Chapter 28: Noninvasive Airway Management

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High Flow Nasal Cannula (HFNC)

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HFNC is the delivery of humidified and heated oxygen at flow rates up to 60L/minute. It is an alternative to intubation or noninvasive positive-pressure ventilation. See additional content below on HFNC.

INTRODUCTION

Airway management is a critical need in many acutely ill and injured patients. Optimal strategies seek to assist with airway patency, oxygen delivery, and carbon dioxide excretion. Commonly, many classify airway management techniques into two categories: noninvasive (passive oxygenation, bag-valve mask ventilation, supraglottic airways, and noninvasive positive-pressure ventilation) and invasive (endotracheal intubation, cricothyroidotomy, transcutaneous needle jet ventilation, and tracheostomy). This chapter discusses noninvasive airway management strategies. Detailed discussion of invasive airway management strategies is found in the chapters 29, Intubation and Mechanical Ventilation and chapter 111, Intubation and Ventilation in Infants and Children.

ASSESSMENT OF THE AIRWAY AND VENTILATORY EFFORT

The decision to initiate airway support must often be made rapidly based on the patient's clinical condition. Laboratory testing or other studies should not delay the decision to initiate airway management strategies.

First, assess every patient for airway obstruction, which can be functional (e.g., unconscious patient) or mechanical (e.g., foreign body). The ability to spontaneously swallow and speak provides a basic indication of airway patency, and the absence is a potential sign of obstruction.

Other potential signs of airway obstruction include anxiety, wheezing or stridor, and coughing. Many conditions can cause airway obstruction (Table 28–1).

Table 28–1

Causes of Upper Airway Obstruction

Congenital/Genetic	Infectious	Medical	Trauma/Tumor
Large tonsils	Tonsillitis	Cystic fibrosis	Laryngeal trauma
Macroglossia	Peritonsillar abscess	Angioedema	Hematoma/masses
Micrognathia	Pretracheal abscess	Laryngospasm	Smoke inhalation
Neck masses	Epiglottitis	Inflammatory	Thermal injuries
Large adenoids	Laryngitis/respiratory syncytial virus Ludwig angina Retropharyngeal abscess	Airway muscle relaxation	Foreign body/hemorrhage

Some obstructions, such as foreign bodies or masses, are subglottic, or below the vocal cords.

Laryngospasm is obstructive closure of the glottis by constriction of laryngeal muscles. Laryngospasm may result from stimulation of the upper airway receptors on the tongue, palate, and oropharynx. Other causes include chemical irritation, secretions, blood, water, and vomitus in the upper airway and traction on the pelvic/abdominal viscera. Laryngospasm can persist after the causative stimulus has departed.

SIGNS AND SYMPTOMS OF RESPIRATORY FAILURE

Patients with hypoventilation (inadequate carbon dioxide excretion) and hypoxia (inadequate alveolar oxygen content) can present with a variety of symptoms including weakness, fatigue, chest pain, or shortness of breath. Inadequate oxygenation and ventilation can lead to altered

mentation, including anxiety, confusion, obtundation, or coma. Patients with respiratory distress can present with audible wheezing, stridor, or a silent chest. A subjective gauge of respiratory distress is the patient's respiratory effort or "work of breathing."[1] Dyspnea, tachypnea, hyperpnea, or hypopnea, accessory muscle use, and cyanosis are signs of increased work of breathing.

TYPES OF RESPIRATORY FAILURE

There are two types of respiratory failure. **Type 1 respiratory failure** is characterized by hypoxia *without* hypercapnia. Type 1 respiratory failure may be the result of conditions that affect oxygenation but not necessarily ventilation (e.g., pneumonia, pulmonary embolism). Patients with type 1 respiratory failure require assistance with oxygenation. Treatment of type 1 failure focuses on optimizing oxygenation. **Type 2 respiratory failure** is characterized by hypoxia *with* hypercapnia. Type 2 respiratory failure is often the result of conditions that affect ventilation (e.g., chronic obstructive pulmonary disease). Treatment of type 2 failure requires not only optimizing oxygenation but also supporting ventilation.

PREPARATION FOR AIRWAY MANAGEMENT

AIRWAY EQUIPMENT

Having key equipment at the bedside is a fundamental requirement for optimal airway management. Table 28–2 provides a model list of equipment.

Table 28–2

Sample List of Equipment for Noninvasive Airway Management

Oxygen source and tubing
Tongue blade
Bag-valve mask device
Clear facemasks—various sizes and shapes
Oropharyngeal airways—small, medium, large
Nasopharyngeal airways—small, medium, large
Suction catheter
Suction source
Pulse oximetry
End tidal carbon dioxide detector
Laryngoscope blades and handles
Syringes
Magill forceps
Water-soluble lubricant or anesthetic jelly
CPAP/BiPAP mask and machine
Supraglottic airways: laryngeal mask airway, intubating laryngeal mask airway, Shiley™ esophageal tracheal airway (Covidien, Boulder, CO), King LT® (King Systems, Noblesville, IN)
Backup equipment in the case of unsuccessful NIPPV*†

*See chapter 29, "Intubation and Mechanical Ventilation."

†See chapter 30, "Surgical Airways."

Abbreviations: BiPAP = bilevel positive airway pressure; CPAP = continuous positive airway pressure; NIPPV = noninvasive positive-pressure ventilation.

