

# Current Concepts in the Management of The Difficult Airway

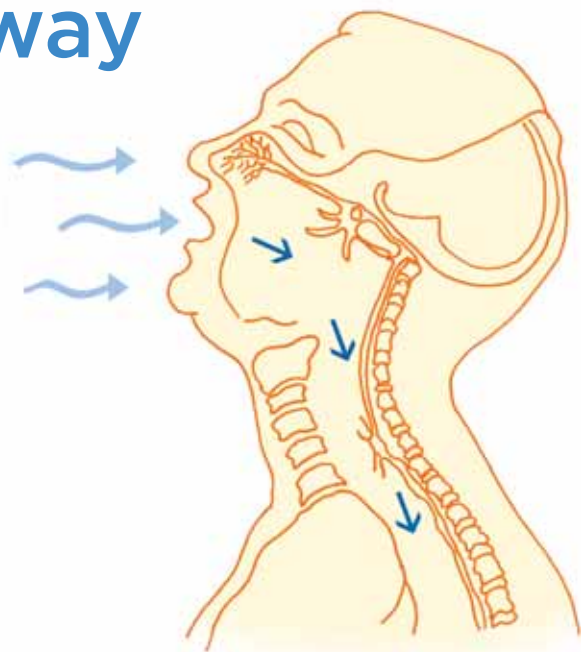


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The practice of airway management has become more advanced in recent years. This advancement is demonstrated by the introduction of many new airway devices, several of which have been included in the American Society of Anesthesiologists (ASA) Difficult Airway Algorithm (Figure).<sup>1</sup>

Management of the difficult airway remains one of the most relevant and challenging tasks for anesthesia care providers. Claims involving airway management continue to comprise an important aspect of the ASA Closed Claims Project database, which tracks all anesthesia-related insurance claims.<sup>2</sup>

This review focuses on several of the alternative airway management devices/techniques and their clinical applications, with particular emphasis on the difficult or failed airway.

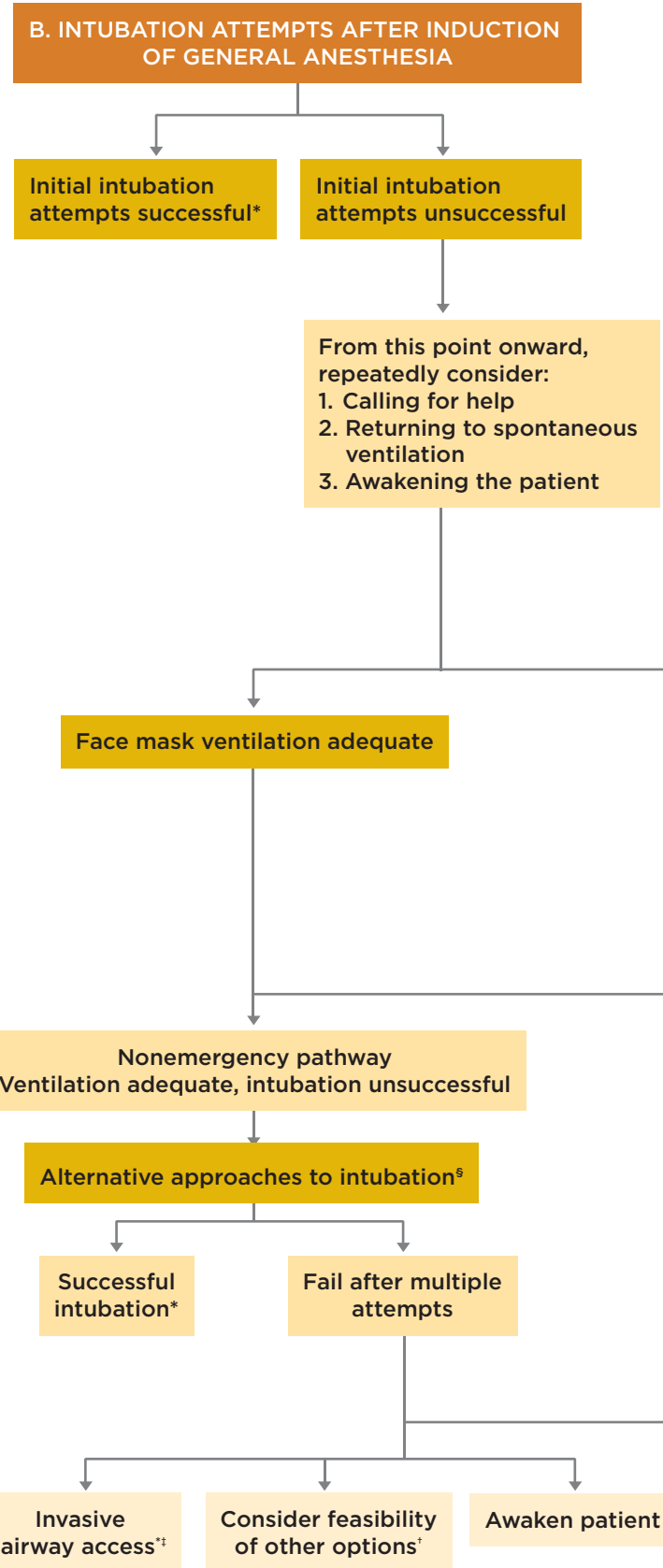
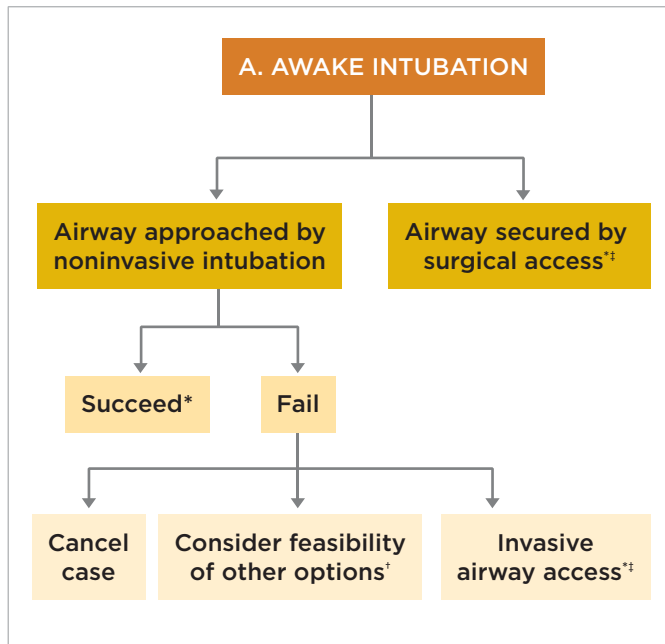
## Alternative Airway Devices

A common factor preventing successful tracheal intubation is the inability to visualize the vocal cords during the performance of direct laryngoscopy. Many devices and techniques are now available to circumvent the problems typically encountered with a difficult airway using conventional direct laryngoscopy.

## ENDOTRACHEAL TUBE GUIDES

A number of endotracheal tube (ET) guides (Table 1) have been used to aid in intubation, including the Portex Venn Tracheal Tube Introducer (Smiths Medical ASD, Keene, NH/Smiths Medical, Hythe, Kent, England) and, more recently, the Single-Use Bougie (Smiths Medical ASD), Frova Intubating Introducer (Cook Critical Care, Bloomington, Ind), the Aintree Intubation Catheter (Cook Critical Care), the Arndt Airway Exchange Catheter Set (Cook

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**Figure. Difficult airway algorithm.**

\* Confirm ventilation, tracheal intubation, or LMA placement with exhaled CO<sub>2</sub>.

† Other options include (but are not limited to): surgery utilizing face mask or LMA anesthesia, local anesthesia infiltration, or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the emergency pathway.

‡ Invasive airway access includes surgical or percutaneous tracheostomy or cricothyrotomy.

§ Alternative noninvasive approaches to difficult intubation include (but are not limited to): use of different laryngoscope blades, LMA as an intubation conduit (with or without fiber-optic guidance), fiber-optic intubation, intubating stylet or tube changer, light wand, retrograde intubation, and blind oral or nasal intubation.

|| Consider reparation of the patient for awake intubation or cancellation of surgery.

¶ Options for emergency noninvasive airway ventilation include (but are not limited to): rigid bronchoscope, esophageal-tracheal Combitube ventilation, or transtracheal jet ventilation.

