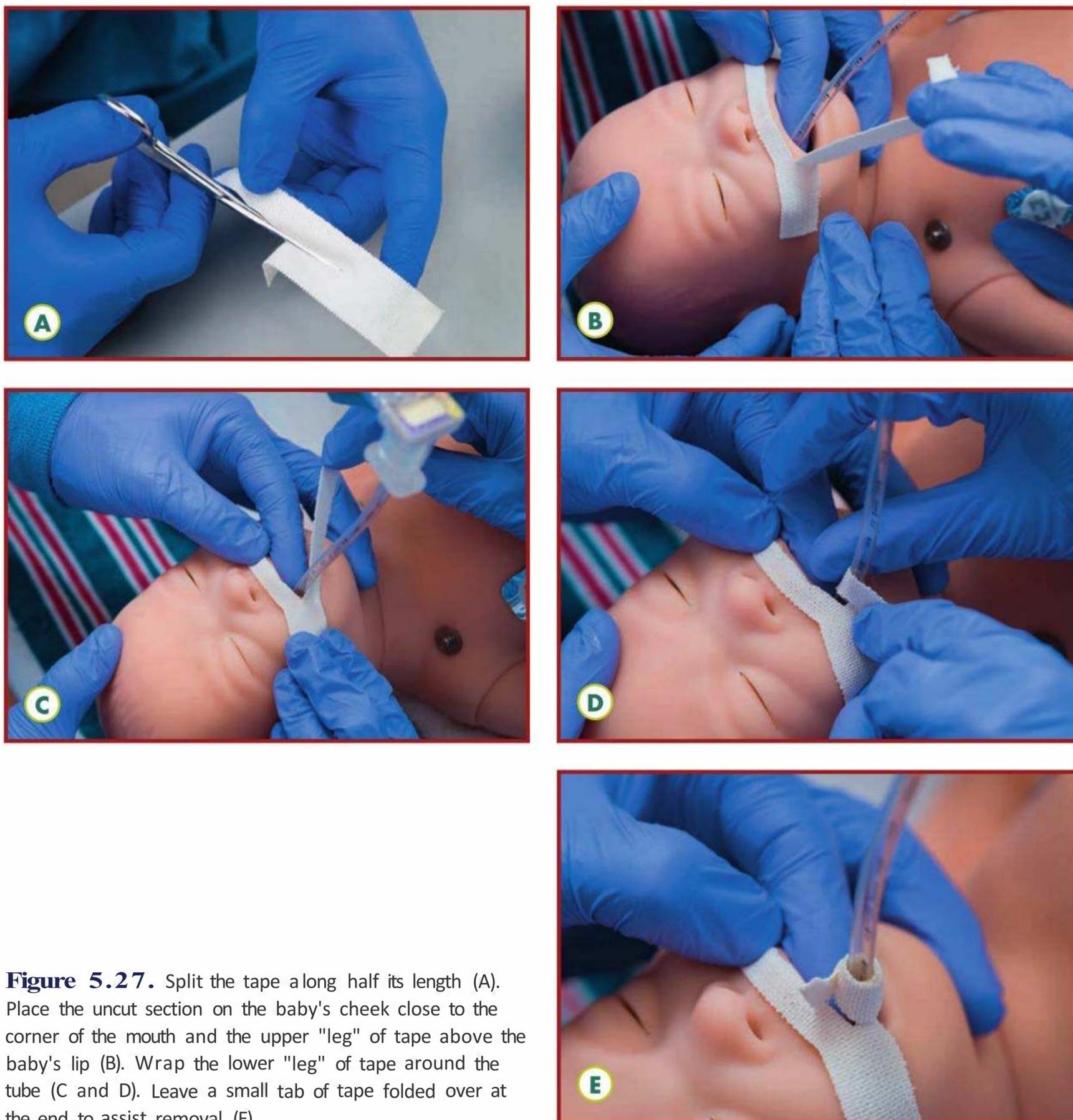


Figure 5.27. Split the tape along half its length (A). Place the uncut section on the baby's cheek close to the corner of the mouth and the upper "leg" of tape above the baby's lip (B). Wrap the lower "leg" of tape around the tube (C and D). Leave a small tab of tape folded over at the end to assist removal (E).

- o At the end, turn the tape onto itself to leave a small "tab" that you can hold to unwind the tape when you want to adjust the insertion depth or remove the tube (Figure 5.27E).
- fj Listen with a stethoscope over both sides of the chest to be sure the tube has not been displaced. Assess color change on the CO₂ detector and rise and fall of the chest with each assisted breath.
- o If the tube will be left in place beyond the initial resuscitation, obtain a chest x-ray for final placement confirmation.

The tip of the tube should appear in the mid-trachea *adjacent to the first or second thoracic vertebra* (Figure 5.28). The tip should be above the carina, which is generally adjacent to the third or fourth thoracic vertebra. Avoid using the clavicles as a landmark because their location varies depending upon the baby's position and the angle that the x-ray is taken. If the tube advanced too far, it may touch the carina or enter the right main bronchus and cause the right upper lobe or left lung to collapse (Figure 5.29).

