3

Oxygenation and Airway Management

Quick Look

Few events cause greater anxiety than being thrown into an emergency situation involving a patient without the appropriate knowledge and skills. This is how many health care professionals are when it comes to managing a patient's airway. Why am I the one closest to the bag valve mask?

Most patients having a cardiovascular emergency are in need of supplemental oxygen and in some cases airway management. The good news is that the skills and knowledge necessary to proficiently maintain an open airway and ventilate a patient are within reach.

The knowledge and skills necessary to increase your confidence in airway management is covered in the pages to follow. Beginning with a brief account of respiratory structure and function, sections on pulse oximetry, airway management techniques and oxygen administration methods round out this chapter.

Take another breath. Now, let's get started.

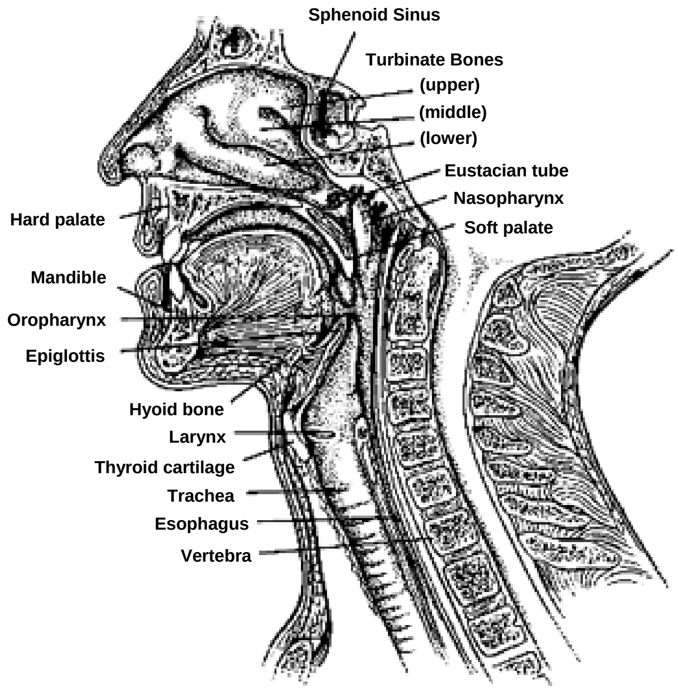
If you can walk, you can dance.
If you can talk, you can sing.

Zimbabwean Proverb

Respiratory Anatomy

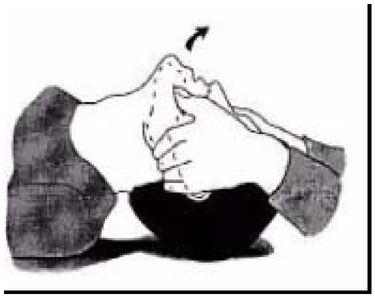
The anatomy of the respiratory system includes the structures of the upper airways and the structures associated with the lungs. Key upper airway structures are depicted in Figure 3.1.

Figure 3.1 Upper Respiratory Tract



Certain structures are especially key to airway management. For example, the displacement of the **tongue** posteriorly against the soft palate and oropharynx is the leading cause of airway blockage in the unconscious patient. Manipulation of the position of the **mandible** with a modified jaw thrust, which includes head tilt, is the best general method to open an airway.