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**1. Assess the likelihood and clinical impact of basic management problems:**

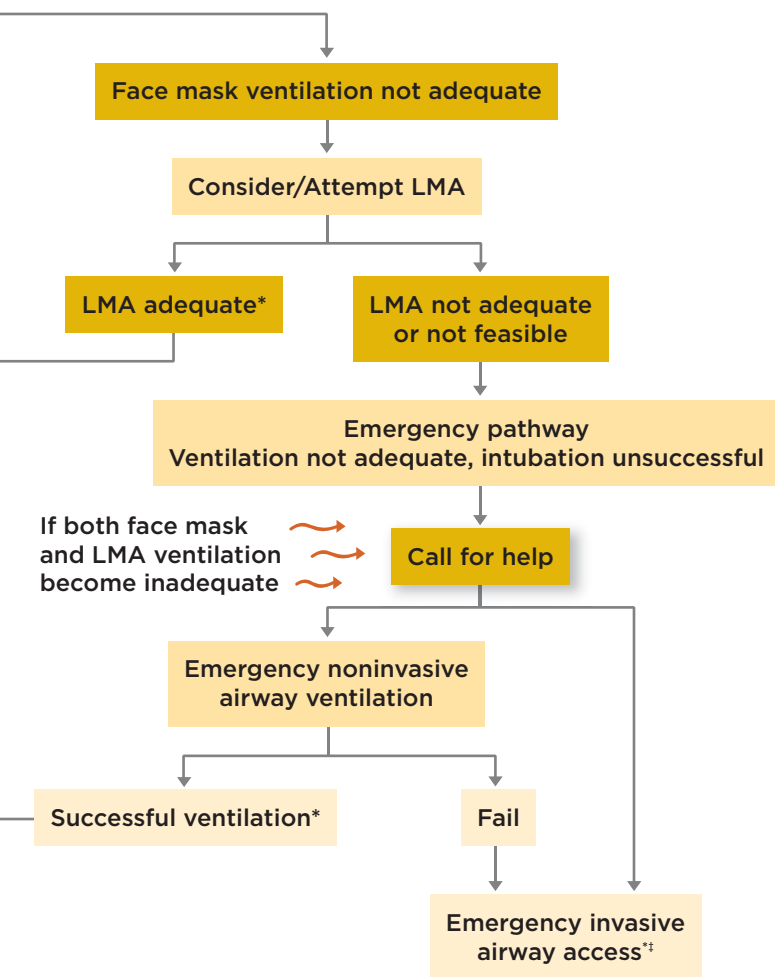
- a. Difficult ventilation
- b. Difficult intubation
- c. Difficulty with patient cooperation or consent
- d. Difficult tracheostomy

**2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.**

**3. Consider the relative merits and feasibility of basic management choices:**

- a. Awake intubation vs intubation attempts after induction of general anesthesia
- b. Noninvasive technique for initial approach to intubation vs invasive technique for initial approach to intubation
- c. Preservation of spontaneous ventilation vs ablation of spontaneous ventilation

**4. Develop primary and alternative strategies:**



Critical Care), the Cook Airway Exchange Catheter EF (Cook Critical Care), and the Cook Airway Exchange Catheter EF Soft Tip (Cook Critical Care).

**LIGHTED STYLETS**

In the past several years, a number of lighted stylets have been developed, including light wands such as the Trachlight (Laerdal Medical Corp, Stavanger, Norway), and visual scopes, such as the Shikani Optical Stylet (SOS; Clarus Medical, Minneapolis), Flexible Airway Scope Tool (FAST; Clarus Medical), Levitan GLS (Clarus Medical), Bonfils Retromolar Intubation Fiberscope (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif), and the Brambrink Intubation Endoscope (Karl Storz Endoscopy). Light wands rely on transillumination of the tissues of the anterior neck to demonstrate the location of the tip of the ET—a blind technique, unless combined with direct laryngoscopy (Table 2).<sup>3,4</sup> The visual scopes, on the other hand, utilize fiber-optic imagery and allow indirect visualization of the airway. They also can be used alone or in conjunction with direct laryngoscopy.

**RIGID LARYNGOSCOPES**

It is beyond the scope of this review to discuss all of the laryngoscopes that have been manufactured; thus, only some of the most recently developed blades will be described. Modifications of traditional laryngoscope blades are primarily designed to overcome certain problems associated with difficult airway management, such as limited mouth opening, anterior larynx, sternal space restriction, small intraoral cavity, and immobile or unstable cervical spines (Table 3).<sup>5-8</sup>

**INDIRECT RIGID FIBER-OPTIC LARYNGOSCOPES**

These laryngoscopes were designed to facilitate tracheal intubation in the same population that would be considered for flexible fiber-optic bronchoscopy, such as patients with limited mouth opening or neck movement. Relative to the flexible fiber-optic bronchoscopes (FOBs), they are more rugged in design, control soft tissue better, allow for better management of secretions, are more portable (with the exception of the new portable FOBs), and are not as costly. Intubation can be performed via the nasal or oral route and can be accomplished in awake or anesthetized patients (Table 4).<sup>9-11</sup>

**SUPRAGLOTTIC VENTILATORY DEVICES**

The Laryngeal Mask Airway (LMA; LMA North America, Inc, San Diego) is the single most important development in airway devices in the past 25 years. Since its introduction into clinical practice, it has been used in more than 150 million patients worldwide with no reported deaths.<sup>12</sup> Several new variants of the LMA Classic, or standard LMA, are available, including the

**Table 1. Endotracheal Tube Guides**

Name/Manufacturer	Description	Length, cm	Clinical Applications	Special Features
Portex Venn Tracheal Tube Introducer (Smiths Medical ASD, Keene, NH/Smiths Medical International, Hythe, Kent, England)	15-Fr ET introducer made from a woven polyester base, with a coude tip (angled 35 degrees at its distal end). Also known as the <i>gum elastic bougie</i> . Color: golden brown.	60	Proven useful in patients with an anterior larynx (grades 2b, 3, and 4) and those with limited mouth opening. Can be used by slightly protruding through the ET, or placing it directly into the glottis and then placing an ET over it.	Nondisposable and reusable. Size 5 Fr is single use. Has excellent memory properties. Coude tip effectively detects “tracheal clicks” to confirm correct placement. Part of a range of introducers, stylets, and guides for adults and pediatrics. Can be reused after cold water disinfection.
Single-Use Bougie (Smiths Medical ASD, Keene, NH/Smiths Medical International, Hythe, Kent, England)	New 15-Fr PVC ET introducer with coude tip. Has a hollow lumen that discourages reuse and is provided sterile. Color: ivory.	70	Single-use product reduces the risk of cross contamination. Otherwise, same as Portex Venn Tracheal Tube Introducer.	Similar to Portex Venn Tracheal Tube Introducer, but hollow lumen allows oxygenation/ventilation. Single use.
Frova Intubating Introducer (Cook Critical Care, Bloomington, Ind)	Polyethylene 8- and 14-Fr AEC with angled distal tip and 2 side ports. Has a hollow lumen and is packaged with a stiffening cannula and removable Rapi-Fit adapters. Color: blue.	35, 65	Facilitates endotracheal intubation and allows simple ET exchange. Can also be used by placing it first in the ET, with its tip protruding, or placing it directly into the glottis and then placing the ET over it.	Can be used in pediatric population for ETs as small as 3.0 mm. Hollow lumen allows oxygenation/ventilation in all sizes. Single use.
Aintree Intubation Catheter (Cook Critical Care, Bloomington, Ind)	Polyethylene 19-Fr AEC allows passage of an FOB through its lumen. Has 2 distal side holes and is packaged with Rapi-Fit adapters. Color: light blue.	56	Exchange of SGAs for ETs $\geq 7.0$ mm using an FOB. Its hollow lumen allows insertion of an FOB directly through the catheter so that the airway can be indirectly visualized.	Large lumen (4.7 mm) allows passage of FOB. Rapi-Fit adapters allow both jet ventilation and ventilation with 15-mm adapter (anesthesia circuit or Ambu bag). Single use.
Arndt AEC Set (Cook Critical Care, Bloomington, Ind)	Polyethylene 8- and 14-Fr AEC with a tapered end, multiple side ports, packaged with a stiff wire guide, bronchoscope port, and Rapi-Fit adapters. Color: yellow.	50, 65, 78	Exchange of LMAs and ETs using an FOB.	Tapered end and multiple side ports. Rapi-Fit adapters allow both jet ventilation and ventilation with 15-mm adapter (anesthesia circuit or Ambu bag). Single use.
Cook AEC EF (Cook Critical Care, Bloomington, Ind)	Polyethylene 11- and 14-Fr EF AEC that facilitates exchange of DLT of 4.0 mm or larger ID. Also comes in a soft-tipped version. Color: green.	100	Exchange of DLTs.	Extra firm with 2 distal side holes. The soft-tip version offers a more flexible tip to help minimize tracheal trauma. Rapi-Fit adapters as above, but should be used primarily for jet ventilation because of length. Single use.

