Essentials of Airway Management, Oxygenation, and Ventilation: Part 2: Advanced Airway Devices: Supraglottic Airways

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Offices and outpatient dental facilities must be properly equipped with devices for airway management, oxygenation, and ventilation. Part 1 in this series on emergency airway management focused on basic and fundamental considerations for supplying supplemental oxygen to the spontaneously breathing patient and utilizing a bag-valve-mask system including nasopharyngeal and oropharyngeal airways to deliver oxygen under positive pressure to the apneic patient. This article will review the evolution and use of advanced airway devices, specifically supraglottic airways, with the emphasis on the laryngeal mask airway, as the next intervention in difficult airway and ventilation management. The final part of the series (part 3) will address airway evaluation, equipment and devices for tracheal intubation, and invasive airway procedures.

Key Words: Airway management; Ventilation; Devices; Supraglottic airways; Laryngeal mask airways.

This article reviews the evolution and use of advanced airway devices, specifically supraglottic airways (SGAs), with the emphasis on the laryngeal mask airway (LMA), as the next intervention in difficult airway and ventilation management after bag-mask ventilation has been attempted. Management of the unexpected difficult airway during deep sedation and general anesthesia remains the most important aspect in avoiding mortality and morbidity because of the severe consequences of inadequate ventilation and oxygenation, especially in out-of-operating-room locations.[1]

There are several predictors and tests that might alert the clinician to anticipate the possibility of a difficult airway, which will be discussed and reviewed in the third paper in this series. Thankfully for patient safety, most airway difficulties are overcome with relatively straightforward airway maneuvers, devices, and techniques, but it is the training and experience of the operator that often makes the difference when airway and ventilation management becomes difficult.

The American Society of Anesthesiologists (ASA) Difficult Airway Management Algorithm, a part of the ASA Practice Guidelines, has become the gold standard in addressing the urgent response to the inability to oxygenate and ventilate.[2] This program was driven by the fact that airway complications were associated in the ASA Closed Claims Database as a leading cause of death or permanent neurologic injury during general anesthesia.[3] The guidelines are dynamic, and have changed over the years to recognize newer concepts with the introduction of newer airway devices. It is very important to note in the ASA guidelines that the use of LMA has been replaced with the generic term SGA. This includes the LMA and other supraglottic devices.

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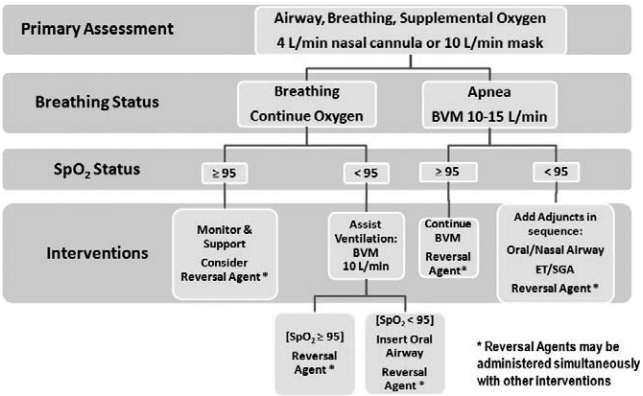

Figure 1. American Dental Society of Anesthesiology unconscious patient airway algorithm.

Building on the ASA guidelines, the American Dental Society of Anesthesiology, the American Dental Association, and the American Association of Oral and Maxillofacial Surgeons have incorporated the use of SGA as an advanced airway device in their emergency airway rescue curriculum and team emergency simulation workshops. (Figure 1.)

SUPRAGLOTTIC AIRWAYS

An SGA is any airway device that sits outside the larynx and forms a seal around it, permitting increased ventilation pressure between 20 and 40 cm H_2O and reducing the chance of gastric distention that can be encountered during face-mask ventilation. Although intubation continues as the gold standard for airway management and protection from aspiration, correct SGA use requires less expertise and training than endotracheal intubation. The SGA combines the features of the face mask with those of the endotracheal tube and permits ventilation with more pressure than is possible with face-mask ventilation, as face-mask ventilation may permit drop of the epiglottis, partially or completely blocking the glottis, when ventilation pressure exceeds 20 cm H_2O. With occlusion of the glottis, the volume delivered by the resuscitation bag then enters and pressurizes the stomach, leading to the possibility of emesis and aspiration. (Figure 2.)

