

## Airway Management

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### OBJECTIVES

1. Recognize signs of a threatened airway.
2. Describe manual techniques for establishing an airway and for mask ventilation without and with suspected cervical spine injury.
3. Be familiar with airway adjuncts such as the laryngeal mask airway and the esophageal-tracheal Combitube.
4. Describe preparation for endotracheal intubation including the recognition of a potentially difficult intubation and pharmacologic therapy.
5. Describe alternative methods for establishing an airway when endotracheal intubation cannot be accomplished.

### I. INTRODUCTION

The focus of this chapter is to ensure that the airway is open and able to support gas exchange — the “A” in the “ABCs” of resuscitation. Secondary goals include the preservation of cardiovascular stability and the prevention of aspiration of gastric contents during airway management. Endotracheal intubation will often be required, but establishing and maintaining a patent airway instead of or prior to intubation is equally imperative and often more difficult. Healthcare providers must be skilled in manually supporting the airway and providing the essential processes of oxygenation and ventilation. Securing an artificial airway via oro- or nasotracheal intubation, cricothyrotomy, or tracheostomy is an extension of, not a substitute for, the ability to provide that primary response.

### II. ASSESSMENT

Assessment of airway patency and spontaneous breathing effort is the crucial first step. The clinician must *look, listen, and feel* for diminished or absent air movement.

- Observe the patient's level of consciousness and determine if apnea is present. If respiratory efforts are absent and an immediate remedy is not available, proceed to manual support and assisted ventilation while preparing to establish an artificial airway.
- Identify injury to the airway or other conditions (e.g., a possible cervical spine fracture that will affect assessment and manipulation of the airway) (see below).
- Observe chest expansion. Ventilation may be adequate with minimal thoracic excursion, but respiratory muscle activity and even vigorous chest movement do not assure that tidal volume is adequate. The absence of chest movement implies apnea.
- Observe for suprasternal, supraclavicular, or intercostal retractions; laryngeal displacement toward the chest during inspiration (a tracheal “tug”); or nasal flaring. These often represent respiratory distress with or without airway obstruction.

- Auscultate over the neck and chest for breath sounds. *Complete* airway obstruction is likely when there is visible chest movement but breath sounds are absent. *Incomplete* obstruction due to soft tissue, liquid, or a foreign body in the airway may be associated with snoring, stridor, gurgling, or noisy breathing.
- The assessment of protective airway reflexes (i.e., cough and gag), although not necessarily associated with obstruction, is part of the initial survey of the airway. However, overly aggressive stimulation of the posterior pharynx while assessing these reflexes may precipitate emesis and aspiration of gastric contents. Absence of protective reflexes generally implies a need for longer-term airway support if the cause cannot be immediately reversed.

***For Pediatric Patients***

In young children, common causes of airway obstruction are infectious in nature and include viral croup, bacterial tracheitis, and epiglottitis. In the semiconscious patient, posterior displacement of the tongue and collapse of the hypopharynx should be recognized as common causes of obstruction. Since infants are obligate nose-breathers until approximately 6 months of age, suctioning the nares can be an important intervention in establishing airway patency.

### **III. MANUAL METHODS TO ESTABLISH AN AIRWAY**

Initial interventions to assure a patent airway in a spontaneously breathing patient *without possible injury to the cervical spine* include the elements of the "triple airway maneuver":

- slight neck extension
- elevation of the mandible (jaw thrust maneuver)
- mouth opening.

Figure 2-1 illustrates these steps. *If a cervical spine injury is suspected*, neck extension is eliminated. After the cervical spine is immobilized, manual elevation of the mandible and opening of the mouth are performed.

Adjunctive devices such as properly sized oropharyngeal or nasopharyngeal airways may be useful. The oropharyngeal airway is intended to hold the base of the tongue forward toward the teeth and away from the glottic opening. The plastic flange should rest against the outer surface of the teeth while the distal end curves around the base of the tongue. If the oropharyngeal airway is too small, it may push the tongue back over the glottic opening; if it is too large, it may stimulate gagging and emesis. Oropharyngeal airways should not be inserted if airway reflexes are intact, as gagging, laryngospasm, and emesis will be provoked. The diameter of a nasopharyngeal airway should be the largest that will easily pass through the nares into the nasopharynx. Its length should extend to the nasopharynx, but it should not be so long as to obstruct gas flow through the mouth or touch the epiglottis. A nasopharyngeal airway is contraindicated in patients with suspected basilar skull fracture or coagulopathy. The correct size for each airway may be estimated by placing the device against the face in the correct anatomic position.



*Figure 2-1.* Triple airway maneuver: the operator stands above the patient's head and, in the absence of possible cervical spine injury, (a) extends the neck and maintains extension with his/her hands on both sides of the mandible, (b) elevates the mandible with the fingers of both hands, thus lifting the base of the tongue away from the glottic opening, and (c) opens the mouth with the thumbs or forefingers. Reproduced with permission from Safar P, Bircher NG: *Cardiopulmonary Cerebral Resuscitation*. Third Edition. Philadelphia, WB Saunders, 1988, p 28.

