INTRODUCTION — Basic airway management is most often needed because of inadequate ventilation, which can result from impaired respiratory effort or airway obstruction. Basic airway interventions may also be needed to manage the patient with inadequate oxygenation and during cardiopulmonary resuscitation. Bag-mask ventilation is the cornerstone of basic airway management.

This topic will review the essential techniques involved in basic airway management in adults. Airway management of children is discussed separately. (See "Advanced airway management in children"). Issues related to endotracheal intubation and other advanced airway management techniques are discussed elsewhere.

CAUSES OF INADEQUATE VENTILATION

Respiratory effort — Inadequate respiratory effort can result from intrinsic (eg, intracranial hemorrhage) or extrinsic (eg, opioid overdose) factors. Poor respiratory effort causing inadequate ventilation can be difficult to discern: it is often silent and detection depends on close observation of chest wall movement. Thorough evaluation requires that the patient be undressed and the clinician observe the rate, pattern, and depth of breathing, use of accessory muscles, abnormal sounds, and signs of injury. Both laymen and health care professionals often fail to accurately determine the adequacy of respiratory effort [1,2].

Airway obstruction — Soft tissue airway obstruction in the unconscious patient can occur by several mechanisms. These include prolapse of the tongue into the posterior pharynx and loss of muscular tone in the soft palate [31,32]. Simple airway maneuvers, such as the head-tilt chin-lift or jaw-thrust with or without a head tilt, often ameliorate this problem quickly. (See "Airway maneuvers" below). Obstruction by foreign bodies, injured tissue, blood, and secretions can also occur.

Noises produced by the obstructed upper airway often make such obstruction easier to detect than poor respiratory effort. As an example, snoring or gurgling noises may be heard when the upper airway becomes partially obstructed by soft tissue or liquid (blood, emesis). Complete airway obstruction is silent but may manifest transiently as retractions of the accessory muscles of respiration (suprasternal, supraclavicular, intercostal, subcostal) or cyanosis, until frank respiratory arrest supervenes.

If the patient is making respiratory effort but not adequately ventilating because of airway obstruction, the clinician must immediately attempt to determine the cause of the obstruction while taking measures to alleviate it. In a conscious adult, there are data supporting the efficacy of chest thrusts, back blows/slaps, and abdominal thrusts in relieving complete foreign body airway obstruction (FBAO) [3-5]. The chance of relieving an FBAO
may be highest when using a combination of these techniques. One study showed that 50 percent of airway obstruction episodes were not relieved by a single technique [6].

The 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care recommend rapid-sequence abdominal thrusts, followed by chest thrusts if unsuccessful. Chest thrusts are the initial recommended technique if one is unable to encircle the abdomen of the patient or if the patient is late in pregnancy [7]. There have been several case reports of injuries (eg, gastric rupture) from abdominal thrusts, so a quick physical assessment after thrusts are performed is reasonable [8-10].

Unresponsive patients with presumed FBAO should receive cardiopulmonary resuscitation (CPR), as chest thrusts in these patients may produce higher airway pressures when compared with abdominal thrusts [11]. The 2005 American Heart Association guidelines recommend that a blind finger sweep NOT be used in the unconscious patient with an obstructed airway unless, during the course of CPR, solid material becomes visible in the airway [7]. This change from the 2000 Advanced Cardiac Life Support (ACLS) guidelines is based, in part, on multiple reports of injuries to the clinician’s fingers and to the patient’s oropharynx [12,13].

**AIRWAY MANEUVERS** — Two positioning maneuvers can be performed to improve airflow in the patient receiving basic airway management: head-tilt chin-lift and jaw-thrust.

**Head-tilt chin-lift** — The head-tilt chin-lift is the primary maneuver used in any patient in whom cervical spine injury is NOT a concern. In this technique, the clinician uses two hands to extend the patient’s neck and open the airway. While one hand applies downward pressure to the patient’s forehead, the tips of the index and middle finger of the second hand lift the mandible at the mentum, which lifts the tongue from the posterior pharynx (show figure 1). This technique has been shown in multiple studies to improve airway patency [14].