The initial SGA was the esophageal obturator airway, which evolved into the Combi-Tube. Both of these devices had problems related to confirming correct placement, esophageal injury, and limited size availability. The King LTS-D evolved from these devices and is currently an accepted SGA in the prehospital setting. This device has received US Food and Drug Administration approval but is currently not endorsed by the American Heart Association as an advanced airway during cardiopulmonary resuscitation (CPR).

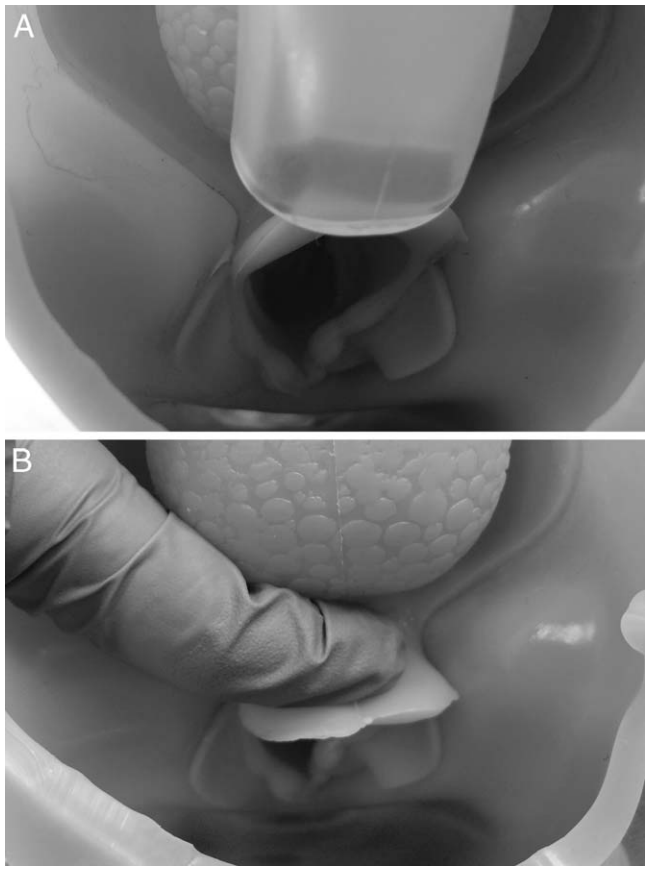

Figure 2. Positioning of oropharyngeal airway. (A) Oropharyngeal airway does not seal glottis and requires caution when bag mask pressures exceed 20 cm H_2O. (B) Epiglottis drops down over glottis when excessive bag mask pressure is used, potentially pressurizing the stomach.

Since 1983 the elective use of the LMA has revolutionized the practice of anesthesia as an alternative to mask ventilation and endotracheal intubation. The introduction of the LMA is the single most important advance in airway devices over the last 25 years, and the LMA has been used worldwide in over 200 million patients. Although endotracheal intubation has been and continues to be the standard to secure the airway during urgent or emergent situations, the use of an SGA is extremely beneficial as a primary airway rescue device. Rapid control of the airway is critical in airway rescue for patients with acute apnea and/or airway obstruction. SGAs have totally revolutionized airway rescue as a first alternative after difficult mask ventilation and endotracheal intubation, failure or difficulty with the simple airway rescue maneuvers, or inability to perform adequate bag-valve-mask ventilations. The ease and versatility of use of the SGA still make it a crucial management tool for practitioners accomplished in