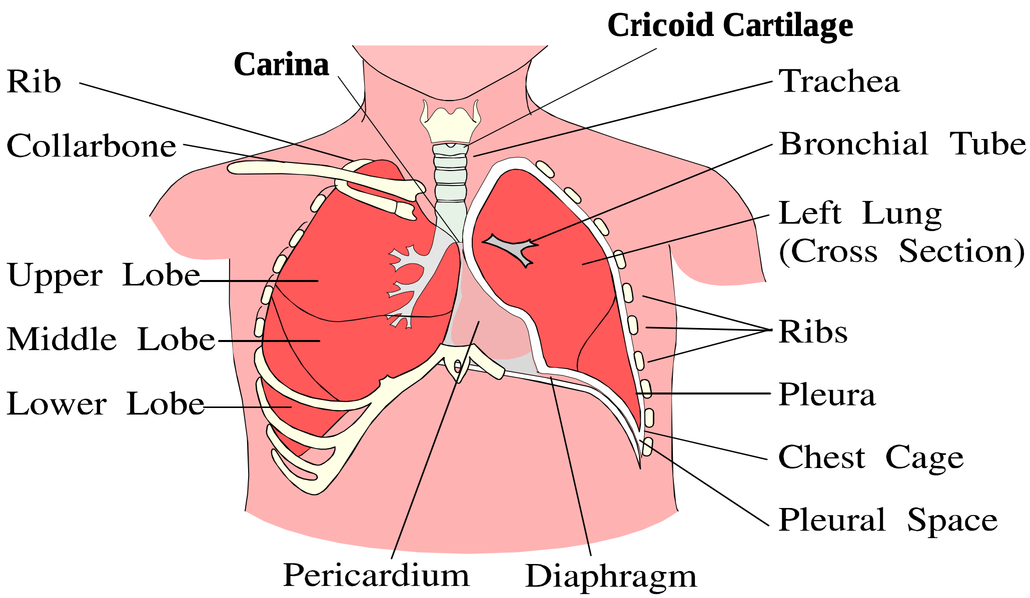
Figure 3.2 Modified Jaw Thrust



As well, the **vallecula** is the notch between the base of the tongue and the epiglottis, an important target in the process of intubation. The tip of the laryngoscope blade pulls up from this notch to cause the epiglottis to open. The **epiglottis** is a leaf shaped cartilage that acts like a trap door covering the glottis, the opening to the trachea. This is another common site for airway obstruction. An oversized oral airway can push the epiglottis closed.

The anatomy of the lungs is depicted in Figure 3.3.

Figure 3.3 Lung Anatomy



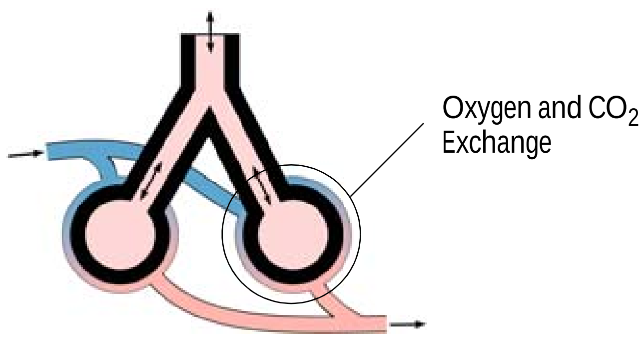
"Give me cricoid pressure". The **cricoid cartilage** is an important anatomical landmark if assisting intubation. Also, the membrane between this cartilage and the one superior to the thyroid cartilage is the location for a cricothyroidomy.

The point where the trachea branches into the right and left mainstem bronchi is called the **carina**. The angles that the bronchi branch off are not identical; the right bronchi dips at a steeper angle. As a result, an endotracheal tube that is inserted too deeply tends to go down the right bronchi. This causes ventilation of the right lung only. Most aspiration pneumonias also occur in the right lung.

The right bronchus branches from the trachea in a more acute angle than the left bronchus. As a result, foreign bodies that enter the lung tend to enter the right lung. Aspiration pneumonia is more frequently in the right lung than the left. An endotracheal tube advanced too far generally ends up in the right lung. If this occurs, breath sounds are audible to the right lung; absent in the left lung.

The lung's anatomy maximizes air and oxygen exchange. The respiratory tree branches from the main **bronchi** to the smaller bronchioles becoming narrower but exponentially more plentiful with each successive bifurcation. The brochioles terminate in the **alveoli** where true oxygen exchange occurs with the pulmonary capillary bed.

Figure 3.4 The Alveoli and Oxygen Exchange



At this point, only a two cell thickness separates the air within the alveoli from the blood in the capillaries. It is not surprising that increased pressure within the capillaries (hydrostatic pressure due to back up of blood volume into the lungs i.e. left ventricular failure) can lead to fluid accumulation in the lungs.

Ventilation and Changing Pressures

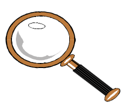
How does air move in and out of our lungs? Air moves from an area of high pressure to an area of lower pressure. A lung air pressure that is lower than atmospheric pressure causes air to flow into the lungs. This is accomplished by increasing the volume of the closed thoracic cavity (inspiration). By increasing the lung volume, air pressure within the lung drops.

In a closed system, pressure is inversely related to volume.

In other words, in a closed system pressure decreases when volume increases. Conversely, pressure increases as volume decreases. Therefore, by increasing lung volume, intrapleural (lung) pressure drops below atmospheric pressure and air rushes into the lungs. This **negative pressure ventilation** - better known as breathing spontaneously - is how we move air into our lungs.

To review, inspiration causes the pleural cavity to increase, intrapleural pressures become negative, and air moves from an area of higher pressure (the atmosphere) to an area of lower pressure (the alveoli). During expiration the intrapleural pressures are increased in relation to atmospheric pressure as the closed thoracic cavity decreases in size. This causes air to flow back out to the atmosphere.