Abbreviation key for all tables is on page 19.

LMA Flexible (wire-reinforced flexible), LMA Unique (disposable), LMA Fastrach (intubating, reusable, and disposable), the LMA ProSeal (50% higher seal pressure, with gastric drain tube), the LMA CTrach (a Fastrach with integrated fiber optics), and most recently, the LMA Supreme (disposable ProSeal).

Other supraglottic ventilatory devices (Table 5)<sup>13-16</sup> include the Soft-Seal Laryngeal Mask (Smiths Medical ASD), the CobraPLA<sup>17</sup> (Engineered Medical Systems, Indianapolis), the King Laryngeal Tube (King Systems Corp, Noblesville, Ind/VBM Medizintechnik GmbH, Sulz, Germany), and the Esophageal Tracheal Combitube (Tyco Healthcare/Mallinckrodt Nellcor Puritan Bennett, Pleasanton, Calif).

## Special Airway Techniques

### *FLEXIBLE FIBER-OPTIC INTUBATION*

Flexible fiber-optic intubation is a very reliable approach to difficult airway management and assessment. It has a more universal application than any other technique. It can be used orally or nasally for both upper and lower airway problems and when access to the airway is limited, as well as in patients of any age and in any position. Technological advances, including improved optics, battery-powered light sources, better aspiration capabilities, increased angulation capabilities, and improved reprocessing procedures, have been developed. Rescue techniques, such as direct laryngoscopy and placing a retrograde guidewire through the suction channel, may be used if the glottic opening cannot be located with the scope, or if blood or secretions are present.<sup>18</sup> Insufflation of oxygen or jet ventilation through the suction channel may provide oxygen throughout the procedure, and allow additional time when difficulty arises in passing the ET into the trachea.<sup>19</sup>

### *RETROGRADE INTUBATION*

Retrograde intubation (Table 6) is an excellent technique for securing a difficult airway either alone or in conjunction with other airway techniques.<sup>20</sup> Every anesthesia care provider should be skilled in employing this simple, straightforward technique. It is especially useful in patients with limited neck mobility (ie, that is associated with cervical spine pathology, or in those who have suffered airway trauma). Recent advancements in the technique include the introduction of the Arndt Airway Exchange Catheter and needle holder to the preexisting retrograde intubation set.

### *TRANSTRACHEAL JET VENTILATION*

Transtracheal jet ventilation (TTJV) is a well-accepted method for securing ventilation in rigid and interventional bronchoscopy (Table 6).<sup>21</sup> There are a number of commercial manual jet ventilation devices currently available, including the Manujet III Jet Ventilator (VBM

Medizintechnik GmbH, Sulz, Germany), the Manual Jet Ventilator (Instrumentation Industries, Bethel Park, Pa), and the Jet Ventilator (National Anesthesia Associates, Inc, San Marcos, Calif). The Enk Oxygen Flow Modulator (Cook Critical Care) is a new device that is recommended for use when jet ventilation is appropriate but a jet ventilator is not available.<sup>22</sup> The Wadhwa Emergency Airway Device (Cook Critical Care) can also be used for TTJV.<sup>23,24</sup> It is actually several devices in one (Table 6). It has an emergency nasopharyngeal airway catheter; a large diameter transtracheal needle for a cricothyrotomy procedure with the option for TTJV; and the main body of the device, which acts as a blow tube or 15-mm adapter.

### *CRICOTHYROTOMY*

Cricothyrotomy (Table 7), a lifesaving procedure, is the final option for “cannot-intubate, cannot-ventilate” patients according to all airway algorithms, whether they concern prehospital, emergency department, intensive care unit, or operating room patients.

In adults, needle cricothyrotomy should be performed with catheters at least 4 cm and up to 14 cm in length. A 6-Fr reinforced fluorinated ethylene propylene Emergency Transtracheal Airway Catheter (Cook Critical Care) has been designed as a kink-resistant catheter for this purpose.

Percutaneous cricothyrotomy involves using the Seldinger technique to gain access to the cricothyroid membrane. Subsequent dilation of the tract permits passage of the emergency airway catheter. The Melker Cuffed Emergency Cricothyrotomy Catheter Set is available with a 5.0-mm cuffed airway catheter (Cook Critical Care). A Portex (Smiths Medical) emergency cricothyrotomy kit is available (United Kingdom only) that uses a Veress needle and integral dilator to insert a 6.0-mm cuffed ET. The QuickTrach (VBM Medizintechnik GmbH) is available for children and adults in 2.0-mm and 4.0-mm IDs, respectively.

Surgical cricothyrotomy is performed by making incisions through the cricothyroid membrane using a scalpel, followed by the insertion of an ET. This is the most rapid technique and should be used when equipment for the less invasive techniques is unavailable and speed is particularly important.

### *TRACHEOSTOMY*

Tracheostomy (Table 8) establishes transcutaneous access to the trachea below the level of the cricoid cartilage.<sup>25</sup> Emergency tracheostomy may be necessary when acute airway loss occurs in children younger than 10 years of age or children whose cricothyroid space is considered too small for cannulation, as well as in individuals whose laryngeal anatomy has been distorted by the presence of pathologic lesions or infection.<sup>26</sup>

Percutaneous dilatational tracheostomy is the most commonly performed tracheostomy technique, yet it is

**Table 2. Lighted Stylets**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
Trachlight Stylet (Laerdal Medical AS, Stavanger, Norway/Wappingers Falls, NY)	Consists of 3 parts: a reusable handle, a flexible wand, and a stiff, retractable stylet.	Available in 3 sizes: adult, child, and infant. Accommodates ETs 2.5-10.0 mm ID. <sup>3</sup>	Although it can be used for routine intubations, it is especially useful in situations in which the FOB is unavailable (eg, in ambulances or outside locations) or in which bronchoscopy is difficult to perform (eg, when an airway is obscured by blood or secretions or when a patient's head cannot be flexed or extended).	Blind technique that can be used alone or in conjunction with other techniques.
Shikani Optical Stylet (SOS; Clarus Medical, Minneapolis)	High-resolution, stainless steel, malleable fiber-optic stylet that comes in a preformed J-shape. Has an adjustable tube stop and integral oxygen port for oxygen insufflation.	Adult (ETs $\geq 5.5$ mm ID). Pediatric (ETs 2.5-5.0 mm ID).	Similar to flexible FOB. Can be used alone or as an adjunct to laryngoscopy and is especially useful for those unable to maintain skills with a bronchoscope. <sup>4</sup>	Has the simple form of a standard stylet, plus the advantage of a fiber-optic view and maneuverability of its tip. Portable, rugged, and better maneuverability than the flexible FOB. Light sources include battery-powered (4 AA-size), fiber-optic light source, or green line laryngoscope handle with adapter.
Flexible Airway Scope Tool (FAST; Clarus Medical, Minneapolis)	Flexible stylet with a nondirectable tip.	Adult (ETs $\geq 5.0$ mm).	Allows for visualization during intubation through ILMA or quick confirmation of SGA or ET placement.	This device has been modified with a tip that allows it to be used for nasal intubation—FAST Plus (Clarus Medical, Minneapolis).
Levitan GLS (Clarus Medical, Minneapolis)	Similar to the SOS, but does not have a movable tube stop.	Adult (ETs $\geq 5.5$ mm).	Designed as an adjunct to direct laryngoscopy. Can also be used as a stand-alone device similar to the SOS.	Very similar to the SOS, but requires the user to cut the ET because it does not have a movable tube stop. Use either a GreenLine laryngoscope handle or an LED light source.
Bonfils Retromolar Intubation Fiberscope (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif)	High-resolution rigid fiber-optic stylet with a fixed 40-degree curved shape at the distal end. Available with and without a working channel for ease of cleaning. Available with a standard eyepiece or with a DCI for video.	3.5- and 5.0-mm OD. ET must be $\geq 0.5$ mm larger to fit.	Able to elevate a large, floppy epiglottis and navigate through the oropharynx of patients with excessive pharyngeal soft tissue.	Fixed-shaped shaft with an adjustable eyepiece that allows ergonomic movement during intubation, in addition to an adapter for fixation of ETs and oxygen insufflation. Portable, rugged, and better maneuverability than the flexible FOB. Used with a battery-powered or fiber-optic light source.
Brambrink Intubation Endoscope (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif)	High-resolution semiflexible fiber-optic stylet with a 40-degree curved shape at the distal end, 40x magnification, a fixed eyepiece, a movable ET tube holder, and an insufflation port.	2.0-mm OD. ET must be $\geq 0.5$ mm larger to fit.	Similar to Bonfils Retromolar Intubation Fiberscope.	Available with a standard eyepiece or a DCI for video cameras.