PREDICTING THE DIFFICULT AIRWAY

Anticipating challenges with airway management is best done before any attempts to intervene. Table 28–3 lists some factors that may complicate noninvasive airway management.

Table 28–3

Predictors of Difficult Noninvasive Airway Management Techniques[2]

BVM ventilation			
	M	Mask seal	Beard, trauma, or other situations that may cause BVM to not seal
	O	Obesity or Obstruction	
	A	Age	Age >55 years
	N	No teeth	
	S	Stiff lungs or chest wall	
Supraglottic airway			
	R	Restricted mouth opening	
	O	Obesity or Obstruction	
	D	Disrupted or Distorted airway	
	S	Stiff lungs or cervical spine	

Abbreviation: BVM: bag-valve mask ventilation.

OXYGENATION

Provide supplemental oxygen to all critically ill patients requiring airway management. The method of oxygenation used depends on the patient's clinical condition and oxygen requirement (**Table 28–4**). Even if the patient is apneic, providing supplemental oxygenation with nasal cannulae can extend the time to hypoxia and hypoxemia, allowing providers additional time to prepare for or attempt airway maneuvers.[3]

Table 28–4

Oxygen delivery methods

	O_2 Flow	Fio_2 Delivered
Nasal cannulae	2–5 L/min	20%–40%
Simple face mask	6–10 L/min	40%–60%
Non-rebreather mask	10–15 L/min	Near 100%

Abbreviation: Fio_2 = inhaled fraction of oxygen.

PATIENT POSITIONING

The first step in airway management is to optimize patient positioning to facilitate airway patency and subsequent airway management efforts.

Upper airway obstruction occurs in the unconscious patient as the intrinsic muscles of the neck and upper airway relax, causing the epiglottis to obstruct the laryngeal inlet. Although the tongue displaces posteriorly during anesthesia in supine patients, it may not always occlude the pharynx.[4]

The first relief step in upper airway obstructions is extension of the neck with anterior displacement of the mandible. This maneuver moves the hyoid bone anteriorly and, in turn, lifts the epiglottis away from the laryngeal inlet. Forward flexion of the neck in addition to extension ("sniffing" position) may also help to relieve upper airway obstructions and requires less neck extension. This can be accomplished by placing a *folded* towel

(not rolled) or foam rubber device underneath the patient's occiput. Neither maneuver should be attempted in patients when there is concern for cervical spine injury.

Oropharyngeal (Oral) Airway

An oropharyngeal or oral airway (Figure 28–1) is a curved, rigid instrument used to prevent the base of the tongue from occluding the hypopharynx. Use only in a comatose or deeply obtunded patient without a gag reflex. Properly sized oral airways should reach from the corner of the mouth to the angle of the mandible. Place an oral airway with the concave portion of the airway cephalad and rotated 180 degrees after passing the tongue. Alternatively, the concaved portion can be oriented horizontally and rotated 90 degrees, following the curvature of the tongue, after insertion.

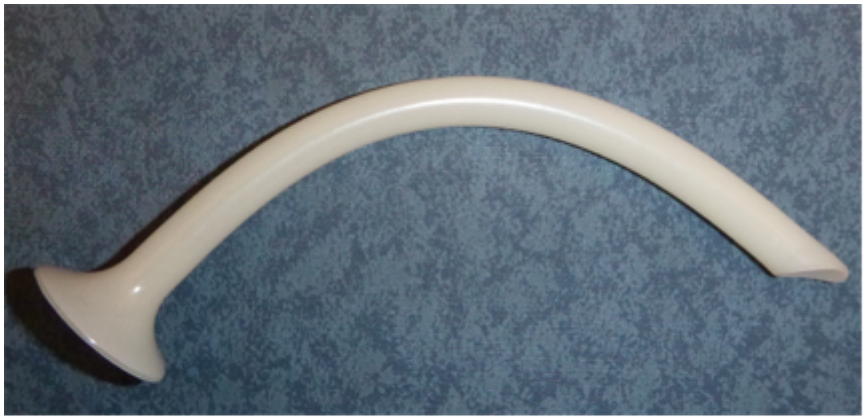
FIGURE 28–1.
An oral airway.

Nasopharyngeal (Nasal) Airway

A nasopharyngeal or nasal airway (Figure 28–2) is made of pliable material and is placed into the nostril, displacing the soft palate and posterior tongue. Nasal airways are helpful in patients with an intact gag reflex absent any midface trauma. Properly sized nasal airways should reach from

the corner of the mouth to the angle of the mandible. After lubrication, insert the nasopharyngeal airway in the most patent nostril and horizontal to the palate with the bevel oriented toward the nasal septum.