During manual support of the airway, supplemental oxygen should be supplied with a device providing high oxygen amounts at a high flow rate. Such devices include a face mask or a bag-mask-valve resuscitation unit.

#### **IV. MANUAL MASK VENTILATION**

Manual assisted ventilation by means of a bag-mask-valve resuscitation unit is indicated

- if the patient is apneic
- if spontaneous tidal volumes are determined by physical examination to be inadequate
- to reduce the work of breathing by assisting the patient during spontaneous inspiration
- if hypoxemia is associated with poor spontaneous ventilation.

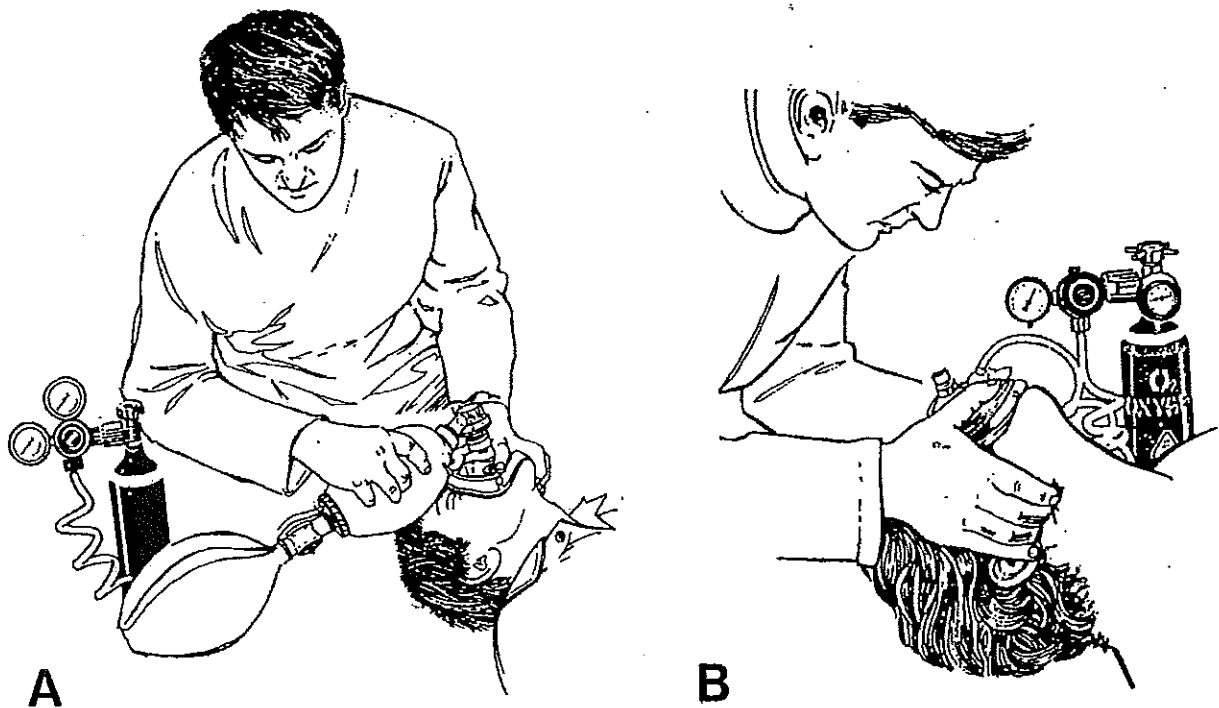
Successful manual mask ventilation depends upon (a) maintaining an open airway, (b) establishing a seal between the patient's face and the mask, and (c) delivering an optimal minute ventilation from the resuscitation bag to distal lung units. The first two elements are combined through the correct placement of the mask over the patient's nose and mouth (Fig. 2-2) and completion of the triple airway maneuver as previously described.

##### **A. When No Cervical Spine Injury Is Suspected**

1. If tolerated by the patient, an oropharyngeal airway is inserted, or a nasopharyngeal airway may be placed. A small pad or folded towel may be placed under the occiput.
2. The operator stands above and behind the head of the supine patient. The height of the bed should be quickly adjusted for the comfort of the operator.
3. The base of the mask is first placed into the skin crease between the lower lips and the chin, and the mouth is gently opened.
4. The apex of the mask is placed over the nose, being careful to avoid pressure on the eyes.
5. As most operators are right-handed, the mask is stabilized on the face with the left hand by holding the superior aspect of the mask apex adjacent to its connection to the bag between the thumb and first finger. This position allows gentle downward pressure on the mask over the face.
6. The fifth, fourth, and perhaps third fingers of the left hand are then placed along the mandible on the left side of the patient's jaw. As this placement occurs, it is helpful to gently encircle the left side of the mask with the soft tissues of that cheek so as to reinforce the seal along the left edge. This position further secures the mask to the patient's face but, importantly, allows the mandible to be partially elevated.
7. The operator gently rotates the left wrist to cause slight neck extension and contracts the fingers around the mandible to raise it slightly. The composite motions of the left hand, therefore, produce slight neck extension, mandibular elevation, and gentle downward pressure of the mask on the face.