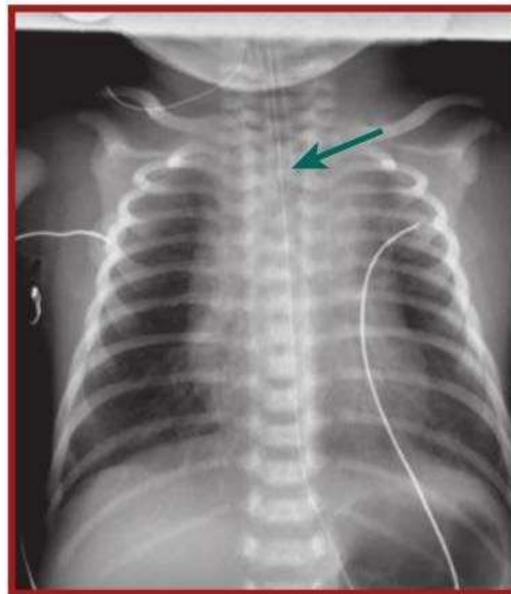


Figure 5.28. Correct placement. The tip of the endotracheal tube is adjacent to the second thoracic vertebra.



Figure 5.29. Incorrect placement. The tip of the endotracheal tube is inserted too far. It is touching the carina, approaching the right mainstem bronchus, and the left lung is collapsed.

What can an assistant do to help the operator during the intubation procedure?

Effective teamwork is required to complete the intubation procedure quickly and efficiently. A skilled assistant can perform multiple steps that improve teamwork, shorten the duration of the intubation procedure, and increase the likelihood of first-attempt success.

- Check that the laryngoscope is working.
- f) Check that suction is set at 80 to 100 mm Hg.
- E) Prepare the tape or tube-securing device.
- 8 Attach chest leads and begin cardiac monitoring if not already done.
- Ensure that the correct-sized laryngoscope blade and endotracheal tube are selected based on the newborn's expected gestational age or weight.
- Communicate with the operator about what method will be used to estimate the endotracheal tube insertion depth—the NTL or the estimated insertion depth table.
- Check that the stylet, if used, does not protrude beyond the tube's side or end hole.
- Ensure that the newborn and bed are correctly positioned before starting the procedure and maintained in the correct position throughout the procedure.



- O Hold equipment and pass as directed so that the operator does not need to look away from anatomic landmarks to suction secretions or grasp the tube in preparation for insertion.
- E) Monitor the newborn's heart rate and alert the operator if the intubation attempt lasts longer than 30 seconds.
- 4D Provide thyroid and cricoid pressure as directed.
- O After endotracheal tube insertion, carefully remove the stylet and attach the CO₂ detector.
- O, Listen for increasing heart rate and assess CO₂ detector color change.
- 4D Check the tip-to-lip insertion depth.
- G, Listen for breath sounds in both axillae and assess chest movement with PPV.
- Assist with securing the tube.

How do you use an endotracheal tube to suction thick secretions from the trachea?

If a baby's condition has not improved and you have not been able to achieve chest movement despite all the ventilation corrective steps and a properly inserted endotracheal tube, there may be thick secretions obstructing the airway. Thick secretions may be from blood, cellular debris, vernix, or meconium. You may attempt to clear the airway using a suction catheter inserted through the endotracheal tube (Table 5-2).

If you cannot quickly clear the airway with the suction catheter, you may be able to clear the airway by applying suction directly to the endotracheal tube using a tracheal aspirator. Although this device is often called a meconium aspirator, it may be used for any thick secretions that are obstructing the airway.

Once the endotracheal tube has been inserted,

- O Connect a tracheal aspirator, attached to a suction source (80-100 mm Hg suction), directly to the endotracheal tube connector. Several types of tracheal aspirators are commercially available. Some endotracheal tubes have an integrated suction port.
- f) Occlude the suction-control port on the aspirator with your finger and gradually withdraw the tube over 3 to 5 seconds as you continue suctioning secretions in the trachea (Figure 5.30).
- E) Be prepared to resume face-mask PPV, insert a laryngeal mask, or re-intubate with a clean tube.

How many times should suctioning be repeated if thick secretions prevent you from achieving effective ventilation through an endotracheal tube?

If the airway is obstructed by secretions that have prevented you from achieving effective ventilation, you must repeat the procedure until you have cleared the airway sufficiently to intlate the lungs and achieve effective ventilation.

What problems should you consider if a baby's condition worsens after endotracheal intubation?

If a baby's condition suddenly worsens after intubation, the endotracheal tube may be inadvertently displaced. It may have been advanced too far into the airway or pulled back into the pharynx and outside the trachea. The tube may be obstructed by blood, meconium, or other thick secretions. The baby may have developed a tension pneumothorax that collapses the lungs and prevents gas exchange. Additional information about this complication is discussed in Lesson 10 (Special Considerations). Finally, the device used to provide PPV may have become disconnected from the endotracheal tube or compressed gas source, or it may have developed a leak.