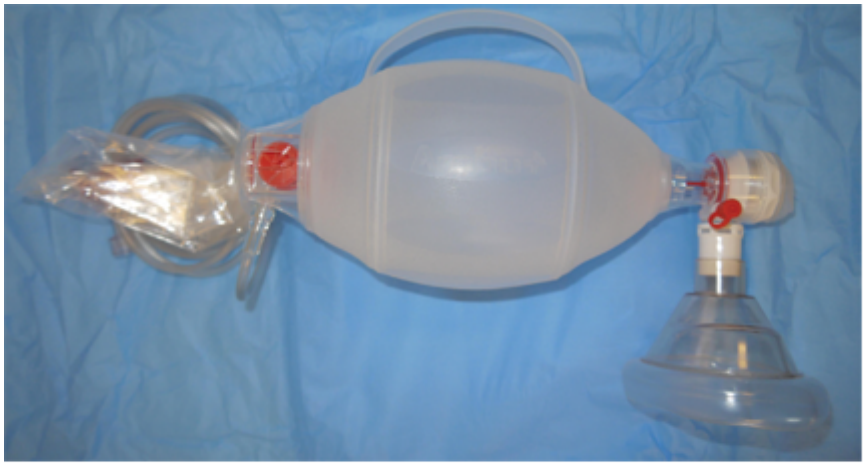
FIGURE 28–2.
A nasal airway.



Bag-Valve Mask

Bag-valve masks (BVMs) (**Figure 28–3**) contain a self-inflating insufflation bag coupled with a facemask and a valve to prevent re-inhalation of exhaled air. Effective BVM ventilation requires a good seal and a patent airway. Although typically used with supplemental oxygen, the BVM can aid even when used with room air. Most BVM systems deliver approximately 75% oxygen. A demand valve attached to the reservoir port of the ventilation bag may help to a deliver higher concentration of oxygen.[5] Adequate oxygenation and ventilation with a BVM require a good face–mask seal, which may be difficult in patients with facial trauma, facial hair, or anatomic anomalies or in those who are edentulous.

FIGURE 28–3.
Bag-valve mask.

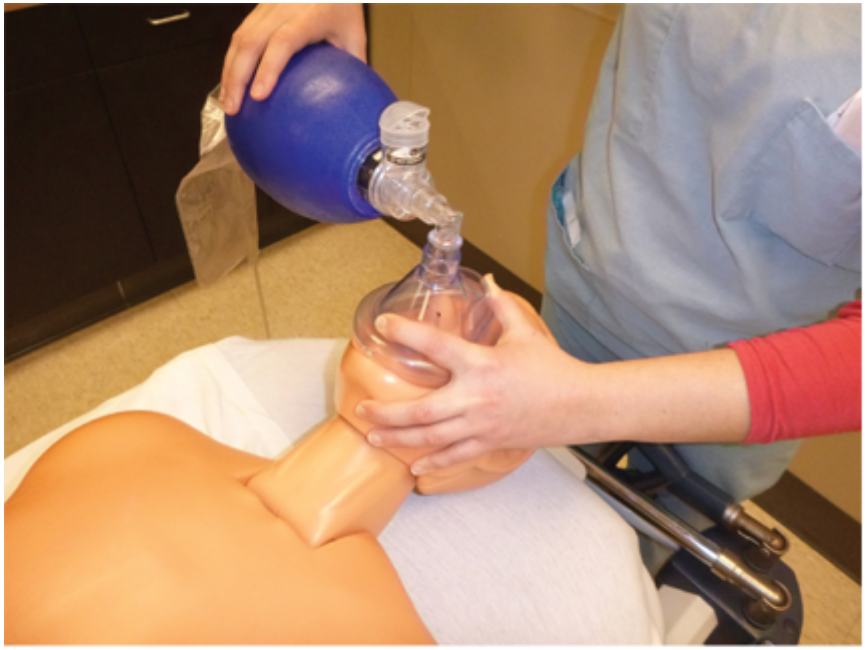


BVM ventilation is performed using one- or two-person techniques. Two-person techniques deliver greater tidal volumes than one-person techniques and are preferred if possible.[6]

With the one-person approach, the rescuer uses one hand to grasp and seal the mask and the other hand to squeeze the BVM reservoir bag. A common mask-sealing technique is to grasp the mask with the thumb and index finger in a "C" shape while placing the third, fourth and fifth digits in an "E" shape to lift the mandible. During mask ventilation, be careful to keep the fingers *on* the mandible, not compressing the soft tissue beneath (and hence compressing the airway) (**Figure 28–4A**).

FIGURE 28–4.

A. One-person bag-valve mask ventilation. B. Two-handed mask seal. C. Modified two-handed mask seal.



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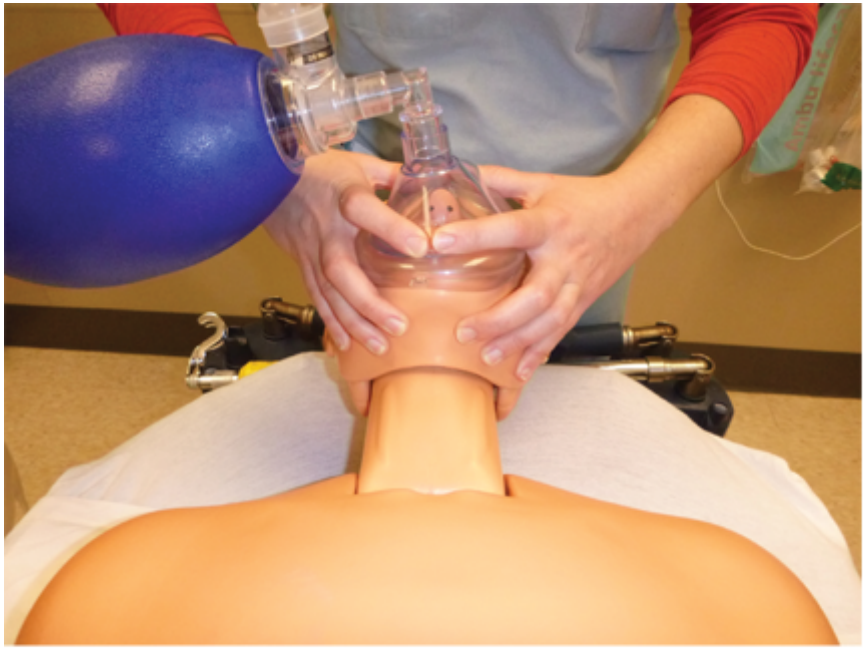