##### **B. When a Cervical Spine Injury Is Suspected**

1. The operator stands in the same position and an oro- or nasopharyngeal airway is inserted, if possible.
2. Under unusual circumstances, successful manual ventilation can be accomplished while the neck is stabilized in a cervical collar. Often, however, an assistant is required to stand to the side, facing the patient. The anterior portion of the collar is removed, and the assistant places one hand/arm along each side of the neck to the occiput. *Traction is not applied*, but the patient is prevented by the assistant from flexing, extending, or rotating the neck.



*Figure 2-2.* One-handed (A) and two-handed (B) technique for application of the face mask. Reproduced with permission from Safar P, Bircher NG: *Cardiopulmonary Cerebral Resuscitation*. Third Edition. Philadelphia, WB Saunders, 1988, p 82.

3. The operator may then proceed with the steps described above, *except no rotation is applied from the left wrist to produce neck extension*. Alternatively, the operator may choose the two-handed method for mask placement, which further assures that no neck movement occurs. This method is discussed below.

**C. Alternative Two-Handed Method to Assure Airway Patency and Mask Application**

This technique is useful if the face is large, if the patient has a beard, after neck injury, or in any other situation when a mask seal is difficult to secure.

1. The operator stands in the same location at the head of the bed, and adjunctive airway devices are used as previously suggested.
2. The base and apex of the mask are placed in the manner previously described.
3. The third, fourth, and fifth fingers of both hands of the operator are placed along the mandible on each side of the face, while the thumbs and first fingers rest over the apex and base of the mask, respectively.
4. Soft tissues of the cheek are brought upward along the side edges of the mask and held in place by each hand to reinforce the mask's seal with the face.
5. *In the absence of possible cervical spine injury*, the neck is slightly extended as the operator gently elevates the mandible from both sides and provides gentle pressure on the mask over the face.
6. An assistant provides ventilation, as needed, by compressing the resuscitation bag.

**D. Compression of the Resuscitation Bag to Provide Assisted Manual Mask Ventilation**

The goal of manual mask ventilation is to provide an optimal minute ventilation, the product of the tidal volume delivered during each compression of the resuscitation bag reservoir and the number of times per minute the bag is compressed. The total gas volume within the reservoir of most resuscitation bags is 1 to 1.5 L. Overzealous compressions of the bag at a rapid rate may produce dangerous hyperventilation and respiratory alkalemia, as well as gastric distension.

1. If a single-handed method of mask placement is used, the resuscitation bag reservoir is compressed by the operator's right hand.
2. The delivered tidal volume must be estimated from the observed chest expansion, auscultated breath sounds, etc.
3. During bag compression, the operator should listen carefully for any gas leaks around the mask. Similarly, when a good seal is present, the "feel" of the bag during lung inflation reflects some resistance caused by the normal airway anatomy. If gas is "felt" to be moving from the bag too easily, a leak is likely to be present.
4. If the patient is apneic, one-handed compressions of the bag should be delivered 12 to 16 times per minute. If spontaneous breathing is present, bag compression should be synchronized with the patient's inspiratory efforts. If the patient is breathing easily and inhaling adequate tidal volumes frequently enough to produce adequate minute ventilation, the bag need not be compressed at all.
5. Oxygen (100%) is delivered to the resuscitation bag, usually at a flow rate  $\geq 15$  L/min.

6. If the mask-to-face seal is not adequate and a leak is detected, the operator should consider the following interventions.
  - Reposition the mask and hands.
  - Consider more or less inflation of the facial cushion of the face mask, if possible, or change to larger or smaller mask.
  - Apply slightly more downward pressure to the face.
  - Convert to the two-handed technique described above.
    - Reposition an oro- or nasogastric tube, if present, to a different part of the mask. Leaks are common when such a tube is present, but rarely will it need to be removed.
    - Consider compensating for the leak if it is small by increasing the frequency of bag compressions or the volume of gas delivered per compression.
    - Some resuscitation bags have a pressure relief ("popoff") valve designed to prevent transmission of high pressures to the lungs. In patients with stiff lungs or high airway resistance, the popoff valve should be closed to assure adequate tidal volumes.

Manual assisted ventilation should be continued in preparation for intubation or until the cause of inadequate ventilation is reversed, if possible. An assistant should prepare medications, equipment, etc., for intubation while the primary operator maintains ventilation. Pulse oximetry is a valuable adjunctive monitoring device throughout assisted ventilation.

#### **E. Cricoid Pressure (Sellick Maneuver)**

Cricoid pressure denotes downward (posterior) pressure on the anterior neck overlying the cricoid cartilage. The downward movement of the cricoid ring will physically occlude the esophagus and will decrease the risk of gastric distension during manual mask ventilation and reduce the risk of passive reflux of gastric contents into the lungs. If the patient has absent protective airway reflexes, cricoid pressure should be applied during mask ventilation and during attempts at tracheal intubation and should be removed only after tracheal intubation has been confirmed.