**Jaw-thrust maneuver** — The jaw-thrust maneuver is an effective airway technique, particularly in the patient in whom cervical spine injury is a concern. This maneuver moves the tongue anteriorly with the mandible, minimizing the tongue’s ability to obstruct the airway [15]. With the patient supine and the clinician standing at the head of the bed, the technique is performed by placing the heels of both hands on the parieto-occipital areas on each side of the patient’s head, then grasping the angles of the mandible with the index and long fingers, and displacing the jaw anteriorly (show figure 2). The jaw thrust is the safest first approach to opening the airway of a casualty with a suspected neck injury because, properly performed, it can generally be accomplished without extending the neck.

The reduced emphasis on the jaw-thrust technique in the current Advanced Cardiac Life Support (ACLS) guidelines has to do with reducing the complexity of cardiopulmonary resuscitation (CPR) for lay persons, rather than opposition to its use.

**Cervical spine immobilization** — Most airway maneuvers are associated with some movement of the cervical spine (c-spine) [16,17]. Regardless of the maneuver chosen, it is important that the clinician stabilize the c-spine in order to minimize head and neck movement in any patient with a possible c-spine injury. Failure to do so is associated with a 7 to 10-fold increase in neurologic injury among patients with c-spine trauma [18]. If
sufficient personnel are present, manual in-line stabilization, rather than mechanical restraints, should be used to ensure c-spine stabilization. Cervical collars can interfere with airway maneuvers and have been shown to cause increased intracranial pressure (ICP) from partial obstruction of venous outflow [19,20]. Collars may be removed, provided manual in-line stabilization is maintained continuously, while basic airway management is performed. If the collar is left in place, clinicians should open or remove the front half to permit basic airway management.

**AIRWAY ADJUNCTS** — Once an open airway has been established, it must be maintained. Oropharyngeal and nasopharyngeal airway devices are important adjuncts in achieving this goal. Both will prevent the tongue from occluding the airway and provide an open conduit for air to pass. Unless bag mask ventilation is expected to be needed only transiently (eg, while naloxone takes effect), we suggest an oropharyngeal airway (OPA) be placed whenever bag mask ventilation is required. The OPA may be supplemented by one, or even two, nasopharyngeal airways. Neither of these airway devices will protect the trachea from aspiration of secretions or gastric contents. An endotracheal tube should be inserted as soon as possible in any patient unable to protect his or her airway.

**Oropharyngeal airway** — Oropharyngeal airways (OPAs) should only be used in a deeply unresponsive patient who is unable to maintain their airway. In responsive patients they can cause vomiting and aspiration. The OPA is a curved, firm, hollow tube, with a rectangular aperture, that is used to maintain a conduit between the mouth and the glottis and to prevent obstruction by the patient's tongue and other soft tissue. OPAs have a flange that, when properly inserted, rests against the patient's lips to prevent inadvertent inward migration of the OPA. This flange does not interfere with forming an adequate seal from a face mask.

OPAs come in multiple sizes (show figure 3). A line between the posterior angles of the mandible approximates the plane of the posterior oropharynx. Therefore, a rough method for choosing the correct OPA size is to hold the airway beside the patient's mandible, orienting it with the flange at the patient's mouth and the tip directed toward the angle of the mandible. The tip of an appropriately sized OPA should just reach the angle of the patient's mandible (show figure 4).

When inserting an OPA, the clinician must avoid pushing the tongue into the posterior pharynx. This can be accomplished by starting with the curve of the OPA inverted (ie, directed cephalad) and then rotating it 180 degrees as its tip reaches the posterior pharynx (show figure 5). Alternatively, a tongue depressor can be used to move the tongue out of the way as the airway device is passed, or care can be taken not to push the tongue posteriorly with the tip of the OPA.