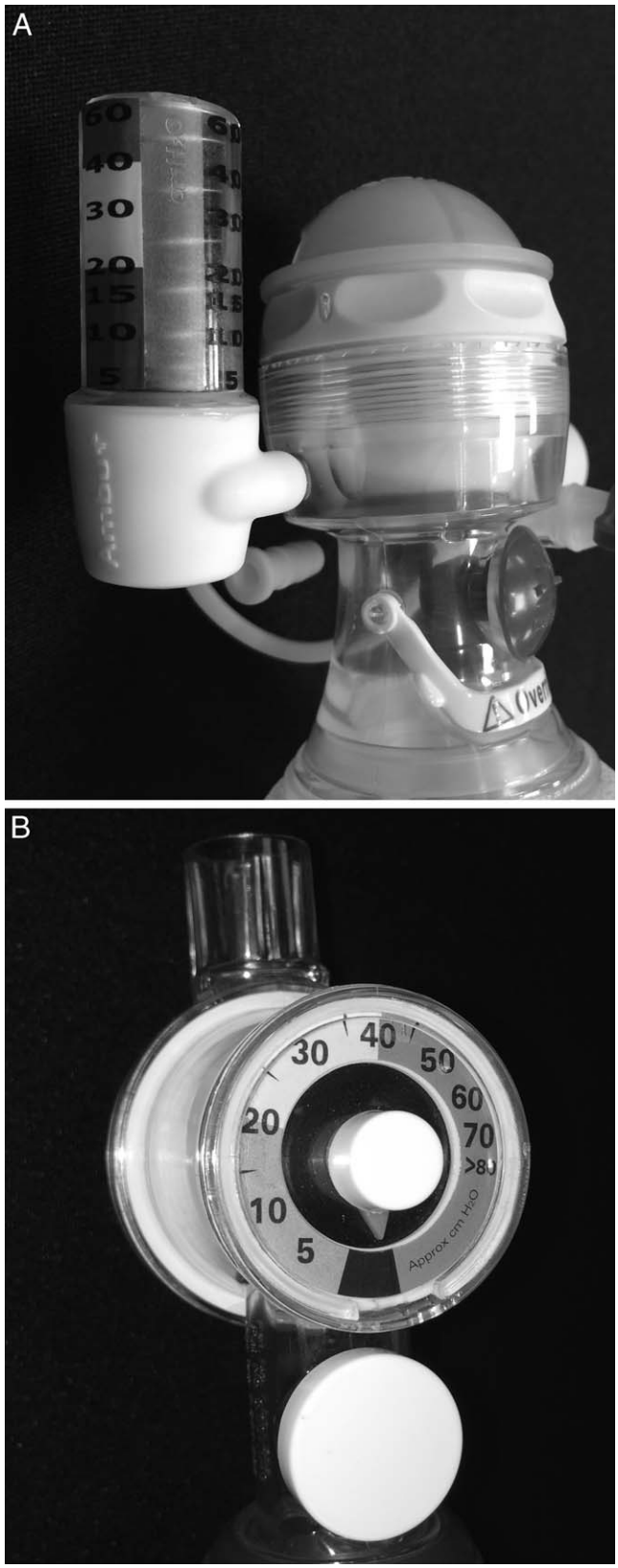

Figure 3. Exemplary resuscitation bag manometers. Resuscitation bag manometers provide 3 colored zones indicating pressure being delivered during bag ventilation: (a) 0–20 cm H_2O (green), safe for bag mask ventilation with or without oropharyngeal or nasopharyngeal airways; (b) 20–40 cm H_2O (yellow), safe for bag ventilation with advanced airway (SGA or endotracheal tube); and (c) >40 cm H_2O (red) unsafe pressure due to potential barotrauma.

intubation and also for those who have limited intubation skills. Many studies validate the use of SGA in providing an adequate airway conduit to overcome apnea and soft tissue airway obstruction in the unconscious patient.

SGA is a lifesaving maneuver when intubation of the trachea is not an option or not possible within the American Heart Association recommendation of 30 seconds, especially when patient comorbidities may include obesity, bronchospasm, and/or emphysema, which potentially would create bag-mask ventilation pressures greater than 20 cm H_2O. To allow appropriate team management of ventilation pressures, resuscitation bags with manometers are beneficial. (Figure 3.) Additionally, if the patient is pulseless, the SGA optimizes CPR chest compressions, because once the SGA is placed, there is no need for a pause in the compressions to allow time for ventilations. The increased efficiency in compressions over each 2-minute interval is as follows: (a) 200 with the SGA versus 150 with the mask and (b) not stopping 5 times during each 2-minute interval, which otherwise drops coronary and cerebral perfusion pressure to zero and requires 3–5 compressions just to regain perfusion pressures.

The original, classic design of the LMA was revolutionary, permitting a seal directly over the glottis. (Figure 4.) However over time, use of the device revealed that (a) the tip could be flipped forward or backward, resulting in a poor airway seal over the glottis; (b) the practitioner needed to properly inflate the LMA to achieve a positive seal of the glottis; (c) if a patient bit down with the LMA in place, the LMA could become occluded; and (d) if bag-mask ventilation prior to placement of the LMA used excessive pressures resulting in pressurization of gastric contents, the LMA did not permit release of the gastric pressure, and the patient would still be at risk for aspiration.