#### **V. AIRWAY ADJUNCTS**

In approximately 5% of the general population, manual mask ventilation is difficult or impossible. Intubation via direct laryngoscopy is difficult in approximately 5% of the general population and impossible in approximately 0.2 to 0.5%. The inability to both manually mask ventilate and intubate is a crisis situation. The laryngeal mask airway (LMA) and esophageal-tracheal Combitube (ETC) are useful adjuncts to provide an open airway and permit gas exchange in these situations. The LMA and ETC are blindly inserted, cuffed pharyngeal ventilation devices for use when mask ventilation is difficult or impossible and to buy time after failed intubation. The choice of device depends on the experience of the operator and the individual clinical circumstances.

**A. Laryngeal Mask Airway (LMA North America, Inc., San Diego, CA)**

The LMA (Fig. 2-3) is an endotracheal tube attached to a bowl-shaped cuff that fits in the pharynx behind the tongue. The standard LMA is reusable, but a single-use device is also available. It may be used to ventilate the lungs when mask ventilation is difficult, provided that the patient does not have periglottic pathology. It may also be used as a conduit for intubation when using a bronchoscope or as a rescue technique after failed intubation. Less sedation is required with an LMA than with direct laryngoscopy because stimulation to the airway (e.g., gagging, laryngospasm, sympathetic stimulation) in passing the device is only moderate. It is effective in ventilating patients ranging from neonates to adults. Sizing guidelines for LMAs are provided in Table 2-1.



**Figure 2-3.** Single-use size 4 Laryngeal Mask Airway.



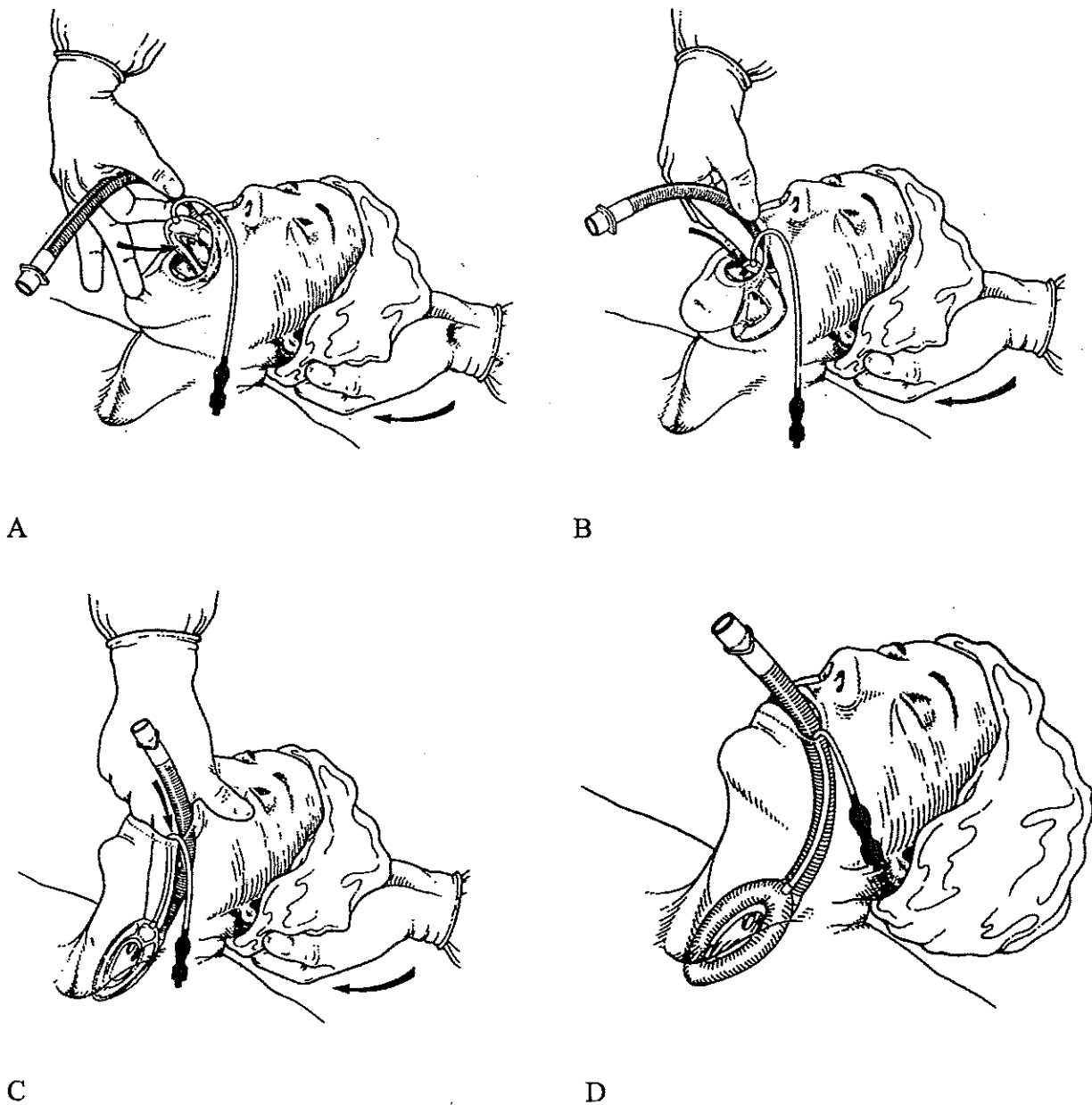
**Table 2-1. Laryngeal mask airway size and cuff inflation**