The mnemonic "DOPE" can be used to help remember these potential problems (Table 5-5).

Focus on Teamwork

Inserting an endotracheal tube highlights several opportunities for effective teams to use the Neonatal Resuscitation Program® (NRP®) Key Behavioral Skills.



Figure 5.30. Suctioning thick secretions that obstruct ventilation using an endotracheal tube and tracheal aspirator

Table 5-5. Sudden Deterioration After Intubation

| The <i>DOPE</i> mnemonic | |
|--------------------------|------------------------------|
| D | Displaced endotracheal tube |
| O | Obstructed endotracheal tube |
| p | Pneumothorax |
| E | Equipment failure |

Adapted from Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: Pediatric advanced life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010; 122(18 Suppl):5876-5908.

| Behavior | Example |
|---------------------------------------|--|
| Call for additional help when needed. | If unanticipated intubation is required, you will likely need 3 or more health care providers to quickly perform all of the required tasks without delay. |
| Communicate effectively. | When preparing to insert an alternative airway, clearly and calmly request the desired supplies. |
| Maintain professional behavior. | Confirm the insertion depth with your team members before securing the tube. |
| Delegate workload optimally. | Determine which team member(s) will perform important tasks such as inserting the endotracheal tube, providing thyroid and cricoid pressure, monitoring the baby's heart rate, placing the CO ₂ detector, auscultating breath sounds, assisting with securing the tube, and documenting events. |
| Allocate attention wisely. | Maintain situation awareness. At all times, a team member needs to be monitoring the baby's condition, the number of insertion attempts, the duration of insertion attempts, and alerting the operators to any important changes (eg, heart rate, oxygen saturation). |

| Behavior | Example |
|--------------------------|--|
| Use available resources. | <p>If an alternative airway is needed, but initial intubation attempts are unsuccessful, do not make repeated intubation attempts. Use your other resources, such as another individual with intubation expertise, a laryngeal mask, or a video laryngoscope.</p> <p>Allow all team members to use their unique skills during the resuscitation process. For example, respiratory therapists may have valuable skills specific to intubation. Using the respiratory therapist's skills during intubation may allow another provider to focus attention on preparing equipment for vascular access and medications.</p> |

Quality Improvement Opportunities

Ask yourself the following questions and begin a discussion with your team if you find a difference between the NRP recommendations and what is currently done in your own hospital setting. Consider using the suggested process and outcome measures to guide your data collection, identify areas for improvement, and monitor if your improvement efforts are working.

Quality improvement questions

- o Who is responsible for checking and preparing intubation supplies and equipment before every birth?
- f) Who are the providers that have intubation skills in your delivery room setting?
- E) Is someone with intubation skills immediately accessible if needed?
- 8 How often do providers practice their intubation skills?
- o Do assistants know how to measure and secure an endotracheal tube?

Process and outcome measures

- o How often are newborns intubated in your delivery room setting?
- f) When intubation is required, how often is a skilled provider present at the time of birth?
- E) How often is intubation successful on the first attempt?
- 8 How often does intubation require more than 30 seconds?
- o How often do adverse events occur during intubation?

Frequently Asked Questions

Why should I insert an endotracheal tube before starting chest compressions? Does that just delay the initiation of chest compressions?

In most situations, this program recommends inserting an endotracheal tube prior to starting chest compressions to ensure maximum ventilation efficacy both before and after chest compressions begin. In many cases, the baby's heart rate will increase during the 30 seconds of ventilation following intubation and compressions will not be necessary.

Can the provider with intubation skills be on call outside the hospital or in a distant location?

No. A person with intubation skills should be in the hospital and available for immediate assistance if needed. If the need for intubation is anticipated, this person should be present in the delivery room at the time of birth. It is not sufficient to have someone on call at home or in a remote area of the hospital.

Should sedative premedication be used before intubation?

When emergency intubation is performed as part of resuscitation, there is generally insufficient time or vascular access to administer sedative premedication. This program focuses on resuscitation of the newly born baby and, therefore, the details of premedication are not included. Premedication is recommended for non-emergent intubation in the neonatal intensive care unit (NICU).

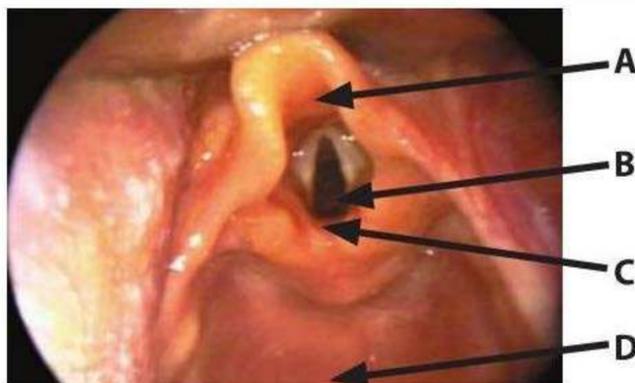
Can a video laryngoscope be useful for neonatal intubation?