B

Source: J.E. Tintinalli, J.S. Stapczynski, O.J. Ma, D.M. Yealy, G.D. Meckler, D.M. Cline: Tintinalli's Emergency Medicine: A Comprehensive Study Guide, 8th Edition
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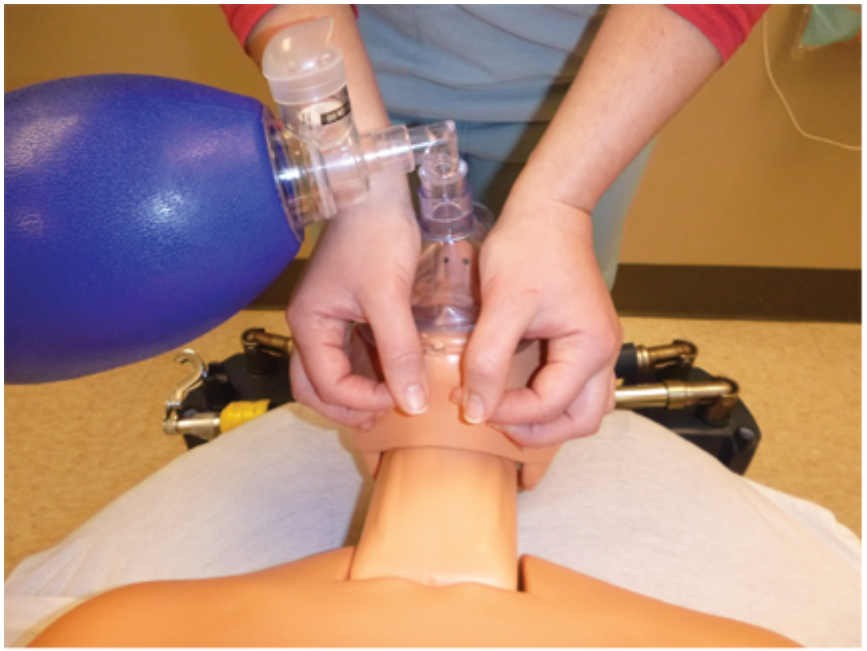


C

In the two-operator approach, one rescuer seals the facemask using both hands, while the other squeezes the reservoir bag. The rescuer sealing the mask may use the same "E-C" approach but with both hands applied to the mask (Figure 28–4B). In an alternate modified two-handed technique, the practitioner places the thenar eminence and thumb of each hand on the mask while the remaining digits grasp the mandible (Figure 28–4C). Both two-handed techniques provide similar tidal volumes.[6]

NONINVASIVE POSITIVE-PRESSURE VENTILATION

Noninvasive positive-pressure ventilation (NIPPV) provides positive-pressure airway support through a face or nasal mask without the use of an endotracheal tube or other airway device. NIPPV is an initial noninvasive airway management strategy. In adults, NIPPV includes continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP).

NIPPV helps to augment spontaneous respirations. Ideal patients for NIPPV are cooperative, have protective airway reflexes, and have intact ventilatory efforts. NIPPV is not appropriate in patients who have absent or agonal respiratory effort, impaired or absent gag reflex, altered mental status, severe maxillofacial trauma, potential basilar skull fracture, life-threatening epistaxis, or bullous lung disease. Use NIPPV with

caution in hypotensive patients because any volume depletion can be worsened from the positive pressure, triggering more hypotension (Table 28–5).

Table 28–5

Advantages and Adverse Effects of Noninvasive Positive Pressure Ventilation

Advantages	Disadvantages
Reduces work of breathing	Air trapping
Improves pulmonary compliance	Increased intrathoracic pressure leading to decreased venous return, afterload, and cardiac output, and hypotension
Recruits atelectatic alveoli	Pulmonary barotrauma leading to pneumothorax
Less sedation	Respiratory alkalosis
Shorter hospital stay	Abdominal compartment syndrome
Decreased rate of intubation without risks of endotracheal intubation	

NIPPV reduces work of breathing through multiple mechanisms.[7,8] NIPPV improves pulmonary compliance and recruits and stabilizes collapsed alveoli, improving alveoli aeration and ventilation-perfusion mismatches.[1] NIPPV increases both intrathoracic and hydrostatic pressure, shifting pulmonary edema into the vasculature. Increased intrathoracic pressure can also decrease venous return, transmural pressure, and afterload, leading to improved cardiac function. NIPPV also increases tidal volume and minute ventilation, leading to increased PaO_2 and reduction in $PaCO_2$. NIPPV reduces work of breathing by 60% and dyspnea scores by 29% to 67%, while improving inspiratory muscle endurance by 14% to 95% over spontaneous respirations.[1] The ability of NIPPV to improve pulmonary function such as forced expiratory volume and forced vital capacity is unclear.[9–11]

CPAP delivers a constant positive pressure throughout the respiratory cycle. **BiPAP** provides different levels of positive airway pressure during inspiration (inspiratory positive airway pressure [IPAP]) and expiration (expiratory positive airway pressure [EPAP]). Although the terms EPAP and positive end-expiratory pressure are often used interchangeably, positive end-expiratory pressure is specific to the end of the respiratory cycle whereas EPAP refers to the pressure administered via the BiPAP machine during the entire expiratory phase. Both CPAP and BiPAP can be used in a variety of patient populations with limited data directly comparing the two methods.