<b>LMA Size</b>	<b>Patient Size</b>	<b>Maximum Cuff Volume</b>	<b>Largest ETT ID (mm)*</b>
1	Neonate/infant to 5 kg	Up to 4 mL	3.5
1.5	5-10 kg	Up to 7 mL	4.0
2	10-20 kg	Up to 10 mL	4.5
2.5	20-30 kg	Up to 14 mL	5.0
3	>30 kg/small adult	Up to 20 mL	6.0 cuffed
4	Normal adult	Up to 30 mL	6.0 cuffed
5	Large adult	Up to 40 mL	7.0 cuffed

\*Largest endotracheal tube size (ID) that will fit through LMA tube lumen.

The technique for insertion includes the following steps (Fig. 2-4):

1. Completely deflate the cuff so that it forms a spoon shape, and assure that it has no folds in the mask.
2. Lubricate only the posterior aspect of the deflated mask with a water-based lubricant.
3. The operator should stand behind the patient and place the patient in the sniffing position (i.e., head extended, neck flexed) unless potential or definite cervical spine injury prevents neck extension.
4. The bowl of the mask faces anteriorly. Hold the device like a pencil, with the index finger of the dominant hand at the junction of the bowl and tube, pressing against the palate and pharyngeal wall with the index finger.
5. Insert the cuff into the hypopharynx until definite resistance is felt.
6. Without holding the device, inflate the cuff with enough air to obtain a seal. This step results in an outward movement of the tube.
7. Attach a manual ventilation device and assure chest movement. Correct position should be confirmed with a qualitative or quantitative end-tidal CO<sub>2</sub> detector.
8. If chest movement is inadequate, or a large air leak is present, remove and reinsert the device.



**Figure 2-4.** Insertion technique for Laryngeal Mask Airway.- A, insert lubricated and deflated mask into the open mouth with the bowl facing anterior. B, hold the device like a pencil pressing against the palate and pharyngeal wall with the index finger. C, continue inserting the cuff behind the tongue into the hypopharynx until finite resistance is felt. D, without holding the device, inflate cuff with enough air to obtain a seal. Attach manual ventilation device and assure chest movement. From Brain AII: The Intra-vent Laryngeal Mask Instruction Manual. Berkshire, UK, Brain Medical, 1992.

## **B. Esophageal-Tracheal Combitube (Kendall Sheridan Catheter Corporation, Argyle, NY)**

The ETC is a dual-lumen device with two inflatable balloon cuffs that is designed primarily for blind intubation during cardiorespiratory arrest. It can provide ventilation if the distal cuffed portion of the tube device is inserted in the esophagus or trachea. When the tube is inserted in the esophagus, the stomach may be suctioned through the tracheal lumen. The ETC is available in two sizes: 41-Fr for male adults and 37-Fr for women and small adults. The ETC is contraindicated for patients with intact laryngeal or pharyngeal reflexes or known esophageal pathology. Adequate training is required to ensure appropriate use. The technique for insertion and use includes the following steps:

1. The patient's tongue and jaw are grasped between the thumb and index finger, and the ETC is inserted blindly. It is advanced until the black ring markers on the tube are positioned at the teeth.
2. The pharyngeal cuff is inflated first to seal the posterior pharynx.
3. The distal cuff is then inflated.
4. Ventilation should be attempted first through the pharyngeal lumen and the chest auscultated for breath sounds. The tube enters the esophagus approximately 95% of the time.
5. If breath sounds are absent, ventilation should be attempted through the tracheal lumen while auscultating for breath sounds.
6. Use of the correct lumen for ventilation should be confirmed with a qualitative/quantitative end-tidal CO<sub>2</sub> or esophageal detector device.

## **VI. ENDOTRACHEAL INTUBATION**

Indications for tracheal intubation include the following:

- airway protection
- relief of obstruction
- provision of mechanical ventilation and oxygen therapy
- respiratory failure
- shock
- hyperventilation for intracranial hypertension
- reducing the work of breathing
- facilitation of suctioning/pulmonary toilet.

Direct laryngoscopy with orotracheal intubation is the principal method for tracheal intubation because of the speed and success rates of this method and the availability of equipment. Blind nasotracheal intubation may be useful for selected patients and in selected situations. The techniques for oro- and nasotracheal intubation are discussed and illustrated in Appendix 1.

In preparation for intubation, important issues include:

- Assessment of airway anatomy and function to estimate degree of difficulty for intubation (see below).
- Assurance of optimal ventilation and oxygenation. Preoxygenation with 100% oxygen, using a bag-mask valve device, occurs during periods of apnea and intubation attempts.