Yes, a video laryngoscope may be a helpful device for training novice operators and for intubating a baby with a difficult airway. A video laryngoscope is a laryngoscope that has an integrated camera that displays a magnified view of the airway structures on a video screen. Several different types are available, including devices that are shaped like a traditional laryngoscope and others that have a more pronounced curve. When using a video laryngoscope, an instructor can watch the video screen and see what the trainee is seeing directly through the laryngoscope. This allows the instructor to give advice and feedback and confirm that the operator has inserted the tube into the glottis. Studies have shown that trainees have improved first-attempt intubation success when guided by an instructor using a video laryngoscope. Some video laryngoscopes have a recording function that can be used for debriefing after the procedure is completed. For

a newborn with a difficult airway, a video laryngoscope may allow the operator to see the airway structures more easily with less airway manipulation. Using a video laryngoscope does require training and practice, and the smallest blade on some video laryngoscopes is too large for very premature newborns.

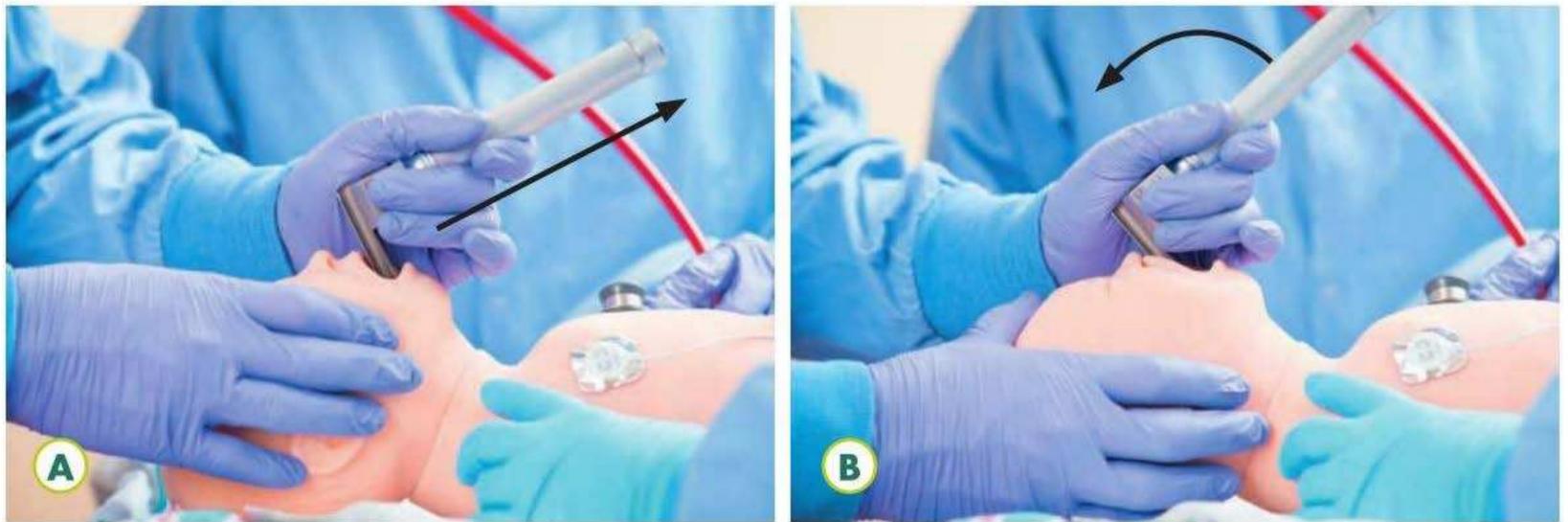
LESSON 5 REVIEW

1. A newborn has been receiving face-mask ventilation but is not improving. Despite performing the first 5 ventilation corrective steps, the heart rate is not rising and there is poor chest movement. An alternative airway, such as an endotracheal tube or a laryngeal mask, (should)/(should not) be inserted immediately.
2. For babies weighing less than 1 kg, the recommended endotracheal tube size is (2.5 mm)/(3.5 mm).
3. If using a stylet, the tip of the stylet (must)/(must not) extend beyond the endotracheal tube's side and end holes.
4. The preferred laryngoscope blade size for use in a term newborn is (No. 1)/(No. 0).
5. In the photograph, which arrow is pointing to the epiglottis?

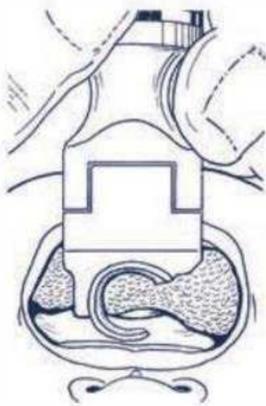


6. You should try to take no longer than (30)/(60) seconds to complete the endotracheal intubation procedure.
7. If a baby's condition worsens after endotracheal intubation, list 4 possible causes.
 1. _____, 2. _____, 3. _____, 4. _____

8. Which image shows the correct way to lift the tongue out of the way and expose the larynx?



9. You have inserted an endotracheal tube and are giving positive-pressure ventilation through it. The CO_2 detector does not change color and the baby's heart rate is decreasing. The tube is most likely inserted in the (esophagus)/(trachea).
10. The 2 most important indicators that the endotracheal tube has been inserted in the trachea are demonstrating exhaled _____ and observing a rapidly increasing _____.
11. You have inserted a laryngoscope and are attempting intubation. You see the view depicted in the following illustration. The correct action is to (advance the laryngoscope farther)/(withdraw the laryngoscope).