For patients who require assistance breathing, a ventilator or bag valve mask (BVM) delivers air forcefully into the lungs. The air pressure created by the action of these devices is higher than the air pressure in the lungs. This is **positive pressure ventilation** (PPV) and it has many benefits in cardiovascular emergencies. For example, PPV can help expand collapsed alveoli or cause fluids to be forced out of the lungs and into the blood stream i.e. pulmonary edema.



Positive pressure ventilation does have its disadvantages. Positive pressure ventilation can rupture the lung causing a tension pneumothorax. Also, positive pressure ventilation can increase the **positive end expiratory pressure** (PEEP) within the lungs. Additional PEEP increases the pressure on the pulmonary vasculature and reduces the venous return (preload) to the heart. While the reduction of preload may benefit those in left ventricular failure, those who are critically dependent on preload (i.e. acute right ventricular infarction or low cardiac output states) may deteriorate with high PEEP.

Respiratory Physiology

Respiration occurs primarily to provide oxygen to cells for aerobic metabolism. Effective oxygenation occurs if three mechanisms occur:

- •1. Oxygenation at the lungs;
- •2. The transport of oxygen; and
- •3. The release of oxygen at the cellular level.

A breakdown of any these tasks can result in ischemia.

As presented on page 50, gas exchange occurs primarily at the surface of the alveoli (the respiratory bronchioles also engage in gas exchange but to much lesser extent than the alveoli). Oxygen crosses fairly freely into the blood, providing a partial pressure (Pao_2)in the blood of about 80-100 mm Hg. The venous circulation has a Pao_2 of about 40 mm Hg.

While most instances of poor oxygenation produce cyanosis, **carbon monoxide (CO) poisoning** is the exception. Hemoglobin's affinity for carbon monoxide is about 240 times that of oxygen. Carbon monoxide quickly binds to hemoglobin at the sites usually reserved for oxygen. This causes the hemoglobin to reflect a bright red hue typical of full oxygen saturation. While CO poisoning is indeed responsible for severe oxygen depletion, the patient presents without cyanosis (white skinned people become a cherry red). Treatment includes the provision of high flow oxygen.

Several disease processes can impair gas exchange. This includes airway obstruction, respiratory failure, carbon monoxide poisoning and low oxygen gradient (i.e. high altitude where atmospheric Pao_2 is low). For example, emphysema restricts the flow of air into and out of the lungs, impairing gas exchange at the alveoli. The pulse oximeter is a simple, non-invasive device used to measure the blood oxygen saturation.

Respiratory Assessment

Many patients having a cardiovascular incident have respiratory distress either as a result of the incident or as a precipitating factor. Patient assessment starts as you approach your patient.

What body position has your patient chosen? Patients in respiratory distress tend to want to sit upright or even lean forward? Are they oriented? Patients with severe distress who are hypoxic and retaining $C0_2$ often become obtunded. Do they use short sentences when they speak? The inability to complete long sentences is a hallmark of acute dyspnea.

What is their skin color? Cyanosis, a bluish discoloration of the skin due to deoxygenated arterial blood moving through vascular beds is a sign of severe hypoxemia. Are there audible adventitious (abnormal) breath sounds such as crackles, stridor or wheezing? Does the patient have distended neck veins? Is the patient diaphoretic?

The visual inspection of the chest gives information on the work of breathing. Is there accessory muscle use, paradoxical motions, supraclavicular or intercoastal indrawing? These signs indicate respiratory distress as a patient works harder to create positive and negative pressures in relation to atmospheric pressure. Is chest expansion equal bilaterally?

Auscultation gives more information relating to air movement into alveoli. Are there absent sounds indicating atelectasis, pneumothorax, or hemothorax? Are there crackles indicating fluid build-up in the lungs?

Are there associated signs and symptoms such as chest pain which may give evidence as to the cause of the dyspnea? Causes of respiratory distress include myocardial infarction (MI) with left heart failure, pulmonary emboli (PE), pneumothorax, hemothorax, asthma, anaphylaxis, and COPD exacerbation.

With a focused physical exam and history you begin early respiratory management of the patient. Remember that airway management is a dynamic process that requires ongoing re-evaluation. The upside is that many of the signs of altered respiratory status are readily recognized visually without close inspection.

Pulse Oximetry

Pulse oximetry is a non-invasive tool that can aid with your respiratory assessment. The modern pulse oximeter for medical use was first introduced in 1980. Since that time this device has been extensively adopted by medicine. It is sometimes called "the fifth vital sign". Understanding the basics of how oximetry works allows us to also understand its limitations.