Be aware that different NIPPV devices exist with differing operating mechanisms. Many standard ventilators can provide NIPPV, although in these devices, the inspiratory and expiratory pressures are additive. For example, if the IPAP is set at 5 cm H_2O and the IPAP is set at 15 cm H_2O, the total delivered IPAP may be 20 cm H_2O (5 + 15). There are standalone NIPPV units that can provide both CPAP and BiPAP, allowing for independent setting of inspiratory and expiratory pressures. For example, if the IPAP is set at 5 cm H_2O and the IPAP is set at 15 cm H_2O, the total delivered IPAP will be 15 cm H_2O. Specialized adapters that connect directly to oxygen tanks and wall-mounted oxygen units may provide CPAP for a brief period of time. These devices have a limited range of settings and should be used on a temporary basis.

INITIATING AND TITRATING NIPPV

Select the mask for NIPPV to create a tight seal while preserving patient comfort. Base the initial settings on the patient's condition and type of respiratory failure. Typical starting settings for CPAP are 5 to 15 cm H_2O. Typical starting setting for BiPAP include "spontaneous" mode with IPAP set to 8 to 10 cm H_2O and EPAP set to 3 to 5 cm H_2O. Be cautious when using NIPPV at pressures >15 cm H_2O because this may increase the intrathoracic pressure, leading to barotrauma along with decreased venous return, decreased preload and afterload, and eventually decreased cardiac output.

NIPPV requires frequent assessment for work of breathing, heart rate, respiratory rate, oxygen saturation, and blood pressure. Arterial blood gas analysis can aid in titrating NIPPV but is not mandatory. EPAP can help open and stabilize collapsed alveoli and reverse hypoxemia. In patients in whom ventilation is an issue, adjust the IPAP settings to help decrease the work of breathing and improve ventilation.

If the patient is not tolerating NIPPV, the first potential cause is an air leak. NIPPV is a flow-limited, pressure support system, and therefore, leaks prevent the machine from reaching the preprogrammed flow rate for a set pressure. As a result, the inspiratory time may be prolonged, making each breath cycle less comfortable for the patient. Potential solutions for air leaks include programming the machine to limit the inspiratory time or selecting alternative modes of ventilation including proportional assist ventilation.[1] Proportional assist ventilation is a form of synchronized ventilatory support where the NIPPV machine generates pressure in proportion to the patient's instantaneous effort such that as the patient

generates a greater inspiratory effort, the machine generates greater IPAP. This allows the machine to adjust to air leaks that may impair ventilation and oxygenation with other modes (CPAP and BiPAP). Although proportional assist ventilation has not been shown to improve clinical outcomes, it is better tolerated by some patients.[12]

If the patient is not improving with NIPPV, consider endotracheal intubation and ventilation.

NIPPV Applications

The most common use of NIPPV is for **cardiogenic pulmonary edema** where NIPPV may reduce rates of endotracheal intubation, hospital length of stay, and mortality.[13–20] In patients with **chronic obstructive pulmonary disease,** NIPPV is helpful in those with respiratory acidosis.[21] NIPPV may similarly benefit patients with moderate to severe **asthma** exacerbations, although data on effectiveness are limited.[22] Because of the bronchospastic nature of chronic obstructive pulmonary disease and asthma, be vigilant for air trapping and subsequent barotrauma when using NIPPV.

NIPPV may reduce the rate of intubation and in-hospital death in patients with **pneumonia**.[23–25] Exercise caution in this patient group because hypovolemia may coexist, with resultant NIPPV-induced hypotension.

There are reports of NIPPV use in **blunt chest wall trauma,** including **flail chest,** although it does not yet clearly decrease mortality or hospital length of stay.[26–28] NIPPV is also reported in burn patients. Do not use NIPPV in patients with suspected or confirmed high esophageal or tracheal injuries, maxillofacial or basilar skull fractures, or severe facial burns.[29,30]

Prehospital NIPPV

Prehospital NIPPV in patients with cardiogenic pulmonary edema and chronic obstructive pulmonary disease decreases the rate of subsequent intubation and mortality.[31–34] When such patients arrive in the ED, assess the response to NIPPV and determine whether to discontinue NIPPV, adjust the NIPPV settings, or change to invasive airway strategies.

NIPPV Complications

Complications of NIPPV include difficulty with mask seal, patient discomfort, aspiration (rare), air trapping, pulmonary barotrauma including pneumothorax, and increased intrathoracic pressure leading to decreased cardiac output and hypotension. Monitor patients carefully to

determine NIPPV effectiveness and to identify the need to further secure the airway with intubation. Aspiration risk can be minimized by proper patient selection[35]; make sure patients have a gag reflex and do not have altered mental status. Gastric distension and increased intragastric pressure can lead to *abdominal compartment syndrome*, resulting in oliguria, hypoxia, hypercarbia, high peak inspiratory pressures, and even renal failure. A nasogastric tube can decompress the stomach and relieve this syndrome.[36] Although complications are uncommon, evaluate patients frequently to identify any of these complications early.