Answers

1. An alternative airway, such as an endotracheal tube or a laryngeal mask, should be inserted immediately.
2. For babies weighing less than 1 kg, the recommended endotracheal tube size is 2.5 mm.
3. The tip of the stylet must not extend beyond the endotracheal tube's side and end holes.
4. The preferred laryngoscope blade size for use in a term newborn is No. 1.
5. Arrow A is pointing to the epiglottis.
6. You should try to take no longer than 30 seconds to complete the endotracheal intubation procedure.
7. Possible causes include (1) displaced endotracheal tube, (2) obstructed endotracheal tube, (3) pneumothorax, (4) equipment failure.
8. Image A shows the correct way to lift the tongue out of the way and expose the larynx.
9. The tube is most likely inserted in the esophagus.
10. The 2 most important indicators that the endotracheal tube has been inserted in the trachea are demonstrating exhaled CO₂ (CO₂ detector changes to yellow) and observing a rapidly increasing heart rate.
11. The correct action is to advance the laryngoscope farther.

LESSON 5: PRACTICE SCENARIOS

Endotracheal Intubation

Learning Objectives

- 0 Identify the newborn that requires endotracheal intubation.
- f.) Demonstrate preparation for intubation, including choosing the correct-sized tube for the newborn's estimated weight.
- 8 Demonstrate correct technique for inserting an endotracheal tube (operator).
- 8 Demonstrate the role of the assistant during intubation.
- 0 Demonstrate strategies to determine if the endotracheal tube is in the trachea, including increasing heart rate, color change of carbon dioxide (CO₂) detector, bilateral breath sounds, and chest movement with positive-pressure ventilation (PPV).
- 0 Demonstrate how to use a tracheal aspirator to suction thick secretions from the trachea.
- 0 List pertinent Neonatal Resuscitation Program (NRP) Key Behavioral Skills related to successful endotracheal intubation.

These Practice Scenarios are for review/practice and evaluation.

This is the suggested Practice Scenario sequence.

- 0 **Review the Knowledge Check Questions** with your NRP instructor.
 - a. What are the indications for endotracheal intubation during resuscitation?
 - b. How do you determine what size endotracheal tube should be used for various gestational ages and weights?
 - c. What 2 strategies can be used to determine depth of insertion of the endotracheal tube?
 - d. What are the primary indicators that determine correct insertion of the endotracheal tube? What additional indicators can be used?

- e. What is the role of the assistant during intubation?
 - f. What are indications for an obstructed airway and what is the recommended intervention?
- f.) **Practice/review these skills** with your NRP instructor.
- a. Locate and assemble the supplies and equipment needed for intubation, including the cognitive aids available to help you, such as the endotracheal tube size chart for babies of various ages and weights and the chart of initial endotracheal tube insertion depth, if used.
 - b. Practice or assist with the steps of intubation, including PPV delivery and assessing proper insertion of the endotracheal tube in the trachea.
 - c. Practice your unit's method for securing the endotracheal tube in the delivery room.
 - d. Practice using a suction catheter and/or tracheal aspirator in case thick secretions obstruct the airway.
- Q **Practice the scenario(s) as the individual who intubates the newborn or as the assistant** until you need little or no assistance or coaching.
- O **Pass the Lesson 5 Practice Scenario evaluation** by leading practice scenario(s) and performing intubation as the operator or the assistant.
- O When you can lead the scenario(s) and perform the skills with little or no instructor coaching, you may proceed to the next lesson's practice scenario.

Practice Scenarios

Two scenario options are offered. The number of people attending the birth scenarios and their qualifications are determined by the instructor and based on hospital policy.

- O Term newborn with risk factors requires endotracheal intubation
- f.) Newborn of 37 weeks' gestation with risk factors requires intubation and tracheal aspiration for suspected airway obstruction

Option 1: Term newborn with risk factors requires endotracheal intubation

"You are called to attend a birth complicated by a Category III fetal heart rate pattern. The laboring mother is a 28-year-old primigravida at 39 weeks' gestation. Demonstrate how you would prepare for the birth of this baby. As you work, say your thoughts and actions aloud so I will know what you are thinking and doing."