Pulse oximetry is a safe non-invasive method of measuring the oxygen saturation of arterial capillary blood. It is based on the principle that the absorption of light by red blood cells (RBC) varies depending on the amount of oxygen attached to each hemoglobin molecule (of which there are some 250 million within each red blood cell).

The pulse oximeter measures both oxygenated and deoxygenated hemoglobin using two frequencies of light which are emitted through a capillary rich vascular bed and picked up by a sensor on the other side. The fingers and ear lobes are the most common sites for measuring oxygen saturation.

An **acceptable blood oxygen saturation does not guarantee acceptable tissue oxygenation**. Regions of the body may suffer from narrowed or occluded vessels. As well, a low hemoglobin count alone could cause poor tissue oxygenation throughout the body (see example above).

The greater the absorption of red light, the more desaturated the blood. It is the ratio at which these two frequencies of light are absorbed that determine oxygen saturation ($Sp0_2$). The pulse oximeter correlates its values with the pulsations of blood. As a result, the pulse oximeter is able to eliminate tissues and venous blood as they do not have the changing flow values of arterial blood.

Oxygen saturation measures the amount of oxygen bound to the hemoglobin. A hemoglobin that is 100% saturated is carrying a full load of oxygen. Hemoglobin carrying only half the maximum number of oxygen would have an oxygen saturation of 50%. Note that an oxygen saturation of 75% (Pao_2 of about 40 mm Hg) is typical for venous blood returning to the heart.

The following factors can affect the accuracy of your oxygen saturation reading:

- Anemia
- Carboxyhemoglobin
- Sickle Cell Anemia
- Poor blood flow states
- Fetal hemaglobin
- Nail polish
- Bright overhead lighting

Being diligent to remove nail polish and to choose a site that is adequately perfused will increase the likelihood that the resulting value is accurate.

Normal ranges for $Sp0_2$ are 95-100%. Values below 90% indicate severe hypoxemia. Unlike arterial blood gas measurements, pulse oximetry does not give specific information on the adequacy of ventilation. It does not measure the amount of oxygen being carried in the blood stream nor the ability of the body to remove $C0_2$. Nevertheless, pulse oximetry is a valuable tool to assess oxygenation, particularly when values trend up or down.

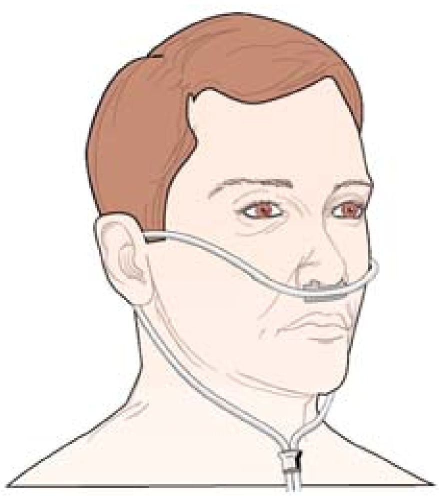
Oxygen Delivery for the Breathing Patient

The delivery of supplemental oxygen takes many forms in a hospital setting. Attention to both the patient's oxygen needs as well as the unintended effects of each modality to the patient will help you determine which delivery method is optimal.

Nasal Prongs

Patients who are experiencing a cardiovascular emergency with or without respiratory distress should receive oxygen. In the absence of respiratory distress nasal prongs are considered the best choice. Nasal prongs allow for oxygen delivery without the claustrophobic feelings associated with face masks, and makes communicating with the patient easier.

Figure 3.5 Nasal Prongs

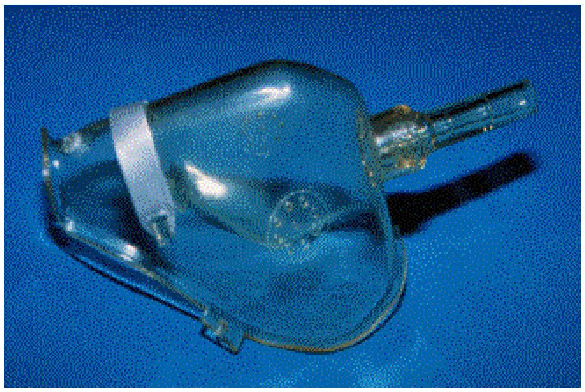


Delivered commonly at 2-4 litres/minute (LPM), inspired oxygen concentration increases approximately 4% for each 1 liter/minute flow. For example, at 2 LPM the inspired oxygen concentration is around 28%, while at 4 LPM inspired oxygen is 36%. Titration of flow can be done according to pulse oximetry.