Occasionally, patients develop anxiety and agitation during NIPPV treatment due to the claustrophobic feeling of the mask or the discomfort of positive-pressure ventilation. Anxiety and agitation can increase the work of breathing and result in NIPPV asynchrony. Although often relieved with encouragement, verbal support, or hand restraints, anxiety and agitation may require the administration of sedatives or anxiolytics. There are no systematic studies of sedation during NIPPV, and sedation practices are typically based on physician preference.[35,37] Avoid agents or doses that cause excess sedation or respiratory depression. Dexmedetomidine, a centrally acting α_2 agent, can provide sedation without decreasing respiratory drive, but its expense and availability limit general use.[38] Benzodiazepines and opiates are commonly used but can be difficult to titrate and may cause respiratory depression.[35,37,38] Haloperidol in low doses may accomplish anxiolysis with less respiratory depression than opiates or benzodiazepines.[37]

HIGH FLOW NASAL CANNULA (HFNC)

Supplemental oxygen via nasal cannula and face-masks often is insufficient for patients in severe respiratory distress. Oxygen delivered through a high-flow nasal cannula (HFNC) provides humidified, heated oxygen at flow rates up to 60 L/minute,[39] providing positive pressure and decreasing the work of breathing.[40,41] HFNC helps in patients with hypoxemia and an intact respiratory drive, often as an alternative to intubation or noninvasive positive-pressure ventilation. It is best avoided in those not breathing or with bullous lung disease and pneumothoraces.[42] Another option is flush rate oxygenation, where the wall oxygen unit is turned past 15 L/minutes to maximum flow rates of 40-60 L/minute.[43,44] The latter aids avoiding desaturation during rapid intubation techniques in addition to other respiratory distress evets. Both HFNC and flush rate oxygenation are best seen as bridges to awaiting clinical improvement or other ventilation methods.

SUPRAGLOTTIC AIRWAYS

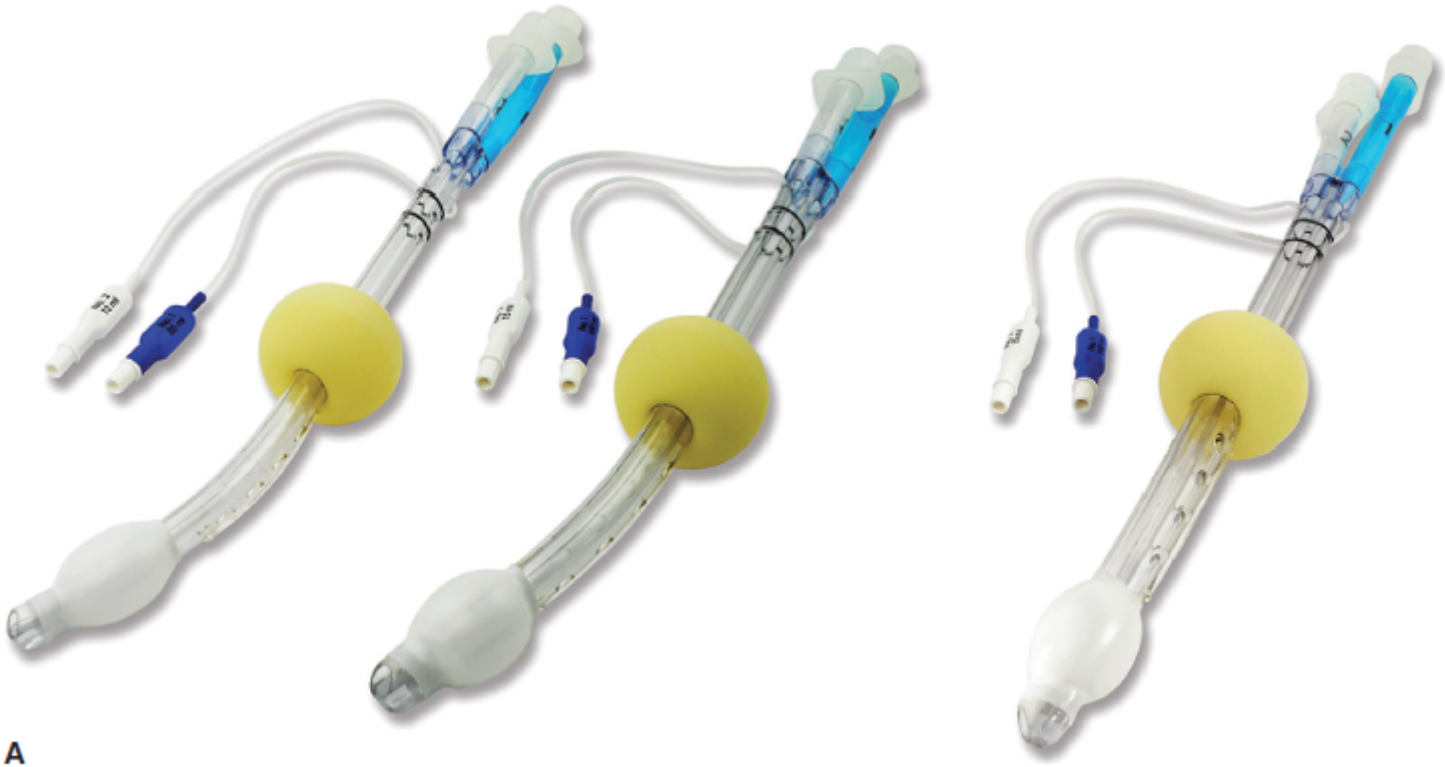
Supraglottic airways (SGAs) are devices placed in the oropharynx, allowing for oxygenation and ventilation without the use of an endotracheal tube. SGAs are the initial bridge to endotracheal intubation or a rescue device after failed intubation efforts. Although SGAs provide adequate