Evolution of the LMA has led to 4 relatively new single-use SGAs that now possess a gastric port to decompress the pressure in the patient's gastrointestinal system and provide solutions to the above limitations of the original LMA. These newer SGAs are recommended for the office airway emergency. Gastric venting is an important addition to the classic SGAs, as during unsuccessful attempts with a bag-valve-mask system because of anatomical factors or the need to generate high inspiratory pressures over 20 cm H_2O, air is forced into the gastrointestinal tract, leading to compression of

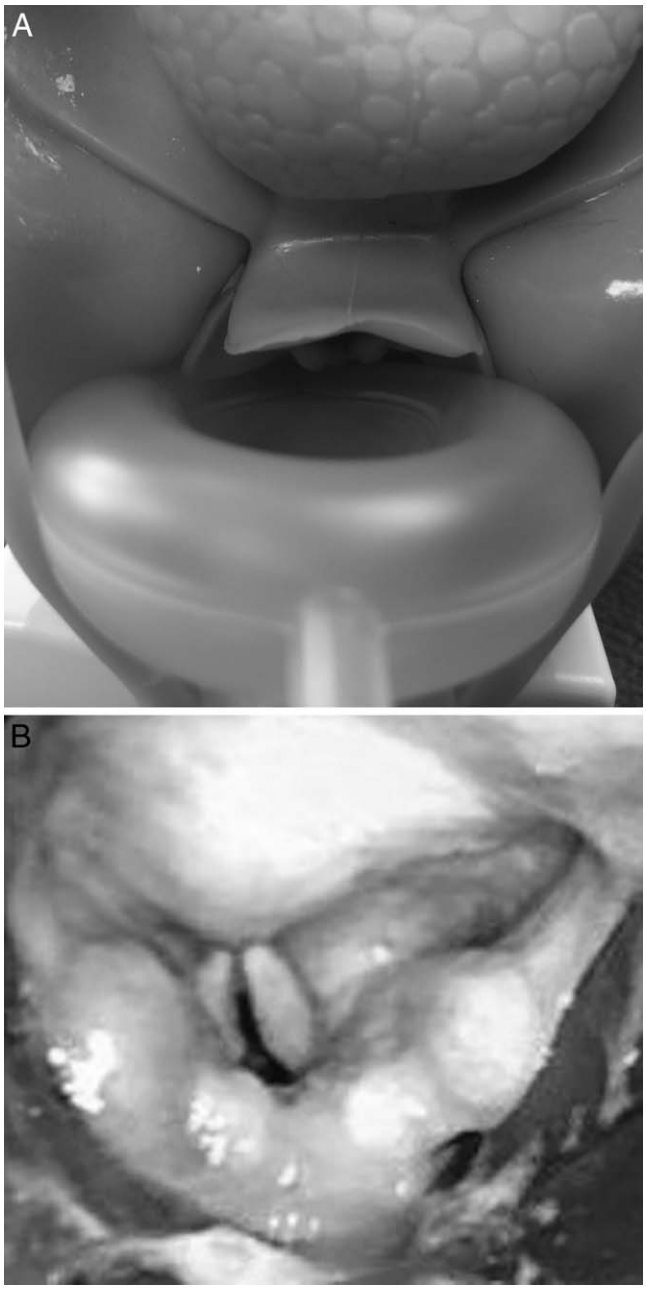

Figure 4. Final positioning of supraglottic airway. (A) Laryngeal mask airway (LMA) slightly moved down to show direct seal over glottis, permitting pressures of 20–40 cm H_2O without pressurizing the stomach. Note that the practitioner must always verify that the device is past the base of the tongue to have adequate depth for creating a seal over the glottis. (B) Bronchoscope visualization of LMA centered over and sealing patient's glottis.

the lung fields and, often, vomiting. SGAs are also useful when attempts at endotracheal intubation fail to establish an airway.[4] As opposed to the older SGAs, the newer ones' tips are reinforced to prevent folding and their bodies are more rigid to prevent rotation and allow for