| Critical Performance Steps | |
|---|---|
| Assess perinatal risk. | |
| Assesses perinatal risk (learner asks 4 pre-birth questions and the instructor ["OB provider", responds) | |
| Gestational age? | "39 weeks' gestation." |
| Clear fluid? | "Amniotic fluid is clear." |
| Additional risk factors? | "Mom has a fever." |
| Umbilical cord management plan? "I will delay cord clamping. If the baby is not crying, I'll take a moment to stimulate the baby. If there's no response, I'll clamp and cut the cord." | |
| Assemble team. | |
| Assembles team based on perinatal risk factors. If risk factors are present, at least 2 qualified people should be present solely to manage the baby. The number of team members and qualifications vary depending on risk. | |
| Perform a pre-resuscitation briefing: | |
| Identifies team leader. Assesses risk factors, delegates tasks, identifies who will document events, determines supplies and equipment needed, knows how to call for additional help. | |
| Perform equipment check (includes checking supplies and equipment for intubation). | |
| "The baby has been born." | |
| Rapid evaluation. | |
| Asks 3 rapid evaluation questions: | |
| • Term? | "Appears term." |
| • Muscle tone? | "No tone." |
| • Breathing or crying? | "No breathing." |
| Initial steps at radiant warmer. | |
| Receives baby at radiant warmer, dries and removes linen, stimulates briefly by rubbing the baby's back, positions airway, suctions mouth and nose | |
| Assess breathing. If breathing, assess heart rate. | |
| Is the baby breathing? | "No." (Heart rate per auscultation = 40 bpm, if assessed) |
| Indicates need for PPV | |
| Begin PPV within 60 seconds of birth. | |
| Positions head in sniffing position | |
| Applies mask correctly | |
| Starts PPV in 21 % oxygen (room air) at 20 to 25 cm H ₂ O (positive end-expiratory pressure [PEEP] of 5 cm H ₂ O if using T-piece resuscitator, flow-inflating bag, or self-inflating bag with PEEP valve); rate 40 to 60 breaths/min | |
| Requests pulse oximeter sensor placement on baby's right hand or wrist | |

| Critical Performance Steps (cont) | |
|--|---|
| Requests cardiac monitor (optional at this time) | |
| Within 15 seconds of beginning PPV, learner asks assistant to state heart rate and if it is increasing. Heart rate = 40 bpm and not increasing "Pulse oximeter has no signal." Asks assistant to assess chest movement "No chest movement." | |
| Perform ventilation corrective steps (MR. SOPA). | |
| Performs M and R, S and O, and P steps; assesses for increasing heart rate and chest movement after PPV following each step Heart rate= 40 bpm and not increasing. "No chest movement." "Pulse oximeter has no signal." Places cardiac monitor leads and connect to monitor in anticipation of intubation (if not already done). | |
| Preparation for intubation. (Most of these tasks are included in the pre-birth equipment check.) | |
| Operator (Intubator) | Operator's Assistant |
| Prepares for intubation <ul style="list-style-type: none"> • Requests correct-sized tube • Requests correct-sized laryngoscope blade • Communicates preference for stylet usage | <ul style="list-style-type: none"> • Ensures suction set at 80 to 100 mm Hg • Selects correct-sized tube • Chooses correct laryngoscope blade (size I [term], size O [preterm]) • Checks laryngoscope light • Inserts stylet correctly (<i>stylet optional</i>) • Obtains CO₂ detector • Prepares tape or tube-securing device |
| Intubating the newborn. | |
| Operator (Intubator) | Operator's Assistant |
| <ul style="list-style-type: none"> • Holds laryngoscope correctly in left hand • Opens baby's mouth with finger and inserts blade to base of tongue • Lifts blade correctly (no rocking motion) • Requests cricoid pressure if needed • Identifies landmarks, takes corrective action to visualize glottis if needed • Inserts tube from right side, not down center of laryngoscope blade • Aligns vocal cord guide with vocal cords • Removes laryngoscope then removes stylet while firmly holding tube against baby's palate • Holds tube against baby's palate | <ul style="list-style-type: none"> • Positions newborn's head in sniffing position, body straight, table at correct height for operator • Monitors heart rate and announces if attempt lasts longer than 30 seconds • Applies cricoid pressure if requested • Hands endotracheal tube to operator • Removes stylet (if used) • Connects CO₂ detector and PPV device to endotracheal tube • Hands PPV device to operator |
| Positive-pressure ventilation and confirming endotracheal tube insertion. | |
| <ul style="list-style-type: none"> • Administers PPV • Observes for symmetrical chest movement | <ul style="list-style-type: none"> • Auscultates for increasing heart rate and assesses CO₂ detector color change • Listens for bilateral breath sounds, notes symmetrical chest movement with PPV, and reports findings |