Simple Face Mask

If a patient is showing signs of respiratory distress, then inspired oxygen concentration (Fio_2) can be increased with the use of a simple face mask (SFM). Flow rates **of at least 6 LPM** are needed to prevent the re-breathing of exhaled $C0_2$. The SFM does not include a reservoir and exhaled air must exit through small side holes.

Figure 3.6 Simple Face Mask

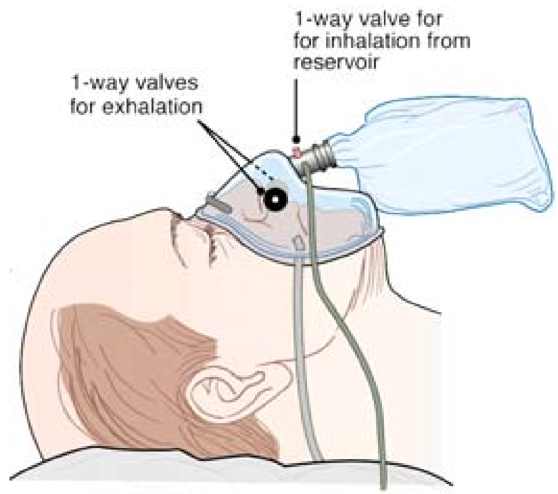


Recommended flow rates are between 8-10 LPM and this will deliver between 40-60% oxygen concentrations. Note that many patients find the mask causes sensations of claustrophobia. As a result, evaluate the use of the SFM and use only when required.

High Flow Masks

The non-rebreather mask and the star wars high flow system provide high inspired oxygen values approaching 100%. The non-rebreather mask delivers oxygen concentrations in the range of 60-95%. It is used for patients suffering acute respiratory distress. An oxygen reservoir bag and a number of one way valves allow for high oxygen delivery. **Flow rates should be at least 10 LPM.**

Figure 3.7 Non-Rebreather Mask



The star wars high flow system is a double flow (two wall regulators) humidified oxygen system. The name originates from the corrugated tubing reservoirs on the mask which gives it a strange appearance. This system delivers similar concentrations as a non-rebreather mask, but with high humidification and higher oxygen flow rates (can reach 100% Fio_2).

Ventilatory Support for Respiratory Distress

There is Level I evidence (the best quality of research) that CPAP (Continuous Positive Airway Pressure) and BiPAP (Bi-level Positive Airway Pressure) decrease mortality and the likelihood of intubation in select patients. CPAP delivers a continuous positive air pressure, most frequently at about 10 cm of water. This is delivered throughout the respiratory cycle.

Both CPAP and BiPap require spontaneous breathing from the patient. On the beginning of inspiration, these devices will initiate a flow of air to ease the work of inspiration. While CPAP produces continuous pressure, BiPap provides a lesser pressure to facilitate expiration while also maintaining sufficient inflation of the alveoli.

> Note that BiPap will maintain increased pressures within the alveoli. The increased pressures can cause the pulmonary capillaries to be compressed, thus inhibiting the quantity of blood flow to the left heart (also known as reduced preload). For pulmonary edema, the reduced preload is a welcome benefit.

BiPAP delivers CPAP but also senses when an inspiratory effort is being made and delivers a higher pressure during inspiration. This positive pressure wave during inspiration unloads the diaphragm decreasing the work of breathing.

Figure 3.8 BiPap Ventilator

What does this all do to help the patient in respiratory distress? The use of these machines can result in:

- Decreased work of breathing
- Reduced intrinsic PEEP, a residual positive pressure at the end of expiration found with obstructive airway diseases like emphysema
- Decreased preload and afterload in CHF
- Improved lung compliance in CHF
- Shift of fluids out of the alveolar sacs

The most frequent problem encountered with CPAP and BiPAP is poor patient compliance. Some patients cannot tolerate having a positive pressure mask on. They tend to be very anxious and even confused. These patients may need to be intubated.

Airway Management for the Compromised Patient

For the patient with a compromised airway, maintaining airway patency and providing ventilations is one of the greatest challenges that you may be tasked with when giving emergency medical care. The time constraints imposed by the threat of brain anoxia requires a developed, organized, and systematic approach to providing the "A" and "B" of the ABCs. Practice the skills, know your equipment, make sure it all works, and know where it is located.

The Oral Airway

This little adjunct is used to **assist** in keeping the tongue from occluding the airway. It should be used only in the fully obtunded patient as it can cause laryngospasm, retching, and vomiting in patients with a gag reflex. Proper insertion is done most often by placing the airway into the patient's mouth upside down until reaching the soft palate where it is then rotated into position.