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**Table 2. Lighted Stylets (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
SensaScope (Acutronic Medical Systems AG, Hirzel, Switzerland)	Hybrid S-shaped, semi-rigid fiber-optic intubation video stylet. Has a 3-cm steerable tip that can be flexed in sagittal plane for 75 degrees in both directions with lever at proximal end of device. Quality of optics is similar to flexible fiber-optic and rigid endoscopes, but has no working channel.	6.0-mm OD. ET must be >0.5 mm larger to fit.	Similar to Brambrink Intubation Endoscope.	Offers an improved view of glottis, simultaneous direct and endoscopic views, full visual control over passage of ET, and confirmation of final position. No need for extreme head extension or forced traction of laryngoscope. Can be rapidly assembled to use immediately. Not currently available in the United States.

**Table 3. Rigid Laryngoscope Blades**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
Döriges Emergency Laryngoscope Blade (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif)	Recently developed in Europe as a universal blade that combines features of both the MAC and Miller laryngoscope blades.	One size only for patients >10 kg.	Blade is inserted into the oropharynx to the appropriate depth, which correlates with the patient's size.	Has 10-kg and 20-kg markings on the blade.
Henderson Laryngoscope Blade (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif)	A straight laryngoscope blade that continues to be modified in design; there has been a resurgence of interest in the routine use of this blade for tracheal intubation.	Adult size only.	Routine or emergency use for tracheal intubation.	When used with the paraglossal technique, a better view is obtained by optimizing control of the soft tissues and improving the line of sight. <sup>5</sup> Has an improved tip and light, as well as a larger cross-sectional area.
<b>Modified MAC Blades</b>				
CLM Laryngoscope Blade (Mercury Medical, Clearwater, Fla)	Flexible tip or levering fiber-optic MAC laryngoscope blades are designed with a hinged tip controlled by a lever at the proximal end. Designed to fit standard handles.	Adult sizes only.	Useful in patients with a recessed mandible and decreased mouth opening.	A lever controls the tip angle through 70 degrees during intubation to lift the epiglottis, if necessary, to improve laryngeal visualization. <sup>6</sup>
Flipper (Rusch Inc, Research Triangle Park, NC)				
Heine Flex Tip Fiber-Optic Laryngoscope Blade (Heine USA, Ltd, Dover, NH)				
Rusch Truview EVO (Truphatek International Ltd, Netanya, Israel; distributed by Rusch Inc, Research Triangle Park, NC)	Indirect rigid laryngoscope with specially designed 42-degree blade curvature; fits onto all standard endoscopic camera heads. Provides clear, unmagnified view of the glottis. Oxygen channel for demisting, clearing secretions, and insufflation.	Adult, pediatric, and neonatal sizes.	Similar to Viewmax Laryngoscope.	Rugged, portable, easy to maintain. Depth lines on the blade to guide insertion. Can be used with all fiber-optic laryngoscope handles. Designed to provide indirect laryngoscopy with continuous oxygen insufflation.

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**Table 3. Rigid Laryngoscope Blades (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Modified MAC Blades</b>				
Viewmax Laryngoscope Blade (Rusch Inc, Research Triangle Park, NC)	Laryngoscope blade that incorporates an unmagnified optic side port with prism on a modified MAC blade with a 20-degree anterior angle of view.	Adult and pediatric sizes.	Same as DCI Video Laryngoscope System.	Distal prism enables a 20-degree refraction and “fish eye” appearance. Can be used as MAC or Miller blade.
<b>Video Laryngoscopes</b>				
DCI Video Laryngoscope System (Karl Storz Endoscopy, Tuttlingen, Germany/Culver City, Calif)	Video laryngoscope system with interchangeable laryngoscope blades. Handles allow a DCI camera head to snap onto any standard eyepiece fiberscopes (flexible or semi-rigid). Required components include a camera control unit, xenon light source, and monitor. MediPack portable combination video/light source/monitor unit is also available for use with this system.	MAC 3,4, Dorges, and all Miller blade sizes.	Useful for anterior airways, obese patients, and patients with limited mouth opening or neck extension. Additionally useful for teaching purposes, verification of ET position, aiding application of external laryngeal manipulation, or passage of an intubating introducer. Recommend styletted or special ET. May also be used for nasal intubation and ET exchange.	The wide-angle camera allows improved visualization and video documentation of laryngoscopy and intubation. Extreme positioning of the head is unnecessary. MAC #3 and #4 blades provide 45- and 60-degree angles of view, respectively.
GlideScope Video Laryngoscopes (GVL) (Verathon Medical, Bothell, Wash)	Video laryngoscope offers improved real-time view of airway and tube placement that enables quick intubation because it is operational in seconds. Includes high-resolution digital color camera, antifogging mechanism to resist lens contamination, nonglare color monitor, and blade with 60-degree blade angle. <sup>8</sup> Video output for remote display or recording.	Large, mid-sized, and small blade sizes.	Useful for difficult adult and pediatric airways, including obese patients, bloody or anterior airways, and patients with limited neck mobility. <sup>7</sup> Also useful for teaching purposes. The more portable Ranger model is ideal for prehospital, helicopter, ambulance, ER, ICU, and crash cart settings.	GVL single-use (Cobalt) or reusable. Ranger model is compact, portable, and built to military and EMS specifications. Rugged, rechargeable, Li polymer battery; 1.5 lb. New GlideRite ET with soft, curved, distal tip, and a rigid stylet that is fashioned to hug GlideScope blade shape, are offered with product.

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still considered invasive and can cause trauma to the tracheal wall. The Portex Ultraperc Percutaneous Dilatational Tracheostomy Kit (Smiths Medical) incorporates a unique introducer to aid smooth insertion of the tracheostomy tube over a Seldinger wire. In addition, the Ciaglia Blue Rhino Percutaneous Introducer Kit (Cook Critical Care) has a flexible tip dilator for less traumatic insertion. The slippery hydrophilic coating and tapered profile eliminate the need for multiple passes with increasingly larger dilators.

Translaryngeal tracheostomy, a newer tracheostomy technique, is considered to be safe and cost-effective, and it can be performed at the bedside.<sup>27</sup> It may be beneficial in patients who are coagulopathic.

Surgical tracheostomy is more invasive, and should

be performed on an elective basis and in a sterile environment.

### Conclusion

Most airway problems can be solved with relatively simple devices and techniques, but clinical judgment born of experience is crucial to their application. As with any intubation technique, practice and routine use will improve performance and may reduce the likelihood of complications. Each airway device has unique properties that may be advantageous in certain situations, yet limiting in others. Specific airway management techniques are greatly influenced by individual disease and anatomy, and successful management may require combinations of devices and techniques.