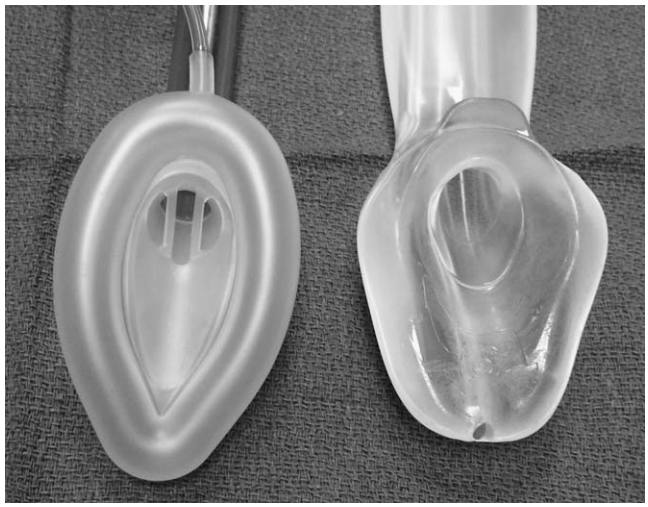

Figure 5. Comparison of classic LMA (left side) versus i-gel (right side). Four beneficial features of i-gel not found in the classic LMA: (a) does not require air inflation to seal over the glottis; (b) tip does not flex forward or backward preventing seal over the glottis; (c) vents gastric pressure if prior bag mask ventilation has pressurized the stomach; and (d) has a bite block to prevent loss of airway if patient bites down during return to consciousness while still needing airway management and ventilation assistance.

easier insertion. The skill set required to master SGA placement is relatively easy to acquire and retain.[5,6] They are all disposable, one-time use and come in adult and some pediatric sizes. Some of these devices also have the capacity to be used as a conduit for "blind" endotracheal intubation.[7] There is no need for laryngoscopy to place an SGA. (Figure 5.)

The American Heart Association via its world-recognized programs of advanced cardiovascular life support[8] supports the use of SGAs as a reasonable alternative to endotracheal intubation. An SGA can be inserted successfully without interrupting chest compression, and its use has been validated in numerous studies.[9] The correct placement of advanced airway devices allows for more chest compressions (200 vs 150) per 2-minute cycle, and ventilations become asynchronous rather that synchronous with them. The placement of an advanced airway allows for effective, high-quality CPR. The correct placement of any advanced airway device is confirmed by auscultation and observation of chest rise and the detection of end-tidal CO_2.

LMA Supreme

The LMA Supreme (LMA of North America) is a fixed-curve device designed for easier insertion, gastric access,

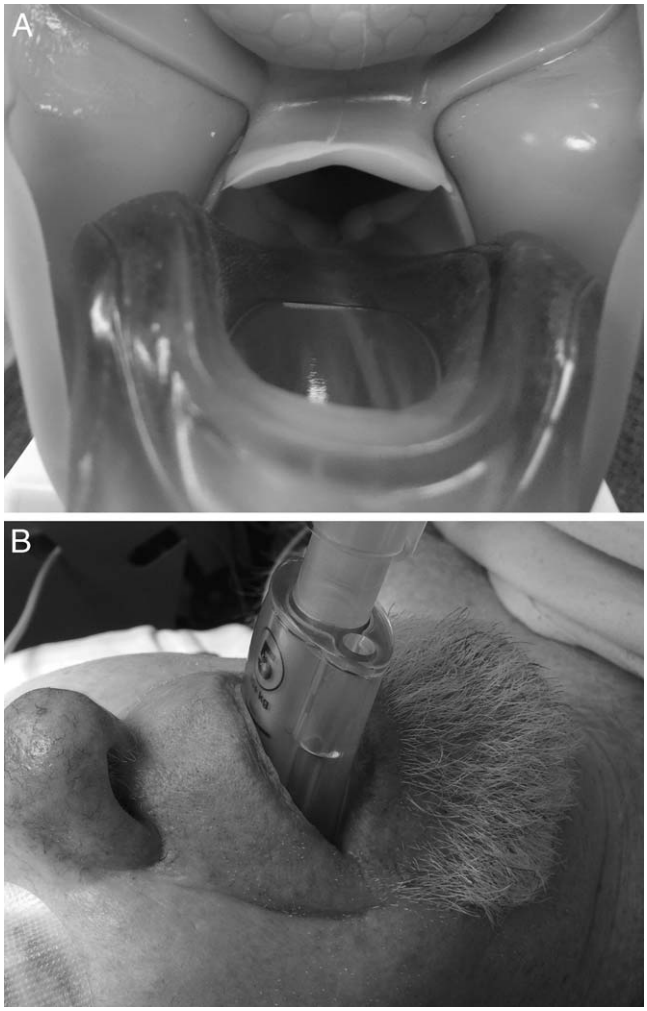

Figure 6. i-gel supraglottic airway. (A) i-gel slightly moved down to show correct placement for seal over glottis permitting pressures up to 40 cm H_2O without pressurization of stomach during ventilation. (B) i-gel patient placement with maxillary central incisors at the black line.