Figure 3.9 Oropharygeal Airway

The phalange rests against the teeth. Sizing is done by selecting a size that reaches from the corner of the patient's mouth to the angle of the jaw. Proper insertion helps keep the tongue from falling against the posterior pharynx in the unconscious patient and blocking their airway.

Suction

The oropharynx often needs to be cleared of vomitus, blood or mucus. A Yankauer suction tip should be attached and ready for use in resuscitation areas. Limit suctioning to 15 seconds and monitor oxygen saturation if possible.

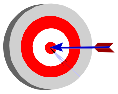
Figure 3.10 Yankauer Suction

Bag-Valve-Mask

Bag-Valve-Mask (BVM) skills are essential for many healthcare professionals. Managing an airway causes anxiety for many people. It takes time to gain confidence. The most common problems often involve either making a good seal with the mask or delivering pressures that are too high. Let's go through some tips for good BVM use. Oxygen flow rates should be 12-15 LPM so that the reservoir bag never fully deflates.

Always think of bringing the face up to the mask, not the mask down into the face. A common mistake is trying to get a mask seal by pushing down onto the face. This leads to neck flexion and further airway obstruction. A modified jaw thrust can be performed by bringing the face up into the mask while providing some head tilt chin lift.

Watch for the chest to rise. **One of the biggest problems associated with BVM use is delivering volumes of air under high pressure, which in the unintubated patient leads to air going down into the stomach.** When you see the patient's chest just starting to rise then you have delivered enough tidal volume. If you deliver the volume over at least two seconds then you will minimize the chances of opening the esophagus and sending air down into the stomach.



The use of cricoid pressure during ventilations with a BVM can occlude the esophagus (the cricoid cartilage compresses the soft esophagus) and significantly reduce the amount of air that enters the stomach.

Figure 3.11 The Bag-Valve-Mask

Minimizing air going down into the stomach is especially important with prolonged bagging without intubation. Work from the head of the bed and remove the headboard. Ask for help if you need and move to two person bagging; one person doing the mask seal, and one person squeezing the bag.

The Combitube

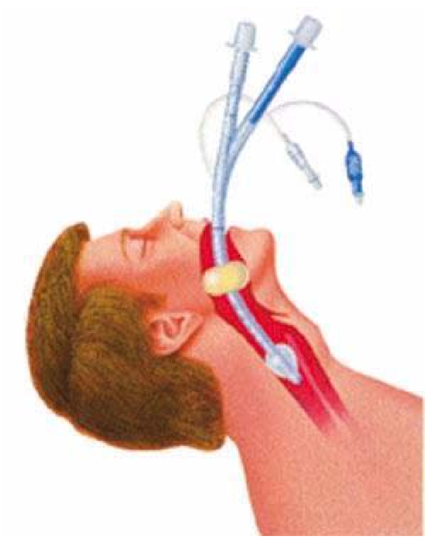
Tracheal intubation remains the golden standard of airway management, but several devices that require less skill to insert have been proven to be effective alternatives to tracheal intubation. The use of these devices also has proven beneficial in difficult airway cases where attempts at intubation have failed.

The combitube is a double lumen tube most often inserted blindly. It has a curved shape that favors insertion into the esophagus. Two cuffs, one large proximal pharyngeal cuff (100-135 ml) and one smaller distal cuff (12-15ml) are inflated. One lumen is blind ended (plugged at the end) with small holes for openings located between the cuffs. It is colored blue and is longer than the second lumen's port.

The BVM is attached to the blue lumen's port first. If the tube terminates in the esophagus, ventilating through the blue port will send air out through the small holes between the inflated cuffs past the glottic opening down the trachea. Auscultation of the chest should reveal bilateral air entry and no epigastric sounds. The second lumen can be used for gastric suctioning with a nasogastric tube.

The second lumen of the combitube is also used for ventilations if the combitube is accidentally or purposely placed in the trachea. This second lumen has only one opening at the distal tip. If on attempting to ventilate through the blue port there are no breath sounds, the BVM is then moved to the second lumen and ventilations are attempted again. The combitube then acts as an endotracheal tube, and air entry should be heard on auscultation of the chest.