- Decompression of the stomach with an existing oro- or nasogastric tube is useful. However, the insertion of an oro- or nasogastric tube to decompress the stomach prior to intubation is often counterproductive, as it may elicit emesis and promote passive reflux of gastric contents.
- Provision of appropriate analgesia, sedation, amnesia, and neuromuscular blockade as required for a safe procedure.

Although emergent intubation leaves little time for evaluation and optimizing of conditions, elective and urgent intubation allows for assessment of factors that promote safe airway management. The patient's clinical situation, intravascular volume status, hemodynamics, and airway evaluation (degree of difficulty) should be assessed as a plan for airway management is formulated. Airway evaluation includes assessment of physical characteristics that together determine if visualization of the vocal cords will be difficult or impossible. This evaluation will suggest whether alternative techniques to direct laryngoscopy (e.g., awake intubation, flexible fiberoptic intubation, surgical airway) are likely to be necessary and whether a more experienced individual should be immediately summoned. Keep in mind that many of these physical characteristics also cause difficulty with mask ventilation and with the ability to perform an emergent cricothyrotomy. These factors are easy to remember if they are considered in the same order as the steps used in oral intubation (i.e., head position, mouth opening, displacement of the tongue and jaw, visualization, and insertion of endotracheal tube).

- Neck mobility – The presence of possible cervical spine injury, short neck, and limitation of neck mobility by prior surgery or arthritis will restrict the ability to position adequately.
- External face – Examine for evidence of micrognathia or presence of surgical scars, facial trauma, small nares, or nasal, oral, or pharyngeal bleeding.
- Mouth – Mouth opening may be limited because of temporomandibular joint disease or facial scarring. Mouth opening should equal at least 3 finger breadths.
- Tongue and pharynx – Tongue size relative to the posterior pharynx estimates the relative amount of room in the pharynx to visualize glottic structures.
- Jaw – Short thyromental distance, the distance in finger breadths between the anterior prominence of the thyroid cartilage ("Adam's apple") and the tip of the mandible (chin). This distance estimates the length of the mandible and the available space anterior to the larynx. Less than 3 finger breadths (approximately 6 cm) indicates that the larynx may appear more anterior and be more difficult to visualize and enter during laryngoscopy. A more acute angulation of the stylet in the endotracheal tube may be helpful.

If one or a combination of these physical characteristics indicates the possibility of difficult intubation and if time allows, other options for obtaining a secure airway and additional airway expertise should be considered. It is important to remember that failed intubation attempts can result in periglottic edema and can create subsequent difficulty with mask ventilation, leading to a "can't intubate and can't ventilate" situation. When difficulty in mask ventilation or intubation is anticipated, care is advised before suppressing spontaneous ventilation with neuromuscular blocking drugs or sedatives that cannot be reversed. Options for safe airway management include the following (note that all methods maintain preservation of spontaneous ventilation):

- Awake intubation by direct laryngoscopy or blind nasotracheal intubation
- Flexible fiberoptic intubation (expert consultation required)
- Awake tracheostomy (expert consultation required).

In the event that visualization of the glottis and mask ventilation are both impossible and there is no spontaneous ventilation, options include

- LMA or ETC
- Needle cricothyrotomy (expert consultation often required)
- Surgical cricothyrotomy/tracheostomy (expert consultation required).

An algorithm for management of the potential or confirmed difficult airway is shown in Figure 2-5. The techniques for needle and surgical cricothyrotomy are outlined in Appendix 2.