separation of the respiratory and alimentary tracts, and an integral bite block.[10] The Supreme consists of an elliptical airway conduit with an integrated gastric venting tube. The bite block, situated at the proximal end, lies between the central incisors when the mask is properly positioned. The LMA cuff must be inflated to provide a seal.

AuraGain LMA

The AuraGain (Ambu) is Ambu's third- generation LMA. It provides airway management control by integrating gastric venting access and intubation capability in an anatomically curved single-use device that facilitates rapid establishment of a safe airway and an integrated bite absorption area to prevent airway occlusion. This LMA has a bite block and reinforced tip. The LMA cuff must be inflated to guarantee a seal.

i-gel LMA

The i-gel (Intersurgical) is a noninflatable SGA that is manufactured from medical grade thermoplastic elastomer that creates an anatomical seal of the laryngeal, perilaryngeal, and pharyngeal structures after placement. It also has an integrated bite block and gastric vent. Some studies indicate that this device may be placed more quickly than others.[11,12] The i-gel is recommended in the American Dental Society of Anesthesiology emergency management team simulation workshops for the practitioner who does not have the clinical experience to intubate the trachea and seldom uses an SGA. The i-gel (a) does not require air inflation to seal over the glottis; (b) has a tip that does not flex forward/backward, which can prevent a seal over the glottis; (c) can vent gastric pressure if bag-mask ventilation has pressurized the stomach; and (d) has a bite block to prevent loss of airway if the patient bites down. Anecdotal authors' experience indicates that because this device does not require inflation of a glottis cuff, the device can be placed as quickly as an oropharyngeal airway and permits all the benefits gained from an advanced airway. (Figure 6.)

King LTS-D

The King LTS-D (Ambu) differs from the previously discussed gastric-venting LMAs, as it is a true SGA device that does not provide a direct seal over the glottis. It is a double-lumen, silicone tube with a large oropharyngeal blocking cuff and smaller esophageal blocking cuff that lies in the esophagus below the glottis. The ventilation port is situated between these cuffs. It has become very popular for first responders in the emergency medical services/EMT community because of its ease of insertion.[13]

CONCLUSION

As novel and innovative as these airway management and rescue devices are, one must remember that their role always must be as part of an emergency airway algorithm that is a stepwise progression that goes

logically and rapidly through decision points. SGAs have a proven role in airway rescue in unanticipated respiratory issues. However, there is no single fail-safe technology in airway management that can overcome every problem. There is no doubt that the devices are only as good as the clinical judgment of the provider and his or her training and experience. The introduction of any critical airway rescue device must be rehearsed and practiced to assure that the device will, in fact, make the difference in patient safety and outcome.

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CONTINUING EDUCATION QUESTIONS

1. According to the American Dental Society of Anesthesiology unconscious patient algorithm, a supraglottic airway should be considered:

   A. initially in all unconscious patients
   B. initially in unconscious patients with apnea
   C. when attempts at bag-valve-mask ventilation are unsuccessful
   D. when attempts at bag-valve-mask ventilation with an oropharyngeal airway are unsuccessful

2. Use of a supraglottic airway will allow the safe use of ventilation pressures of up to how many centimeters of water?

   A. 10–20
   B. 20–40
   C. 40–60
   D. 50–100

3. Which of the following features of various supraglottic airways is unique to the i-gel device?

   A. No requirement for cuff inflation
   B. Gastric venting is provided
   C. Does not require laryngoscopy for insertion
   D. Contains a bite block

4. Correct placement of a supraglottic airway can be confirmed by which of the following?

(1) auscultating breath sounds (2) pulse oximetry (3) chest rise upon ventilation

   A. 1 and 2
   B. 1 and 3
   C. 2 and 3
   D. 1, 2, and 3