oxygenation and ventilation for short periods of time, they are not used for prolonged ventilation. SGA should not be the initial airway management strategy in any patient needing high inspiratory pressures (e.g., chronic obstructive pulmonary disease) given the seal issues and leak that occur.[45] Although these devices are often used during cardiac arrest care, an animal study suggests that the large cuffs of these devices can impair carotid blood flow during cardiac arrest.[46]

SGAs are most often placed in apneic, unconscious patients; their large cuffs can cause gagging and discomfort in awake patients. Another option is use after deploying a rapid sequence induction medication regimen.[47] Providers must confirm proper position of any SGA with end-tidal carbon dioxide and then secure it with tape or commercial holders.[48,49] A number of SGAs are commercially available (Figure 28–5A–C).

FIGURE 28–5.

Esophageal airways. A. Shiley™ esophageal tracheal airway (Copyright ©2014 Covidien. All rights reserved. Used with permission of Covidien, Boulder, CO.). B. King LT. C. Laryngeal Mask Airway.



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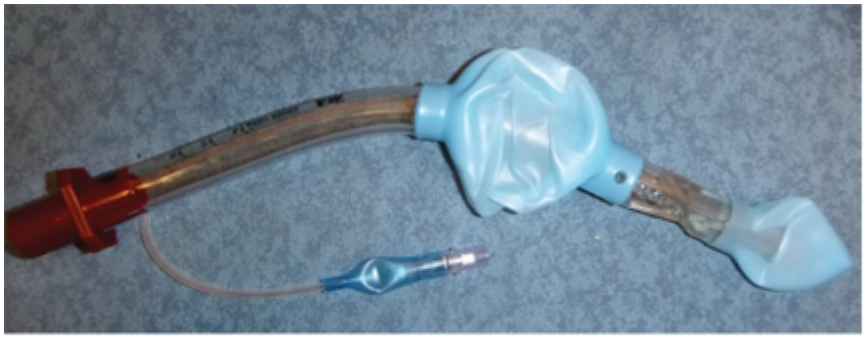

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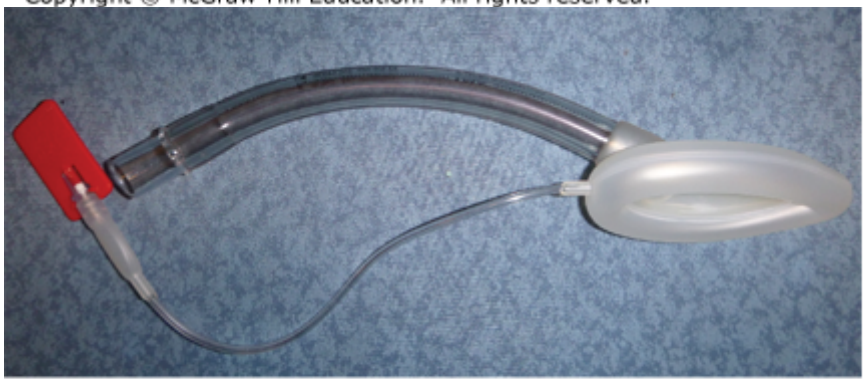

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SHILEY™ ESOPHAGEAL TRACHEAL AIRWAY

The Shiley™ esophageal tracheal airway (Covidien, Boulder, CO; Figure 28–5A) is a plastic double-lumen tube that is inserted blindly. It has a proximal low-pressure cuff that seals the pharyngeal area and a distal cuff that seals the esophagus. After placement, the proximal balloon is inflated with 80 cc of air while the distal balloon is inflated with 10 cc of air. During insertion, the device may rest in the esophagus or trachea. To determine the location of the device, first ventilate through the longer blue port; this allows oxygen to be delivered through fenestrations between the proximal and distal balloons. If chest rise is absent, the ETC is in the trachea; switch to ventilation to the shorter, clear/white port. The standard Shiley™ esophageal tracheal airway is sized for patients 5 feet, 6 inches or taller. The Shiley™ is used for patients 4 feet to 5 feet, 6

inches tall. Complication with the Shiley™ include hypoxia (from ventilating the incorrect port), esophageal perforation, and aspiration pneumonitis.[50]

KING LARYNGEAL TUBE (KING LT™)

The King LT™ (King Systems, Noblesville, IN) (Figure 28–5B) is similar to an ETC but has a *single* lumen. A proximal cuff seals the posterior oropharynx while a distal cuff occludes the esophagus. The King LT is placed blindly into the oropharynx until the lip aligns with the device lip line. The balloon is then inflated to a pressure of 60 cm H_2O. After placement, the provider may need to withdraw the King LT slightly to allow it to fully occlude the oropharynx. The King LT is placed in the esophagus >95% of the time, allowing ventilation of the trachea through the multiple fenestrations between the proximal pharyngeal and distal esophageal cuffs.[51] Complications with the King LT are similar to the Shiley™ but also include tongue engorgement whereby the proximal balloon can impair venous drainage of the tongue.[52] Removing the King LT will relieve this condition. The King LT is available in several sizes depending on the patient's height: 4 to 5 feet, size 3 (yellow); 5 to 6 feet, size 4 (red); and >6 feet, size 5 (purple).