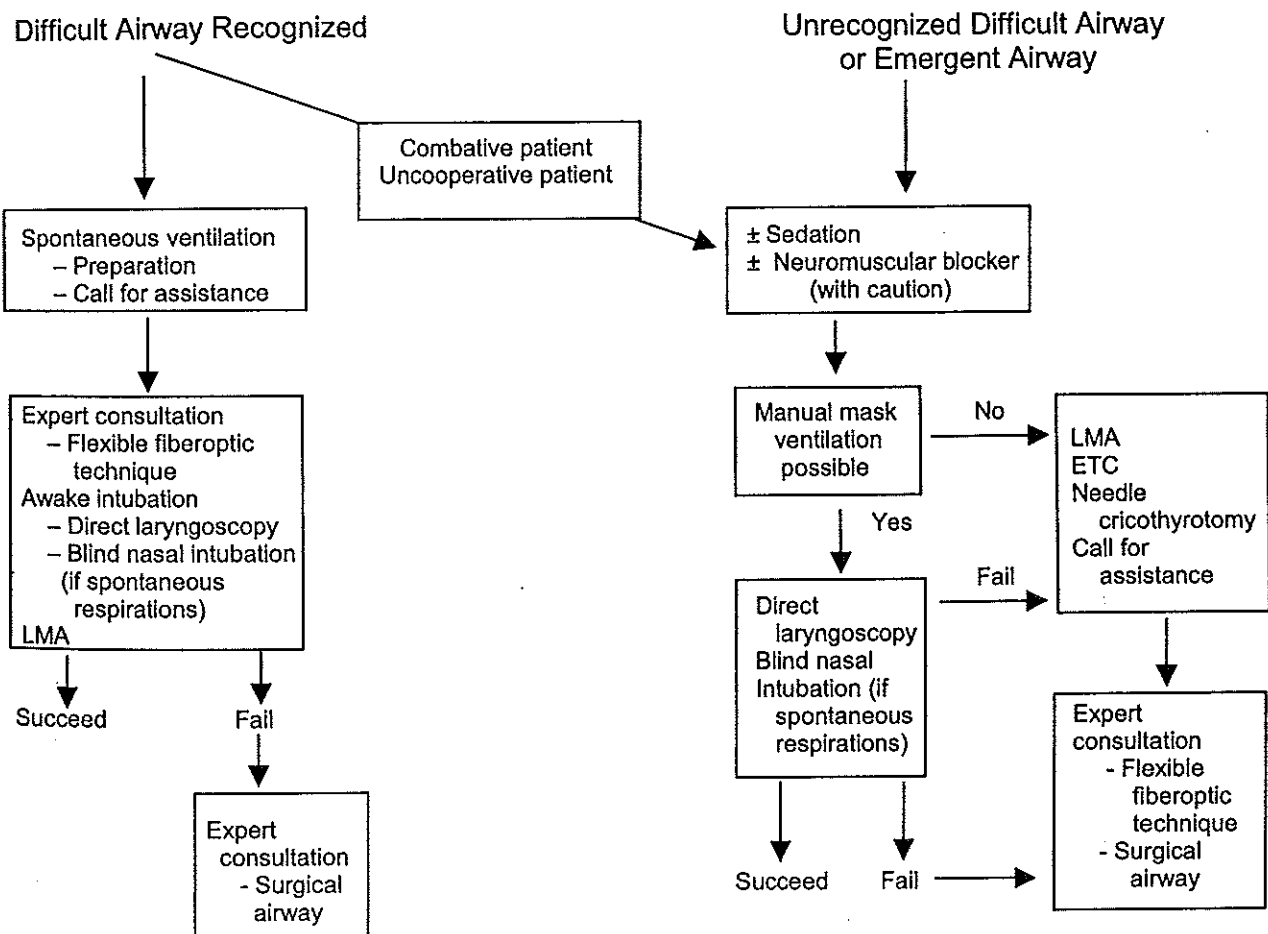


Figure 2-5. Management guideline for known or unrecognized difficult airway.

## **VII. PHARMACOLOGIC PREPARATION FOR INTUBATION**

Significant hemodynamic changes are frequent during the process of airway management. Both parasympathetic and sympathetic responses are common and may need to be blunted with proper pharmacologic therapy. The pharmacologic goal prior to intubation of the patient is to provide optimal analgesia/anesthesia, amnesia, and sedation without altering cardiorespiratory stability. At times, a goal of preserving spontaneous ventilatory drive is necessary. Obviously, the selection of particular methods or drugs depends upon the clinical circumstances and status of the patient, patient allergies, and the experience and preferences of the operator. General recommendations are listed below.

### **A. Analgesia/Anesthesia**

- Topical – a variety of anesthetic sprays are available, or lidocaine may be delivered via aerosol. Anatomic areas for special emphasis include the base of the tongue, directly on the posterior wall of the pharynx, and bilaterally in the tonsillar fossae. Care should be taken not to exceed 4 mg/kg of lidocaine (maximum dose 300 mg), as it is easily absorbed from the airway mucosa.
- Nerve blocks and transcricoid membrane xylocaine require experience in these procedures and are not part of this course.
- Analgesia is also provided by some agents selected for sedation.

### **B. Sedation/Amnesia**

Rapid-acting, short-lived, and potentially reversible agents are preferred. No single agent has every desirable feature, and often more than one agent may be considered to provide a balanced technique for sedation. It is important to restate that the status of the patient's intravascular volume and cardiac function must be carefully considered during the selection of an agent and its dosage. Most agents may induce hypotension when heart failure or hypovolemia is present. The following drugs are representative examples:

- Fentanyl – 25 to 100 µg intravenous bolus every several minutes as titrated to sedative effect; opiate; rapid onset of action; short acting; reversal with naloxone. Chest wall rigidity may occur with rapid administration. Provides analgesia and blunts sympathetic response, but does not inhibit patient awareness of procedure.
- Midazolam – 1 mg intravenous bolus titrated to sedative effect every several minutes; benzodiazepine; provides amnesia; rapid onset; short acting; reversal with flumazenil.
- Etomidate – 0.3 to 0.4 mg/kg single bolus; general sedative; may be preferred in head injury; may induce myoclonus, including mild trismus (consider premedication with 50 µg fentanyl); no reversal agent.
- Lidocaine – 1 to 1.5 mg/kg intravenous bolus; blunts the hemodynamic and tracheal response to intubation; useful in head injury; administer 2 to 3 minutes before laryngoscopy.