| Critical Performance Steps (cont) | |
|-----------------------------------|---|
| | <p>If endotracheal tube is <u>not</u> successfully inserted, "Color is not changing on the CO₂ detector. The chest is not moving." Heart rate = 60 bpm and not increasing</p> <ul style="list-style-type: none"> • Removes endotracheal tube • Resumes PPV by face mask • Repeats intubation attempt or indicates need for laryngeal mask |
| | <p>If endotracheal tube successfully inserted, "Color is changing on the CO₂ detector." Heart rate slowly increases to about 70 bpm.</p> <ul style="list-style-type: none"> • Operator continues PPV x 30 seconds • Assistant checks tip-to-lip depth using gestational age/weight table or nasal-tragus length (NTL) measurement. <ul style="list-style-type: none"> - If using NTL, measures distance from the nasal septum to the ear tragus (insertion depth [cm]= NTL + 1 cm) • Assistant secures endotracheal tube |
| Vital signs. | |
| | <p>Checks heart rate after 30 seconds of PPV through endotracheal tube "Baby is apneic. Pulse oximeter has a signal now." Heart rate = 70 bpm and increasing SpO₂ = 67%</p> |
| | <p>Continues PPV and adjusts oxygen concentration per pulse oximetry</p> |
| | <p>Checks heart rate after 30 seconds of PPV "Baby is apneic." Heart rate is > 100 bpm and increasing SpO₂ = 72% and increasing slowly</p> |
| End scenario. | |
| | <p>Supports baby with PPV and supplemental oxygen per Target Oxygen Saturation Table. Monitors heart rate, respiratory effort, oxygen saturation, activity, temperature. Prepares to move baby to post-resuscitation care setting. Communicates with perinatal team. Updates parents and informs them of next steps.</p> |

Option 2: Newborn of 37 weeks' gestation with risk factors requires intubation and tracheal aspiration for suspected airway obstruction

"You are called to attend a birth complicated by a Category III fetal heart rate pattern. The laboring mother is a 39-year-old primigravida at 37 weeks' gestation. Demonstrate how you would prepare for the birth of this baby. As you work, say your thoughts and actions aloud so I will know what you are thinking and doing."

| Critical Performance Steps | |
|----------------------------|--|
| Assess perinatal risk. | |
| | <p>Assesses perinatal risk (learner asks 4 pre-birth questions and instructor ["OB provider"] responds)</p> <p>Gestational age? "37 weeks' gestation." Clear fluid? "Amniotic fluid is clear." Additional risk factors? "Category III fetal heart rate pattern and maternal chronic hypertension." Umbilical cord management plan? "I will delay cord clamping. If the baby is not crying, I'll take a moment to stimulate the baby. If there's no response, I'll clamp and cut the cord."</p> |

| Critical Performance Steps (cont) | |
|---|--|
| Assemble team. | |
| | Assembles team based on perinatal risk factors. If risk factors are present, at least 2 qualified people should be present solely to manage the baby. The number of team members and qualifications vary depending on risk. |
| Perform a pre-resuscitation briefing. | |
| | Identifies team leader. Assesses risk factors, delegates tasks, identifies who will document events, determines supplies and equipment needed, knows how to call for additional help. |
| Perform equipment check (includes checking supplies and equipment to prep for intubation). | |
| | "The baby has been born." |
| Rapid evaluation. | |
| | Asks 3 rapid evaluation questions: <ul style="list-style-type: none"> • Term? "Appears about 37 weeks' gestation as expected." • Muscle tone? "No tone." • Breathing or crying? "No breathing." |
| Initial steps at radiant warmer. | |
| | Receives baby at radiant warmer, dries and removes linen, stimulates briefly by rubbing the baby's back, positions airway, suctions mouth and nose |
| Assess breathing. If breathing, assess heart rate. | |
| | Is the baby breathing? "No." (Heart rate=40 bpm, if assessed) |
| | Indicates need for PPV |
| Begin PPV within 60 seconds of birth. | |
| | Positions head in sniffing position |
| | Applies mask correctly |
| | Starts PPV in 21 % oxygen (room air) at 20 to 25 cm H ₂ O (PEEP of 5 cm H ₂ O if using T-piece resuscitator or flow-inflating bag, or self-inflating bag with PEEP valve); rate 40 to 60 breaths/min |
| | Requests pulse oximeter sensor placement on baby's right hand or wrist |
| | Requests cardiac monitor (optional at this time) |
| | Within 15 seconds of beginning PPV, learner asks assistant to state heart rate and if it is increasing Heart rate =40 bpm and not increasing "Pulse oximeter has no signal." |
| | Asks assistant to assess chest movement "No chest movement." |
| Perform ventilation corrective steps (MR. SOPA). | |
| | Performs M and R, S and O, and P steps; assesses for increasing heart rate and chest movement after PPV following each step Heart rate =40 bpm and not increasing. "No chest movement." "Pulse oximeter has no signal." |
| | Place cardiac monitor leads and connect to monitor in anticipation of intubation (if not already done). |