LARYNGEAL MASK AIRWAY (LMA™)

The Laryngeal Mask Airway (LMA™; Teleflex, Research Triangle Park, NC; Figure 28–5C) is another SGA placed blindly through the mouth; it occludes the structures around the larynx. The LMA consists of a single cuff inflated with generally 20 to 30 mL of air. To insert the LMA, place a gloved index finger into the oropharynx to guide the device into the oropharynx and position the cuff around the larynx. The LMA is an alternative when the endotracheal tube fails, especially when the vocal cords cannot be visualized, and is successfully placed 88% to 100% of the time.[53,54] There are various models, including an intubating LMA, which allows an endotracheal tube to be passed through the lumen. This permits conversion from an SGA to an endotracheal tube without visualizing the glottis. Complications of the LMA include partial or complete airway obstruction and aspiration of gastric contents, although animal data suggest the LMA may prevent aspiration.[55] The LMA is available in several sizes based on the patient's estimated body weight: 50 to 70 kg, size 4; 70 to 100 kg, size 5; and >100 kg, size 6.

OTHER SUPRAGLOTTIC AIRWAYS

Other SGAs are available including the i-gel® (Intersurgical Inc., Liverpool, NY) and CobraPLA™ (Engineered Medical Systems, Indianapolis, IN). These have not been well studied for emergency care. The i-gel has a soft, gel-like cuff that seals the perilaryngeal structures without inflation. This limits tissue compression that may be caused by devices with large cuffs. Lubricate the gel-like cuff prior to insertion. The device is advanced

into the poster pharynx until resistance is met and the lips align with the lip line on the i-gel. The i-gel is available in various sizes for patients from 2 to >90 kg.

The CobraPLA is a cuffed SGA that is inserted blindly similarly to the King LT. The potential advantage of the CobraPLA is that providers can pass an endotracheal tube through the lumen of the device, easing conversion to an endotracheal tube. Like all SGAs, neither of these is used for long-term ventilation or in conditions that may require elevated peak airway pressures, and neither has proven to prevent aspiration. The CobraPLA is available in various sizes for patients from 2.5 to >130 kg.

Converting a Supraglottic Airway to an Endotracheal Tube

In general, SGAs may have a higher risk of aspiration than endotracheal tubes, and the large cuffs may cause hypopharyngeal mucosal damage. Thus, although SGAs may play an essential role during emergent airway management, endotracheal tubes are better suited for long-term ventilation. **SGAs do not need to be *immediately* changed to an endotracheal tube**. The urgency for conversion depends on the condition of the patient, the adequacy of oxygenation and ventilation through the SGA, and the reasons for SGA insertion. Strategies for converting an SGA to endotracheal tube include:

Remove the supraglottic device and perform direct laryngoscopy. Determine why the SGA was initially inserted. If the SGA was placed because of intubation difficulty, removing the SGA and attempting direct laryngoscopy is risky, and alternative techniques should be strongly considered. When attempting direct visualization, use airway adjuncts (gum elastic bougie, video laryngoscopy, etc.) to help make laryngoscopy efforts successful.

Convert the SGA with a gum elastic bougie (King LT only). To exchange the SGA over a gum elastic bougie, insert the gum elastic bougie blindly though the King LT into the trachea and then remove the King LT, leaving the gum elastic bougie in place. Then pass a standard endotracheal tube over the bougie. This is a "blind" exchange, meaning that the operator does not visualize the glottis during the conversion. This maneuver is not possible with the Shiley™ or standard LMA.

Convert the SGA with a fiberoptic bronchoscope (King LT or LMA). To convert using a fiberoptic bronchoscope, one must use a special intubating catheter (Aintree; Cook Medical, Inc., Bloomington, IN), which is similar to a bougie but is hollow, allowing placement over a fiberoptic bronchoscope. First, place the catheter over the fiberoptic scope, and then direct the scope into the trachea. Next, remove the fiberoptic scope and SGA, leaving the catheter in the trachea. Finally, direct a standard endotracheal tube over the catheter into the trachea. This technique allows for visualization of the glottis but requires expertise in the use of a fiberoptic bronchoscope. This technique is not possible with the Shiley™.

Leave the SGA in place and perform a surgical airway (cricothyroidotomy or tracheostomy). Providers may elect to convert directly to a surgical airway in cases where an SGA was placed due to difficulties with intubation and if the patient requires prolonged mechanical ventilation. This can be done either in the operating room or in the ED if needed depending on the patient's condition, available resources, and skills of the provider.

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USEFUL WEB RESOURCES

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57. American Heart Association 2010 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: Adjuncts for Airway Control and Ventilation—http://circ.ahajournals.org.lproxy.nymc.edu/content/122/18_suppl_3/S729.full