**Table 3. Rigid Laryngoscope Blades (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Video Laryngoscopes</b>				
McGrath Video Laryngoscope (LMA North America, Inc, San Diego)	Fully portable wireless laryngoscope with single-use disposable blades. Flat screen monitor is mounted on the handle.	Adjusts to fit many adult and pediatric sizes.	Useful in patients with limited mouth opening or head and neck movement, and anterior airways; obese patients; patients in whom an increased hemodynamic response is a concern; and for teaching purposes.	Highly portable and lightweight. Does not require an electrical outlet and is thus ideal for settings outside the OR. Uses disposable blades for quick turnaround between uses and for limiting cross-contamination. An adjustable blade allows use of different blade lengths on the spot. Low-profile blade and disarticulating handle can accommodate patients with very limited mouth openings and severe head and neck limitations. The monitor is located on the handle to remain in a more natural line of sight with the patient.
Pentax Airway Scope (Pentax, Tokyo, Japan)	New wireless video laryngoscope with disposable transparent blade (PBLADE) that has a suction port. Has a 12-cm cable with CCD camera and 2.4-in LCD color monitor.	One size only.	Similar to McGrath Video Laryngoscope.	Green target symbol on monitor display indicates direction of the tracheal tube tip. The PBLADE has a suction port through which a suction catheter can be passed. ET is attached to right side of the blade.
Airtraq (Prodol Meditec SA, LLC, Vizcaya, Spain; distributed by King Systems Corp, Noblesville, Ind)	Disposable optical laryngoscope that provides magnified angular view of glottis without alignment of oral, pharyngeal, and tracheal axes. Includes guiding channel to hold ET and direct it towards vocal cords. Optional reusable camera can be attached for viewing on external monitor. Sizes are color coded: regular adult has blue battery cover; small adult has green battery cover.	Two sizes: regular adult for ETs 7.0-8.5 mm); small adult for ETs 6.0-7.5 mm.	Intended to facilitate intubation in routine and difficult airway situations. Useful in emergency settings, C-spine immobilization, fiberoptic guidance, tube exchange, and foreign body removal.	Totally self-contained disposable advanced airway device with built-in anti-fog system, and low temperature light source. Can be used with standard ETs. Integral tracking channel allows ET to be directed without a stylet or bougie.

**Table 4. Indirect Rigid Fiber-Optic Laryngoscopes**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
Bullard Elite Laryngoscope (Gyrus ACMI, Southborough, Mass)	Most recent version of the Bullard laryngoscope and the only indirect fiber-optic laryngoscope that incorporates attachable metal stylets.	Adult and pediatric sizes (new-born/infant and child).	Six methods of intubation have been described. <sup>9,10</sup> Useful for anterior airways and patients with limited neck extension.	Has a working channel for oxygen insufflation, suction, and instillation of local anesthetics. Can be used with a conventional laryngoscope handle or fiber-optic light source.
UpsherScope Ultra (Mercury Medical, Clearwater, Fla)	Simplest in design of indirect rigid fiber-optic laryngoscopes. No detachable stylets or extra ports. C-shaped delivery slot. Unlike the Bullard Elite Laryngoscope, there are no detachable stylets or extra ports along the right side of the instrument.	Adult size only.	Same as Bullard Elite Laryngoscope.	Has several improvements from original UpsherScope, including better optics, an elongated lower flange, and Steris compatibility. Must be used with Upsher Universal handle or fiber-optic light source.
WuScope (Achi Corp, San Jose, Calif)	A combination laryngoscope that has a rigid, curved, bivalved tubular blade incorporated with a flexible fiberscope. The S-piece rigid blade portion consists of a handle and 2 sizes of main-blade and bivalve elements. There are 2 open channels for the fiberscope and ET. <sup>11</sup>	Using the same fiberscope and same handle, adult or large adult sizes can be assembled.	Same as Bullard Elite Laryngoscope.	The fiber-optic mechanism consists of a fiber-optic endoscope. This feature accounts for its better visualization capacity and higher cost than the 2 aforementioned scopes. Used with a battery-powered or fiber-optic light source and a suction catheter as an ET guide.

**Table 5. Supraglottic Ventilatory Devices**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
LMA Classic (LMA North America, Inc, San Diego)	Supraglottic ventilatory device that consists of an oval inflatable silicone cuff in continuity with a wide-bore tube that can be connected to an Ambu bag or anesthesia circuit. Designed to fit the pharynx of patients of various weights.	Adult and pediatric sizes 1-6, accommodating ET 3.5-7.0 mm.	Although originally developed for airway management of routine cases with spontaneous ventilation, it is now listed in the ASA Difficult Airway Algorithm as an airway ventilatory device or a conduit for endotracheal intubation. <sup>1,13</sup> Can be used in both pediatric and adult patients in whom ventilation with a face mask or intubation is difficult or impossible. Can also be used as a bridge to extubation <sup>14</sup> and with pressure support or PPV. <sup>15</sup>	Nondisposable and reusable.

*continues on page 11*

**Table 5. Supraglottic Ventilatory Devices (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
LMA Flexible (LMA North America, Inc, San Diego)	Original LMA cuff design attached to smaller-diameter, flexible armored tube that allows repositioning of the tube without cuff displacement. New single-use version is easier to insert.	Adult and pediatric sizes 2-6.	Particularly useful in ENT/head and neck procedures.	Both reusable and disposable versions now available. Airway tube resists kinking and cuff dislodgment, and thus may be positioned away from the surgical field without loss of seal.
LMA Unique (LMA North America, Inc, San Diego)	Original, disposable LMA design. Sterile, latex-free, available with or without syringe and lubricant. Soft cuff and airway tube allow for conformity to patients' natural anatomy.	Adult and pediatric sizes 1-5.	Same as LMA Classic. Included in AHA 2000 Guidelines for CPR and Emergency Medicine Cardiovascular Care.	Single use.
LMA ProSeal (LMA North America, Inc, San Diego)	Designed with a modified cuff and dual tubes to separate the respiratory/alimentary tracts. Has a built-in bite block.	Adult and pediatric sizes 1½-5.	Same as LMA Classic except drain tube also allows for evacuation of stomach contents.	Second cuff allows higher seal for PPV. Reusable.
LMA Supreme (LMA North America, Inc, San Diego)	Same features as the LMA ProSeal. Design allows easy insertion.	Adult sizes 3-5.	Same as LMA ProSeal.	Same as LMA ProSeal, but disposable.
LMA Fastrach (LMA North America, Inc, San Diego)	Consists of a mask attached to a rigid stainless steel tube curved to align the barrel aperture to the glottic vestibule. The set includes an LMA with a stainless steel shaft covered with silicone (reusable version) and a single movable epiglottic elevating bar, ET stabilizer, and silicone wire-reinforced ET. The single-use Fastrach is made from PVC and includes a disposable wire-reinforced ET.	Adult sizes 3-5 that can accommodate special ETs 6.0-8.0 mm.	Useful for ventilation and intubation. Designed for blind orotracheal intubation but can be used in conjunction with lighted stylets, FOB, or Flexible Airway Scope Tool. FOB recommended when using PVC ET.	Both reusable and disposable versions now available. Can be utilized as a blind or visually guided technique. Benefits include ability to intubate with larger ET and remove the device easily over the ET.
LMA CTrach (LMA North America, Inc, San Diego)	The LMA CTrach is a Fastrach with built-in fiber optics that allow for ventilation, visualization, and intubation of the trachea. It includes an airway (made of silicone) that is similar to the Fastrach, with an attachable lightweight viewer.	Adult sizes 3-5 for patients ≥30 kg. Comes with Fastrach ETs 6.0-8.0 mm.	Useful in unanticipated and anticipated difficult airways. Allows for continuous ventilation during intubation attempts. Provides a direct view of the larynx and real-time visualization of the ET passing through the vocal cords.	Reusable only. Comes with 3 airways, a viewer, charger, 5 ETs, and stabilizer rods.