Whichever technique is chosen, the clinician should be certain that the OPA is correctly positioned. If there are problems ventilating the patient after insertion, the OPA should be removed and reinserted. If ventilation problems persist, the clinician should verify the size of the OPA (often a larger OPA will succeed where a smaller one fails) and insert at least one nasopharyngeal airway. (See "Nasopharyngeal airway" below).

Potential hazards of using the OPA include:
• Pushing the tongue posteriorly, thereby exacerbating the airway obstruction

• Using an incorrectly-sized device: too small a device is ineffective and can be lost in the oropharynx, possibly causing obstruction; too large a device can press against the epiglottis and obstruct the larynx

• Catching the tongue or lips (usually the lower lip) between the airway and the teeth, thereby traumatizing the soft tissue

• Using the device in a patient with intact airway reflexes, possibly inducing vomiting. The OPA must be removed if protective reflexes are present.

Nasopharyngeal airway — The nasopharyngeal airway (NPA) is a soft rubber or plastic hollow tube that is passed through the nose into the posterior pharynx. Patients tolerate NPAs more easily than OPAs, so NPAs can be used when the use of an OPA is difficult, such as when the patient's jaw is clenched or the patient is semiconscious and cannot tolerate an OPA.

Also known as nasal trumpets, NPAs come in sizes based on their internal diameter. The larger the internal diameter of the airway, the longer the tube. A length of 8.0 to 9.0 cm is used for a large adult, 7.0 to 8.0 cm for a medium adult and 6.0 to 7.0 cm for a small adult (show figure 6). Selecting NPAs based on length, rather than diameter, improves accuracy [21]. A rough method for choosing the correct NPA size is to hold the airway beside the patient's mandible, orienting it with the flared end at the tip of the patient's nose and the distal tip directed toward the angle of the mandible. The tip of an appropriately sized NPA should just reach the angle of the patient's mandible

Prior to insertion, the NPA should be coated with water-soluble lubricant or anesthetic jelly. Contact time is insufficient for anesthetic jelly to make insertion more comfortable, but may improve tolerance of the device after it is placed. The device is then inserted along the floor of the naris into the posterior pharynx behind the tongue (show figure 7). Clinicians should note that the floor of the naris inclines in a caudad orientation approximately 15 degrees. The tube can be rotated slightly if resistance is encountered.

Although there are two case reports of intracranial NPA placement in patients with basilar skull fractures, such extreme complications are rare and can only occur with devastating disruption of the basal skull, improper insertion technique (angling the NPA cephalad in the naris, instead of following the floor of the naris), or both [21]. More common potential hazards of using the NPA include:

• Using an airway that is too long; this may cause the tip to enter the esophagus, increasing gastric distention and decreasing ventilation during rescue efforts.

• Injury to the nasal mucosa causing bleeding; this occurs in 30 percent of insertions and can lead to aspiration of blood or clots [22].
**BAG-MASK VENTILATION** — Bag-mask ventilation is a crucial airway management skill and one of the most difficult to perform correctly. The clinician performing bag-mask ventilation must carefully monitor the adequacy of his or her technique at all times. Properly performed bag-mask ventilation enables clinicians to provide adequate ventilation and oxygenation to a patient requiring airway support. This in turn gives the clinician sufficient time to pursue a controlled, well-planned approach to definitive airway management, such as endotracheal (ET) intubation. Successful bag-mask ventilation depends on three things: a patent airway, an adequate mask seal, and proper ventilation (ie, proper volume, rate, and cadence). Airway patency is obtained using airway maneuvers and adjuncts. (See "Airway maneuvers" above and see "Airway adjuncts" above).

**Mask placement** — Prior to placing the mask on a patient's face, the airway should be opened using the airway maneuvers and devices discussed above. (See "Airway maneuvers" above and see "Airway adjuncts" above).