Figure 3.12 Combitube



Advantages of the combitube airway include:

- Direct visualization of the trachea is not needed
- Relatively simple to insert
- Ventilations are possible when either the trachea or esophagus is intubated
- Reduced risk of aspiration compared to BVM
- More reliable ventilation than with BVM
- Gastric inflation of air less likely than BVM
- Easier to maintain skill than endotracheal intubation
- Less invasive than tracheal intubation

Disadvantages of the combitube airway include:

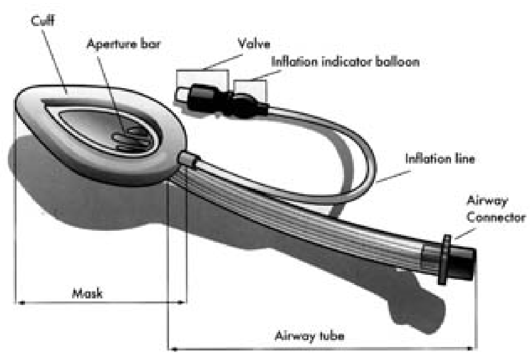
- Potential to ventilate wrong port if proper post-insertion assessment is not done
- Possible complication of esophageal trauma

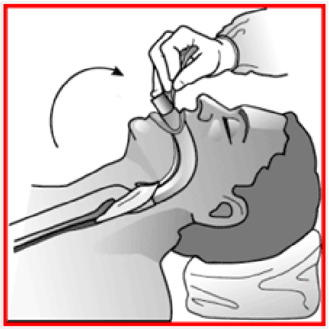
This device is well suited for use by a variety of healthcare professionals who do not have the training or authority to perform endotracheal intubation. Protocols for its use should be developed for such professions as nursing when the potential for difficult airway management exists in the absence of physician attendance.

Laryngeal Mask Airway

This device is an airway adjunct that is composed of an oval-shaped cuffed mask on the end of a tube. It is introduced into the pharynx and advanced until the mask portion is in the distal hypopharynx and meeting resistance. The cuff is then inflated, which provides a seal against the larynx and leaves the distal opening of the tube sitting over the glottis.

Figure 3.13 Laryngeal Mask Airway (LMA)





Images courtesy of LMA North America, Inc.

Advantages of the LMA include:

- •More secure method of ventilation than BVM
- •Less risk of regurgitation, aspiration is uncommon
- •Equivalent positive pressure ventilation to tracheal intubation
- •Less invasive than tracheal intubation
- •Direct visualization of the larynx not necessary
- •Training and skill retention is easier than that of tracheal intubation

Disadvantages of the LMA include:

- •Small proportion of patients cannot be ventilated with a LMA
- •Slightly higher risk of aspiration than with endotracheal intubation

The LMA is also quite popular for short surgical procedures. This increased exposure of the LMA in non-critical scenarios enhances the chances of more wholesale adoption of this device during difficult airway episodes.

Tracheal Intubation

Intubation of the trachea has long been the primary method of securing a patient's airway in advanced life support situations. Tracheal intubation requires a well organized systematic approach by a skilled person in laryngoscopy. We will review the process involved in intubating a patient in the role as assistant.

Tracheal intubation involves placement of a cuffed endotracheal tube into the trachea just past the vocal cords. It is an invasive procedure that requires skill and frequent practice if you are to maintain proficiency. Most often it is performed by a physician or respiratory therapist.

Indications for intubation:

- Cardiac arrest especially if long in duration
- Inability for a conscious patient to maintain adequate ventilations
- Patient without adequate gag reflex unable to maintain their own airway patency
- Inability to ventilate an unconscious patient with less invasive methods
- A Glasgow Coma Score of 8 or less

Equipment needed:

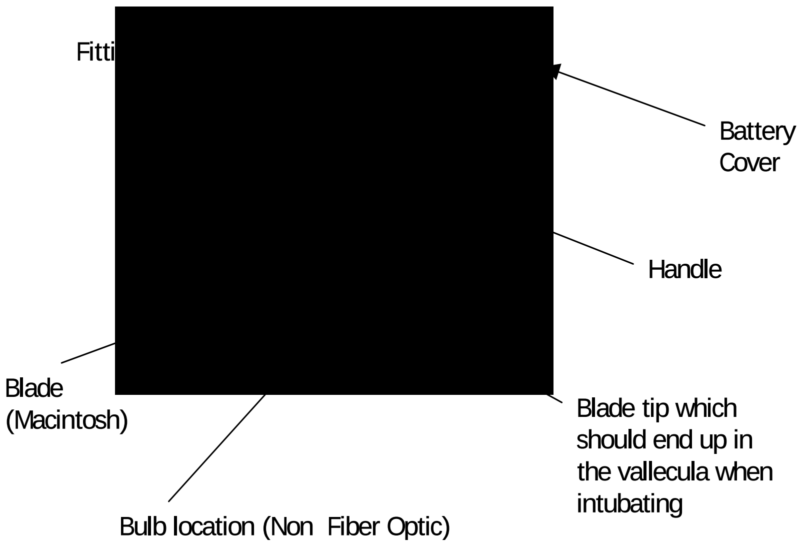
- Laryngoscope
- Handle
- Selection of blades
- Endotracheal Tubes
- Stylet
- 10 ml syringe
- Magill forceps
- Lubricant
- Suction

The next sections will briefly examine equipment unique to intubation followed by the procedure to assist intubation.