| Critical Performance Steps (cont) | |
|--|---|
| Preparation for intubation. (Most of these tasks are included in the pre-birth equipment check.) | |
| Operator (Intubator) | Operator's Assistant |
| Prepares for intubation <ul style="list-style-type: none"> • Requests correct-sized tube • Requests correct-sized laryngoscope blade • Communicates preference for stylet usage | <ul style="list-style-type: none"> • Ensures suction set at 80 to 100 mm Hg • Selects correct-sized tube • Chooses correct laryngoscope blade (size 1 [term], size 0 [preterm]) • Checks laryngoscope light • Inserts stylet correctly (<i>stylet optional</i>) • Obtains CO₂ detector • Prepares tape or tube-securing device |
| Intubating the newborn. | |
| Operator | Operator's Assistant |
| <ul style="list-style-type: none"> • Holds laryngoscope correctly in left hand • Opens baby's mouth with finger and inserts blade to base of tongue • Lifts blade correctly (no rocking motion) • Requests cricoid pressure if needed • Identifies landmarks, takes corrective action to visualize glottis if needed • Inserts tube from right side, not down center of laryngoscope blade • Aligns vocal cord guide with vocal cords • Removes laryngoscope then removes stylet while firmly holding tube against baby's palate • Holds tube against baby's palate | <ul style="list-style-type: none"> • Positions newborn's head in sniffing position, body straight, table at correct height for operator • Applies cricoid pressure if requested • Hands endotracheal tube to operator • Monitors heart rate and announces if attempt lasts longer than 30 seconds • Removes stylet (if used) • Connects CO₂ detector and PPV device to endotracheal tube • Hands PPV device to operator |
| Positive-pressure ventilation and confirming endotracheal tube insertion. | |
| <ul style="list-style-type: none"> • Administers PPV • Observes for symmetrical chest movement | <ul style="list-style-type: none"> • Auscultates for increasing heart rate and assesses CO₂ detector color change • Listens for bilateral breath sounds, notes symmetrical chest movement with PPV, and reports findings |
| Heart rate = 40 bpm and not increasing "Chest is <u>not moving</u> with PPV. No audible breath sounds. "Color is not changing on the CO₂ detector." | |
| "In this scenario, the endotracheal tube has been correctly inserted, but there is no chest movement with PPV. What is your next step?" | |
| Suspect airway obstruction and use tracheal aspirator. | |
| <ul style="list-style-type: none"> • Connects a tracheal aspirator to a suction source (80-100 mm Hg suction) and directly to the endotracheal tube connector or occludes integrated suction port • Occludes the tracheal aspirator with a finger or occludes the suction-control port on the endotracheal tube and gradually withdraws the endotracheal tube over 3 to 5 seconds while continuing to suction secretions in the trachea | |

| Critical Performance Steps (cont) | |
|--|---|
| After tracheal suction, re-intubate baby with a clean endotracheal tube. (Learner may also resume face-mask PPV or insert a laryngeal mask.) | |
| <i>After re-intubation, if endotracheal tube is <u>not</u> successfully inserted,</i> | "Color is not changing on the CO₂ detector." Heart rate= 40 bpm and not increasing <ul style="list-style-type: none"> • Removes endotracheal tube • Resumes PPV by face mask • Repeats intubation attempt or indicates need for laryngeal mask |
| <i>After re-intubation, if endotracheal tube is successfully inserted,</i> | "Color is changing on the CO₂ detector." Heart rate = 60 bpm and increasing Pulse oximeter displays signal as heart rate increases to more than 60 bpm <ul style="list-style-type: none"> • Operator continues PPV x 30 seconds • Assistant checks tip-to-lip depth using gestational age/weight table or NTL measurement <ul style="list-style-type: none"> - If using NTL, measures distance from the nasal septum to the ear tragus (insertion depth [cm]= NTL + 1 cm) • Assistant secures endotracheal tube |
| Vital signs. | |
| Checks heart rate after completing 30 seconds of PPV Heart rate = 70 bpm and increasing "Apneic." SpO₂ = 68% and increasing | |
| Continues PPV and adjusts oxygen concentration per pulse oximetry | |
| Checks heart rate after 30 more seconds of PPV Heart rate is > 100 bpm and increasing "Apneic." SpO₂ = 72% and increasing | |
| End scenario. | |
| Supports baby with PPV and supplemental oxygen per Target Oxygen Saturation Table. Monitors heart rate, respiratory effort, oxygen saturation, activity, temperature. Prepares to move baby to post-resuscitation care setting. Communicates with perinatal team. Updates parents and informs them of next steps. Debriefs the resuscitation. | |

Sample Debriefing Questions

- o What went well during this resuscitation?
- f) What is the most important issue to discuss during this debriefing?
- g At what point did you decide to use a cardiac monitor to assess the heart rate? How did that help you? When is a cardiac monitor recommended during neonatal resuscitation?
- o What will you do differently when faced with intubation in a future scenario?

- 0 (Option 2) After inserting an alternative airway, there was still no chest movement with PPV. How did the leader/team members help each other to manage this emergency? As a leader/team member, what was the most difficult aspect of this scenario? In an actual resuscitation, what if a team member had suggested beginning chest compressions before achieving chest movement with PPV?
- 0 Do you have additional comments or suggestions for your team? For the team leader?
- 0 Give me an example of how you used at least one of the NRP Key Behavioral Skills.

NRP Key Behavioral Skills

- Know your environment.
- Use available information.
- Anticipate and plan.
- Clearly identify a team leader.
- Communicate effectively.
- Delegate the workload optimally.
- Allocate attention wisely.
- Use available resources.
- Call for additional help when needed.
- Maintain professional behavior.