Once the airway is open, the next step is to correctly position the mask on the patient's face. The bag is detached from the mask prior to mask positioning. Having a large, heavy bag pulling on one end of the mask is a common error that unnecessarily complicates proper placement. The nasal portion of the mask should be spread slightly and placed on the bridge of the patient's nose. The body of the mask is then placed onto the patient's face covering the nose and mouth. The three facial landmarks that must be covered by the mask are the bridge of the nose, the two malar eminences, and the mandibular alveolar ridge [23].

Neither the provider's wrists nor the mask cushion should rest on the patient's eyes during bag-mask ventilation, as this can cause a vagal response or damage to the eyes.

There are two methods for holding the mask in place: the single-hand (one hand-one person) mask hold and the two-hand (two hand-two person) mask hold. Although the two-hand mask hold is most effective, it requires a second clinician. Therefore, it is important to be comfortable with both techniques. When ventilation using a one hand-one person technique is unsuccessful, despite oral and nasal airway placement, a two hand-two person technique should be used.

**Single-hand technique for bag-mask ventilation** — One hand is placed on the mask, with the web space between the thumb and index finger resting against the mask connector. The web space is placed in the center of the mask, allowing for a more even application of pressure (show figure 8 and show figure 9). Force should not be exerted via the palm of the hand because it is off-center and more likely to produce an air leak.

The other three fingers (ie, middle, ring, and little) are placed along the mandible and pull the mandible up into the mask in a chin-lift maneuver, allowing the airway to open further. Those with larger hands can place the little finger posterior to the angle of the mandible and perform a jaw-thrust, although this is tiring to the hand. The correct technique is to lift the mandible up into the mask with the middle, ring, and little fingers, while holding the mask tightly against the patient's face with the thumb and index finger (show figure 8 and show figure 9). Clinicians should take care to pull up only on the bony parts of the mandible; pressure to the soft tissues of the neck may occlude the airway.

**Two-hand technique for bag-mask ventilation** — The two-hand mask hold requires two providers, but it is the most effective method of opening the patient's airway while
maintaining an adequate mask seal, and minimizing provider fatigue. With this technique, one provider's sole responsibility is to use both hands to create a good mask seal and to maintain an open airway. Another provider squeezes the bag to ventilate the patient. Proper placement and holding of the mask are essential for a good seal, and are the most difficult aspects of bag-mask ventilation. The most experienced airway manager available should therefore control the mask.

There are two ways to position the hands. In the more traditional method, both thumbs and index fingers hold pressure along the inferior and superior ridges of the mask (show figure 10 and show figure 11). The other three fingers on each hand hold the mandible, in a fashion similar to the one-handed mask hold, and perform a simultaneous chin-lift and jaw-thrust maneuver. This position may not be comfortable to maintain for long periods of time.

We recommend another method of two-handed mask technique that uses the stronger thenar eminences to hold the mask in place. The thenar eminences are positioned parallel to each other along the long axis of each side of the mask, allowing the four remaining fingers to provide chin-lift and jaw-thrust maneuvers (show figure 10 and show figure 12). This technique is easier to perform, allows stronger hand muscles to maintain a proper seal, minimizing provider fatigue, and enables four fingers to perform the chin-lift and jaw-thrust.

**Trouble-shooting problems with bag-mask ventilation** — If obstruction to air flow exists or the chest does not rise, the clinician should consider the most commonly encountered problems:

- Inadequate mask seal: patients with facial hair may need KY jelly or water applied to improve the seal; edentulous patients should have their false teeth reinserted [24] or their cheeks expanded with 4 x 4 gauze.

- Improper mask size: ensure that the corners of the mouth and all airway adjuncts are inside the body of the mask, NOT creating a leak by interfering with mask seal.

- Lack of airway adjuncts (ie, nasopharyngeal and oropharyngeal airways): verify that airway adjuncts are being utilized and in proper position.

- Inadequate airway maneuvers: ensure the jaw-thrust and other maneuvers are being done effectively in order to open the airway.