*continues on page 12*

**Table 5. Supraglottic Ventilatory Devices (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
Soft-Seal Laryngeal Mask (Smiths Medical ASD, Keene, NH/Smiths Medical International, Hythe, Kent, England)	Similar in shape to the LMA Unique, but differs in its one-piece design, in which the cuff is softer and there is no “step” between the tube and the cuff, an integrated inflation line, no epiglottic bars on the anterior surface of the cuff, and a wider ventilation orifice.	Adult and pediatric sizes 1-5.	Same as LMA Classic. Allows easy access for flexible fiber-optic devices.	If intubation becomes necessary or desired, will accommodate up to a 7.5-mm ET. Single use.
Ambu AuraOnce (formerly the Ambu Laryngeal Mask; Ambu Inc, Glen Burnie, Md)	A laryngeal mask with a special built-in curve that replicates natural human anatomy. It is molded in one piece with an integrated inflation line and no epiglottic bars on the anterior surface of the cuff.	Adult and pediatric sizes 1-5.	Same as LMA Classic. Allows easy access for flexible fiber-optic devices.	Anatomically correct curve and reinforced tip that facilitates placement. If intubation becomes necessary or desired, recommend intubation over Aintree AEC. Single use.
Ambu AuraOnce Standard (Ambu Inc, Glen Burnie, Md)	Similar to LMA Unique but without epiglottic bars on the anterior surface of the cuff.	Adult and pediatric sizes 1-5.	Same as Ambu AuraOnce.	Single use. Available only in the United States.
Ambu Aura40 (Ambu Inc, Glen Burnie, Md)	Same design as the Ambu AuraOnce, but reusable.	Adult and pediatric sizes 1-6.	Same as Ambu AuraOnce.	Same as Ambu AuraOnce, but reusable.
Ambu Aura40 Standard (Ambu Inc, Glen Burnie, Md)	Similar to the LMA Classic. No epiglottic bars on the anterior surface of the cuff.	Adult and pediatric sizes 1-6.	Same as Ambu AuraOnce.	Reusable. Available only in the United States.
Air-Q Reusable Laryngeal Mask, formerly the Intubating Laryngeal Airway (Cookgas LLC, St. Louis; distributed by Mercury Medical, Clearwater, Fla)	Hypercurved intubating laryngeal airway that resists kinking, and removable airway connector. Anterior portion of mask is recessed; a larger mask cavity allows intubation using standard ETs. Air-Q removal after intubation is accomplished by using Air-Q reusable removal stylet.	Adult sizes (2.5, 3.5, and 4.5) that can accommodate ETs 5.5-8.5 mm.	Similar to both LMA Classic and Fastrach. Allows easy access for flexible fiber-optic devices.	Designed to minimize folding of the cuff tip on insertion. Same use and benefits as LMA Classic and Fastrach.
Air-Q Disposable Laryngeal Mask (Cookgas LLC, St. Louis; distributed by Mercury Medical, Clearwater, Fla)	Same features as Air-Q Reusable Laryngeal Mask, except disposable.	Adult sizes (1.5, 2.5, 3.5, and 4.5) that can accommodate ETs 5.0-8.5 mm.	Same as Air-Q Reusable Laryngeal Mask.	Same as Air-Q Reusable Laryngeal Mask, but disposable.

*continues on page 13*

**Table 5. Supraglottic Ventilatory Devices (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
CobraPLA Perilaryngeal Airway (Engineered Medical Systems, Indianapolis)	Large ID laryngeal tube, which is soft and flexible in design with a tapered, striated tip. Now has an improved distal curve, softer tube, and softer head. It has a high-volume, low-pressure oropharyngeal cuff.	Adult and pediatric sizes ½-6.	Same as LMA Classic.	Disposable. If intubation becomes necessary or desired, will accommodate up to an 8.0-mm ET. Single use.
CobraPLUS (Engineered Medical Systems, Indianapolis)	Similar to the CobraPLA. Includes temperature monitor (all sizes) and distal gas sampling (pediatric sizes only: ½, 1, and 1½).	Adult and pediatric sizes ½-6.	Same as LMA Classic. An added benefit is the ability to measure core temperature. In addition, distal CO <sub>2</sub> can be monitored in the pediatric population.	Similar to CobraPLA but PLUS allows monitoring of the patient's core temperature. In neonatal and infant patients, PLUS has the ability to increase the accuracy of end-tidal CO <sub>2</sub> and volatile gas analysis.
SLIPA Streamlined Liner of the Pharynx Airway (SLIPA Medical Ltd, London)	Similar to the LMA Unique.	Six adult sizes that relate to the dimension across thyroid cartilage cornu: 47, 49, 51, 53, 55, 57 mm.	Same as LMA Classic.	Its hollow structure allows storage of regurgitant liquids, minimizing aspiration risk. <sup>1</sup> More confident placement by first-time users. <sup>2</sup> Single use. Not available in the United States.
KING LT (King Systems Corp, Noblesville, Ind/VBM Medizintechnik GmbH, Sulz, Germany)	Multi-use, latex-free, single-lumen silicon tube with oropharyngeal and esophageal low-pressure cuffs, 2 ventilation outlets, insertion marks, and a blind distal tip (almost like a single-lumen, shortened Combitube). <sup>16</sup> Color-coded connectors for each size.	Sizes 2-5 available worldwide; sizes 0-1 available outside United States and Canada.	Same as LMA Classic, but with ventilatory seal characteristics like those of LMA ProSeal.	Easily inserted, possible aspiration protection, and allows both positive pressure ventilation and spontaneous breathing. Nondisposable and reusable (up to 50 times).
KING LT-D (King Systems Corp, Noblesville, Ind/VBM Medizintechnik GmbH, Sulz, Germany)	Same design as the KING LT, except disposable.	Adult sizes (3-5). Pediatric sizes (2, 2.5) available mid-2007.	Same as KING LT.	Same as KING LT, but disposable. Also available in an EMS kit.
KING LTS (King Systems Corp, Noblesville, Ind/VBM Medizintechnik GmbH, Sulz, Germany)	Double-lumen laryngeal tube that incorporates a second (esophageal) lumen posterior to the ventilation lumen.	Adult sizes (3-5); pediatric sizes (0, 1, 2, 2.5).	Same as KING LT, except that it has a second lumen for gastric access, similar to LMA ProSeal.	Allows easy passage of a gastric tube to evacuate stomach. Distal tip reduced in size to facilitate insertion.

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**Table 5. Supraglottic Ventilatory Devices (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
KING LTS-D (King Systems Corp, Noblesville, Ind/VBM Medizin-technik GmbH, Sulz, Germany)	Same as KING LTS, except disposable.	Adult sizes (3-5)	Same as KING LTS.	Same as KING LTS, but disposable. Also available in an EMS kit.
Esophageal Tracheal Combitube (Tyco Healthcare/Mallinckrodt Nellcor Puritan Bennett, Pleasanton, Calif)	A disposable double-lumen tube that combines the features of a conventional ET with those of an esophageal obturator airway. Has a large proximal latex oropharyngeal balloon and a distal esophageal low-pressure cuff with 8 ventilatory holes in between.	Two adult sizes. 41 Fr: height >5 ft. 37 Fr: height 4-6 ft.	Same as LMA Classic. Appropriate for prehospital, intraoperative, and emergency use. Especially useful for patients in whom direct visualization of the vocal cords is not possible, patients with massive airway bleeding or regurgitation, limited access to the airway, and patients in whom neck movement is contraindicated.	Ventilation is possible with either tracheal or esophageal intubation. Distal cuff seals off the esophagus to prevent aspiration of gastric contents. Allows passage of an orogastric tube when placed in the esophagus. Single use.
ChouAirway (Achi Corp, San Jose, Calif)	Adjustable oropharyngeal airway of 2-piece construction. The rigid outer tube serves as a conduit for and protects the flexible inner tube, which creates a patent air passage from the mouth opening to the glottis.	Adult (10-13 cm) and large adult (13.5-16.5 cm) sizes.	In conjunction with a face mask, it is placed orally to facilitate and maintain spontaneous or assisted breathing.	The inner tube is longer than other common oral airways, and thus capable of reaching beyond the base of the tongue in patients with a short ramus or large tongue. Single use.
Intersurgical i-gel (Intersurgical, Wokingham, England)	Disposable supraglottic airway with noninflatable cuff designed to match the perilaryngeal anatomy. Incorporates an integral bite block and gastric channel.	Adult sizes (3-5) that can incorporate ET sizes 6.0-8.0 mm and nasogastric tube sizes 12-14 Fr.	Similar to other supraglottic airways, except drain tube allows evacuation of stomach contents.	Noninflatable cuff allows easy and rapid insertion, minimal risk for tissue compression, and stability after insertion. Gastric channel allows suctioning of stomach contents, insertion of a nasogastric tube, and facilitation of venting. Epiglottis blocker minimizes the risk for epiglottis downfolding. Buccal cavity stabilizer reduces the risk for malposition and aids insertion. Single use. Available only in the European Union.