### **C. Neuromuscular Blockers**

Often, intubation can be safely and easily performed after topical anesthesia, (i.e., an "awake" intubation, or with sedation alone. Therefore, neuromuscular blockade is not always required prior to endotracheal intubation. Obviously, if the operator cannot intubate the patient after neuromuscular blockers have been given, effective manual mask ventilation must be continued while a more experienced person is sought, an

alternate plan to secure the airway is developed, or the agent is metabolized and its effect is gone. Hence, a short-acting agent is more advantageous. The following drugs are examples of neuromuscular blockers:

- Succinylcholine – 1.0 to 1.5 mg/kg intravenous bolus; rapid onset; shortest duration, which provides an element of safety; may cause muscle fasciculations because this agent depolarizes skeletal muscle; emesis may occur if abdominal muscle fasciculations are severe; contraindicated when ocular injury is present; relatively contraindicated when head injury is present or if hyperkalemia is present (potassium release of 0.5 to 1 mmol/L will occur routinely, and massive potassium release may occur in burn and crush injury, upper motor neuron lesions, or primary muscle disease); may precipitate malignant hyperthermia. Effects are prolonged in patients with atypical cholinesterase or decreased pseudocholinesterase levels.
- Vecuronium – 0.1 to 0.3 mg/kg, Rocuronium – 0.6 to 1.0 mg/kg, or Cisatracurium – 0.1 to 0.2 mg/kg intravenous bolus; no fasciculations, because these are nondepolarizing agents; slower onset of muscle paralysis; significantly longer duration of effects than with succinylcholine.

#### **D. Rapid Sequence Intubation (RSI)**

Rapid sequence intubation refers to the technique of simultaneous administration of a sedative agent and neuromuscular blocker along with cricoid pressure, designed to facilitate intubation and reduce the risk of gastric aspiration. It is the technique of choice when there is an increased risk of aspiration (e.g., full stomach, pain, gastroesophageal reflux) and examination does not suggest a difficult intubation. Patients for whom intubation is likely to be difficult should not have RSI. The emergency methods described above will be necessary if the patient cannot be intubated and is impossible to ventilate, since the ability to mask ventilate is not tested prior to administration of the neuromuscular blocker.

### **VIII. EARLY COMPLICATIONS OF TRACHEAL INTUBATION**

After tracheal intubation, significant alterations in hemodynamics should be anticipated. Hypertension and tachycardia may occur as a result of sympathetic stimulation and may require therapy in some patients. Hypotension is common, and decreased cardiac output due to reduced venous return with positive pressure ventilation can precipitate arrhythmias or cardiac arrest occasionally. The effects of sedative agents on the vasculature or myocardium and the occasional development of postintubation pneumothorax may also contribute to hypotension.

After intubation has been successfully completed, longer-term sedation and neuromuscular blockade may be necessary. Guidelines are provided in Appendix 8.

#### **KEY POINTS: AIRWAY MANAGEMENT**

1. Assessment of the patient's level of consciousness, airway protective reflexes, respiratory drive, obstruction(s) to gas flow into the airway, and work of breathing will determine the steps necessary to assure appropriate respiratory support.

2. Every primary care provider must be skilled in manual methods to secure and maintain a patent airway.
3. Manual assisted ventilation performed with a bag-mask-valve resuscitation unit is a skill expected of every healthcare provider. The goal is to optimize oxygenation and CO<sub>2</sub> removal prior to, or in lieu of, intubation of the patient.
4. The laryngeal mask airway and the esophageal-tracheal Combitube are useful airway adjuncts when expertise in intubation is lacking or intubation is unsuccessful.
5. Further patient evaluation to assess the degree of intubation difficulty, and appropriate analgesia, sedation, amnesia, and (potentially) neuromuscular blockade are preparatory steps before intubation.
6. A plan for management of the potentially difficult intubation includes maintenance of spontaneous ventilation, alternative techniques to endotracheal intubation, and requesting expert assistance. When manual mask ventilation is impossible after failed intubation, buying time with an LMA, ETC, or needle cricothyrotomy may be lifesaving.

#### **SUGGESTED READINGS**

1. Balk RA: The technique of orotracheal intubation. *J Crit Illness* 1997; 12:316
2. Benumof JL: Laryngeal mask airway and the ASA difficult airway algorithm. *Anesthesiology* 1996; 84:686
3. Benumof JL: Management of the difficult adult airway. With special emphasis on awake tracheal intubation. *Anesthesiology* 1991; 75:1087
4. Gerardi MJ, Sacchetti AD, Cantor RM, et al: Rapid-sequence intubation of the pediatric patient. Pediatric Emergency Medicine Committee of the American College of Emergency Physicians. *Ann Emerg Med* 1996; 28:55
5. Randell T: Prediction of difficult intubation. *Acta Anaesth Scan* 1996; 40:1016
6. Rodricks MB, Deutschman CS: Emergent airway management: Indications and methods in the face of confounding conditions. *Crit Care Clin* 2000; 16:389
7. Schwartz DE, Matthay MA, Cohen NH: Death and other complications of emergency airway management in critically ill adults. A prospective investigation of 297 tracheal intubations. *Anesthesiology* 1995; 82:367