- Inexperienced personnel: determine if a more experienced clinician needs to be recruited to help provide optimal bag-mask technique, particularly mask seal [23].

**Ventilation volumes, rates, and cadence** — Once an open airway and a good mask seal are present, the clinician connects the bag to the mask and ventilates the patient. Three critical errors should be avoided:

- Giving excessive tidal volumes
- Forcing air too quickly
- Ventilating too rapidly
A volume just large enough to cause chest rise (no more than 8 to 10 cc/kg) should be used. During cardiopulmonary resuscitation (CPR), even smaller tidal volumes are adequate (5 to 6 cc/kg) due to the reduced cardiac output of such patients [25]. The bag should not be squeezed explosively. It should be squeezed steadily over approximately one full second. This technique, in addition to producing smaller tidal volumes, reduces the likelihood of creating sufficient pressure to open the gastroesophageal sphincter, which leads to gastric inflation. The ventilatory rate should not exceed 10 to 12 breaths per minute.

These important concepts are based on multiple randomized controlled studies in animals and observational studies in humans showing that the use of larger tidal volumes and ventilation rates is associated with increased intrathoracic pressures, which compromise both coronary and cerebral perfusion pressures [26-30].

Sellick's maneuver — Sellick's maneuver (ie, cricoid pressure) may reduce gastric insufflation, but its effectiveness in reducing aspiration of gastric contents is unproven. The technique is discussed in detail elsewhere. (See "Rapid sequence intubation in adults").

SUMMARY AND RECOMMENDATIONS

- Poor respiratory effort causing inadequate ventilation can be difficult to discern: it is often silent and requires close observation of chest wall movement. The most common cause of airway occlusion in an unconscious patient is prolapse of the tongue into the posterior pharynx. This problem can often be corrected quickly using simple airway maneuvers such as the head-tilt chin-lift or jaw-thrust with or without a head tilt. (See "Causes of inadequate ventilation" above).

- Two positioning maneuvers can be performed to improve airflow in the patient receiving basic airway management: head-tilt chin-lift and jaw-thrust. Proper technique for each is described above. (See "Airway maneuvers" above).

- Oropharyngeal airway (OPA) and nasopharyngeal airway (NPA) devices are important adjuncts for maintaining an open airway. Unlike a cuffed endotracheal (ET) tube, neither one protects the trachea from aspiration of secretions or gastric contents. An ET tube should be inserted as soon as possible in any patient unable to protect his or her airway. Proper insertion technique and common problems encountered with OPAs and NPAs are described above. (See "Oropharyngeal airway" above and see "Nasopharyngeal airway" above).

- Bag-mask ventilation is a crucial airway management skill and one of the most difficult to perform correctly. The clinician performing bag-mask ventilation must carefully monitor the adequacy of his or her technique at all times. Proper bag-mask technique enables clinicians to provide adequate ventilation and oxygenation to a patient requiring airway support and is described above. (See "Bag-mask ventilation" above).

- Successful bag-mask ventilation depends on three things: a patent airway, an adequate mask seal, and proper ventilation (ie, proper volumes, rates, and cadence).
Airway patency is obtained using airway maneuvers and adjuncts. (See "Airway maneuvers" above and see "Airway adjuncts" above). Proper placement and holding of the mask is essential for a good seal. Whenever possible, clinicians should use the two-hand technique that makes use of the thenar eminences to hold the mask in place. (See "Two-hand technique for bag-mask ventilation" above).

- Problems commonly encountered during bag-mask ventilation include: inadequate mask seal; improper mask size; lack of airway adjuncts (i.e., nasopharyngeal and oropharyngeal airways); and inadequate airway maneuvers. (See "Trouble-shooting problems with bag-mask ventilation" above).

- When performing bag-mask ventilation, clinicians must avoid three critical errors: giving excessive tidal volumes, forcing air too quickly, and ventilating too rapidly. (See "Ventilation volumes, rates, and cadence" above).