**Table 6. Special Airway Techniques**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Face Mask Ventilation</b>				
ErgoMask (King Systems Corp, Noblesville, Ind)	Face mask with contoured finger/thumb grip.	Medium adult size.	Intended to facilitate one-handed mask ventilation. Encourages proper chin lift to open airway. Allows improved control of mask seal.	Ventilation port off-center facilitates use with small hand and improves mask seal.
<b>Retrograde Intubation</b>				
Cook Retrograde Intubation Set (Cook Critical Care, Bloomington, Ind)	Complete set includes 14-Fr Arndt Airway Exchange Catheter with Rapi-Fit adapter.	110 cm	Excellent technique for securing a difficult airway, either alone or in conjunction with other alternative airway techniques. Especially useful in patients with limited neck mobility or patients who have suffered airway trauma.	Packaged as a complete kit with everything needed to perform a retrograde intubation. The recently added Arndt Airway Exchange Catheter allows for patient oxygenation and facilitates placement of an ET. Disposable.
<b>Transtracheal Jet Ventilation</b>				
Manujet III (VBM Medical, Inc, Noblesville, Ind)	Complete set including 4-m pressure hose, Luer lock connecting tubing, bronchoscope adapter, Endojet adapter with Endojet catheter, and jet ventilation catheter.	Jet ventilation catheters can accommodate adults, children, and infants.	Well-accepted method for securing ventilation in rigid and interventional bronchoscopy. Because airflow is generally unidirectional, it is important that air has a route to escape (unobstructed airway).	Packaged as a complete kit with everything needed to perform transtracheal jet ventilation. The Endojet adapter allows jet ventilation on an ET, LMA, or face mask. The catheter can be pushed forward through the ET or LMA as far as required, and can be fastened with a screw. Includes a pressure regulator. Reusable.
Manual Jet Ventilator (Instrumentation Industries, Bethel Park, Pa)	Complete set includes an on/off valve, 6 ft of high-pressure tubing, and 4 ft of small-bore tubing.	Jet ventilation catheters can accommodate adults and children.	Same as Manujet III.	Offered with and without a regulator gauge.
Enk Oxygen Flow Modulator Set (Cook Critical Care, Bloomington, Ind)	Complete set including 15-g needle with reinforced FEP catheter, syringe (5 cc), connecting tubing, and Enk oxygen flow modulator with tracheal catheter connector.	7.5 cm (2.0-mm ID).	Same as Manujet III Jet Ventilator. Recommended for use when jet ventilation is appropriate, but a jet ventilator is unavailable.	Packaged as a complete set with everything needed to perform transtracheal jet ventilation. Disposable.

*continues on page 16*

**Table 6. Special Airway Techniques (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>All in One</b>				
Wadhwa Emergency Airway Device (Cook Critical Care, Bloomington, Ind)	Single device that looks similar to a pen. At one end of the “pen” is a needle with a 9-Fr cricothyrotomy catheter. On the other end is a nasopharyngeal airway catheter.	Cricothyrotomy catheter: 6.0 cm. Nasopharyngeal catheter: 9.5 cm (7.0-mm ID).	Can be used for a needle cricothyrotomy, transtracheal jet ventilation, or as a nasal catheter.	The components require some pre-assembly. Once assembled, it is easy to transport to off-site locations and is intended for use in emergencies. The main body of the device acts as a blow tube or 15-mm adapter. Disposable.

**Table 7. Cricothyrotomy**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Needle</b>				
Emergency Transtracheal Airway Catheter (Cook Critical Care, Bloomington, Ind)	6-Fr reinforced fluorinated ethylene propylene catheter.	5.0 and 7.5 cm.	A lifesaving procedure that is the final option for “cannot-ventilate, cannot-intubate” patients in all airway algorithms.	Designed to be kink resistant specifically for the purpose of needle cricothyrotomy.
<b>Percutaneous</b>				
Melker Emergency Cricothyrotomy Catheter Set (Cook Critical Care, Bloomington, Ind)	Complete set including syringe (10 cc), 2- to 18-gauge introducer needles with TFE catheter (short and long), 0.038-in diameter Amplatz extra-stiff guidewire with flexible tip, scalpel, curved dilator with radiopaque stripe, and PVC airway catheter. Also available in a Special Operations kit, which includes all of the above in a slip peel-pouch and 2 airway catheters.	Standard kit: 3.8 cm (3.5 mm-ID), 4.2 cm (4.0-mm ID), and 7.5 cm (6.0-mm ID). Special kit: 4.2 and 7.5 cm.	Same as Emergency Transtracheal Airway Catheter. Intended to be used with the Seldinger technique via the cricothyroid membrane; however, it has the capability to be used as a surgical cricothyrotomy.	Packaged as a complete kit with everything needed to perform a percutaneous cricothyrotomy. The Special Operations kit comes in a slip peel-pouch for easy transport to off-site locations. Also good for use in the operating room. It comes with 2 differently sized airway catheters to reduce the number of kits needed in the field. Disposable.
Melker Cuffed Emergency Cricothyrotomy Catheter Set (Cook Critical Care, Bloomington, Ind)	Same as Melker Emergency Cricothyrotomy Catheter Set.	9.0 cm (5.0-mm ID).	Same as Melker Emergency Cricothyrotomy Catheter Set.	Same as Melker Emergency Cricothyrotomy Catheter Set.

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**Table 7. Cricothyrotomy (continued)**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Percutaneous</b>				
Quicktrach Emergency Cricothyrotomy Device (VBM Medizintechnik GmbH, Sulz, Germany)	Complete kit includes airway catheter, stopper, needle, and syringes that come preassembled.	Adult (4.0-mm ID) and child (2.0-mm ID).	Same as Melker Emergency Cricothyrotomy Catheter Set.	Packaged as a complete kit with everything needed to perform a percutaneous cricothyrotomy—even the necktape and connecting tube. The removable stopper is used to prevent a “too-deep” insertion and avoid the possibility of perforating the rear tracheal wall. The conical needle tip allows for the smallest necessary stoma and reduces the risk for bleeding. Easily transported to off-site locations. Disposable.
<b>Surgical</b>				
There is no special kit for a surgical cricothyrotomy. It is performed by making an incision through the cricothyroid membrane using a scalpel, followed by the caudad insertion of an ET. This is the most rapid technique and should be used when equipment for the less invasive techniques is unavailable and when speed is particularly important.				
<b>Combination Percutaneous and Surgical</b>				
Melker Universal Emergency Cricothyrotomy Catheter Set (Cook Critical Care, Bloomington, Ind)	Same as Melker Cuffed Emergency Cricothyrotomy Catheter Set for percutaneous technique. Also includes for surgical technique: tracheal hook, safety scalpel, Trousseau dilator, and blunt curved dilator.	9.0 cm (5.0-mm ID).	Same as Melker Emergency Cricothyrotomy Catheter Set.	One half of the tray is the same as Melker Cuffed Emergency Cricothyrotomy Catheter Set for the percutaneous technique. The other half of the tray includes all items necessary to perform a surgical emergency cricothyrotomy.

**Table 8. Tracheostomy**

Name/Manufacturer	Description	Size	Clinical Applications	Special Features
<b>Percutaneous Dilatational</b>				
Portex Ultraperc Percutaneous Dilatational Tracheostomy Kit (Smiths Medical ASD, Keene, NH/Smiths Medical International, Hythe, Kent, England)	Complete set with or without a tracheostomy tube.	70.0 mm (7.0-mm ID); 75.5 mm (8.0-mm ID); 81.0 mm (9.0-mm ID).	Establishes transcutaneous access to the trachea below the level of cricoid cartilage. Allows for smooth insertion of the tracheostomy tube over a Seldinger wire.	Packaged as a complete kit with everything needed to perform a percutaneous dilatational tracheostomy. The dilator is single-staged and pre-lubricated with an ergonomic handle to facilitate insertion. Disposable.
Ciaglia Blue Rhino Percutaneous Introducer Set (Cook Critical Care, Bloomington, Ind)	Complete kit includes 24.0-, 26.0-, and 28.0-Fr loading dilators and Shiley 6 or 8 PERC disposable dual cannula tracheostomy tube. A tray version is available that includes lidocaine, connector, iodophor PVP swabs, drape, and suture.	74 mm (6.4-mm ID); 79 mm (7.6-mm ID)	Same as Portex Ultraperc Percutaneous Dilatational Tracheostomy Kit.	Packaged as a complete kit with everything needed to perform a percutaneous dilatational tracheostomy. The single dilator with a hydrophilic coating and flexible tip results in a simpler, less traumatic insertion. The guidewire has a Safe-T-J tip to reduce trauma. Disposable.
Shiley TracheoSoft XLT Extended-Length Tracheostomy Tubes (Tyco Healthcare/Mallinckrodt Nellcor Puritan Bennett, Pleasanton, Calif)	Available in 4 ISO sizes (5.0-, 6.0-, 7.0-, 8.0-mm ID). Each size offers the choice of cuffed or uncuffed stylets, and proximal or distal extensions. Comes with disposable inner cannula; replacements sold in packages of 10.	90 mm (5.0-mm ID); 95 mm (6.0-mm ID); 100 mm (7.0-mm ID); 105 mm (8.0-mm ID)	Flexible dual cannula tube for patients with unusual anatomy. Proximal length extension for thick necks; distal length extension for long necks, tracheal stenosis, or malacia.	The only fixed flange extended-length tube with disposable inner cannula. Flexible inner cannula conforms to the shape of the outer cannula. Sixteen configurations to fit a wide variety of patients. Disposable.

**Surgical**

Surgical tracheostomies are performed by making a curvilinear skin incision along relaxed skin tension lines between sternal notch and cricoid cartilage. A midline vertical incision is then made dividing strap muscles and division of thyroid isthmus between ligatures is performed. Next, a cricoid hook is used to elevate the cricoid. An inferior-based flap or Bjork flap (through second and third tracheal rings) is commonly used. The flap is then sutured to the inferior skin margin. Alternatives include a vertical tracheal incision (pediatric) or excision of an ellipse of anterior tracheal wall. Finally, the tracheostomy tube is inserted, the cuff is inflated, and it is secured with tape around the neck or stay sutures.

## Abbreviation Key

<b>AEC</b> , airway exchange catheter	<b>EMS</b> , emergency medical service	<b>LMA</b> , laryngeal mask airway
<b>AHA</b> , American Heart Association	<b>ENT</b> , ear, nose, and throat	<b>MAC</b> , Macintosh
<b>ASA</b> , American Society of Anesthesiologists	<b>ET</b> , endotracheal tube	<b>OD</b> , outer diameter
<b>CCD</b> , charge-coupled device	<b>FOB</b> , fiber-optic bronchoscope	<b>PERC</b> , percutaneous low-pressure cuffed tracheostomy tube
<b>CLM</b> , Corazelli, London, McCoy	<b>Fr</b> , French	<b>PPV</b> , positive pressure ventilation
<b>CPR</b> , cardiopulmonary resuscitation	<b>ID</b> , internal diameter	<b>PVC</b> , polyvinyl chloride
<b>DCI</b> , direct couple interface	<b>ILMA</b> , intubating laryngeal mask airway	<b>PVP</b> , polyvinylpyrrolidone
<b>DLT</b> , double-lumen tubes	<b>ISO</b> , International Standards Organization	<b>SGA</b> , supraglottic airway
<b>EF</b> , extra firm	<b>LCD</b> , liquid crystal display	<b>TFE</b> , tetrafluoroethylene
	<b>LED</b> , light-emitting diode	

## References

1. American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2003;98:1269-1277.
2. Miller C. Management of the difficult intubation in closed malpractice claims. *American Society of Anesthesiologists Newsletter*. 2000;64:13-19.
3. Davis L, Cook-Sather SD, Schreiner MS. Lighted stylet tracheal intubation: A review. *Anesth Analg*. 2000;90:745-756.
4. Frass M, Kofler J, Thalhammer F, et al. Clinical evaluation of a new visualized endotracheal tube (VETT). *Anesthesiology*. 1997; 87:1262-1263.
5. Henderson JJ. The use of paraglossal straight blade laryngoscopy in difficult tracheal intubation. *Anaesthesia*. 1997;52:552-560.
6. Tuckey JP, Cook TM, Render CA. Forum. An evaluation of the levering laryngoscope. *Anaesthesia*. 1996;51:71-73.
7. Cooper RM. Use of a new videolaryngoscope (GlideScope) in the management of a difficult airway. *Can J Anaesth*. 2003;50:611-613.
8. Agro F, Barzoi G, Montecchia F. Tracheal intubation using a Macintosh laryngoscope or a GlideScope in 15 patients with cervical spine immobilization (letter). *Br J Anaesth*. 2003;90:705-706.
9. Gorback MS. Management of the challenging airway with the Bullard laryngoscope. *J Clin Anesth*. 1991;3:473-477.
10. Bjraker DG. The Bullard intubating laryngoscopes. *Anesthesiol Rev*. 1990;17:64-70.
11. Wu T, Chou HC. A new laryngoscope: the combination intubating device. *Anesthesiology*. 1994;82:1085-1087.
12. Verghese C. Airway management. *Curr Opin Anaesthesiol*. 1999;12:667-674.
13. Benumof JL. Laryngeal mask airway and the ASA difficult airway algorithm. *Anesthesiology*. 1996;84:686-699.
14. Patel P, Verghese C. Delayed extubation facilitated with the use of a laryngeal mask airway in the intensive care unit. *Anaesthesia*. 2000;55:396.
15. Brimacombe J, Keller C, Hormann C. Pressure support ventilation versus continuous positive pressure with the laryngeal mask airway: a randomised, crossover study of anesthetized adult patients. *Anesthesiology*. 2000;92:1621-1623.
16. Dorges V, Ocher H, Wenzel V, Schmucher P. The laryngeal tube: a new simple airway device. *Anesth Analg*. 2000;90:1220-1222.
17. Gaitini LA, Vaida SJ, Somri M, Tome R, Yanovski B. A comparison of the Cobra Perilaryngeal Airway and Laryngeal Mask Airway Unique in spontaneously breathing adult patients. *Anesthesiology*. 2004;101:A518.
18. Gupta B, McDonald JS, Brooks HT, Mendenhall J. Oral fiberoptic intubation over a retrograde guidewire. *Anesth Analg*. 1989;68: 517-519.
19. Sivarajan M, Stoler E, Kil HK, Bishop MJ. Jet ventilation using fiberoptic bronchoscopes. *Anesth Analg*. 1995;80:384-387.
20. Audenaert SM, Montgomery CL, Stone B, Akins RE, Lock RL. Retrograde-assisted fiberoptic tracheal intubation in children with difficult airways. *Anesth Analg*. 1991;73:660-664.
21. Klain M, Smith RB. High-frequency percutaneous transtracheal jet ventilation. *Crit Care Med*. 1977;5:280-287.
22. Enk D, Busse H, Meissner A, Van Aken H. A new device for oxygenation and drug administration by transtracheal jet ventilation. *Anesth Analg*. 1998;86:S203.
23. Safar P, Penninckx J. Cricothyroid membrane puncture with special cannula. *Anesthesiology*. 1967;28:943-948.
24. Safar P, Bircher NG. *Cardiopulmonary-Cerebral Resuscitation*. 3rd ed. London: WB Saunders; 1988.
25. Wong EK, Bradrick JP. Surgical approaches to airway management for anesthesia practitioners. In: Hagberg CA, ed. *Handbook of Difficult Airway Management*. Philadelphia, Pa: Churchill Livingstone; 2000;209-210.
26. Gibbs M, Walls R. Surgical airway. In: Hagberg CA, ed. *Benumof's Airway Management*. 2nd ed. Philadelphia, Pa: Mosby Elsevier; 2007:678-696.
27. Sarpellon M, Marson F, Nani R, Chiarini L, Bradariolo S, Fonzari C. Translaryngeal tracheostomy (TLT): a variant technique for use in hypoxemic conditions and in the difficult airway. *Minerva Anesthesiol*. 1998;64:393-397.

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expires July 31, 2007\*;  
expires July 31, 2008\*

SF606

Assessing the Safety and  
Efficacy of Hemostatic  
Agents in Cardiac Surgery;  
expires December 31, 2007\*

IP00014

*Case-Based Teaching Series  
(Part 3 of 4): Perioperative Care  
And Anesthetic Considerations  
For the High-Risk Patient  
In Abdominal Surgery;*  
expires April 30, 2008\*\*

IP00017

Current and Emerging  
Therapies for Opioid-  
Induced Bowel Dysfunction;  
expires August 31, 2007\*

SF610

The Clinical Management of  
Breakthrough Pain - Current  
And Emerging Perspectives  
(Multimedia Program);  
expires December 31, 2007\*

MN1014

*Case-Based Teaching Series  
(Part 4 of 4): Perioperative Care  
And Anesthetic Considerations  
For the High-Risk Patient  
In Orthopedic Surgery;*  
expires April 30, 2008\*\*

IP00018

Postoperative Pain  
Management: A Review of  
Epidurally Administered  
Opioid Pharmacotherapies;  
expires August 31, 2007\*;  
expires September 30, 2007\*

SF636

Current Status of Nitrous Oxide;  
expires March 31, 2008\*\*

SF660

Novel Technologies for  
Patient-Controlled Analgesia;  
expires April 30, 2008\*\*

SF07003

\* Expiration date for physicians

† Expiration date for nurse anesthetists