Laryngoscope

The laryngoscope is used to expose and view the glottis. It consists of the handle which houses a set of "C" batteries and a separate blade. There is a connection point where the blade attaches to the handle called the fitting. In older laryngoscopes there is an electrical contact point in the fitting and the bulb is located in the blade. Newer laryngoscopes are fiber optic and the light is located in the handle in the fitting and a fiber optic channel is located in the blade. This means only one bulb is running this type of system.

Figure 3.14 Laryngoscope



Know where a spare bulb is and how to change it. In the older system with the bulb in each blade, you have the choice of picking another blade if one bulb burns out and making due with an incorrect blade size.

There is no on/off switch for a laryngoscope. The bulb comes on when you insert the blade into the fitting and swing the blade into the 90 degree locked position. Closing the blade down towards the handle turns the bulb off. This light bulb allows you to view the glottic opening when the blade is in position.

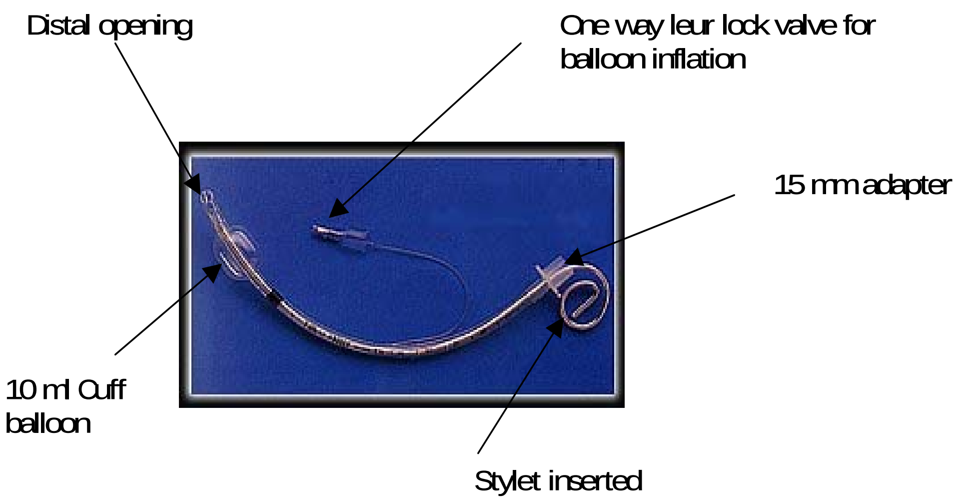
There is a variety of blades used for intubating. The two most common types found on crash carts are the curved Macintosh blade like that shown above, which comes in several sizes. A number three "Mac" blade is the most common size for adults. The second type is the straight Miller blade which also comes in several sizes and is meant for pediatric intubations.

Endotracheal Tube

The next key piece of equipment is the endotracheal tube. This "breathing tube" is sized in millimeters according to the internal diameter. They are available in 0.5 mm increments. Common adult sizes range from 7.0 mm to 8.5 mm ID.

Endotracheal tubes are open at both ends. One end has a 15 mm standard connector for attaching a BVM or ventilator, and the distal end has a 10 ml high volume low pressure balloon cuff which, when inflated, seals against the walls of the trachea.

Figure 3.15 Endotracheal Tube



An inflation tube with a leur-lock one way valve allows for the balloon cuff to be inflated. The length of the tube has markings at two centimeter intervals. When the tube is inserted, the centimeter position at the teeth is recorded. For most adults this is between 20-24 cm.

For emergency intubation a malleable stylet should be inserted into the endotracheal tube to give the tube rigidity. The tube and stylet are usually bent into the "Canadian hockey stick" shape or a "C" shape as shown above. The stylet should be recessed back about 1 cm from the tip of the tube so it does not cause trauma upon insertion. Additional equipment needed includes a 10 ml syringe, water soluble lubricant, Yankauer suction, and Magill forceps.

Procedure to Assist in Tracheal Intubation

Ensure that the head of the bed, if present is removed and that the bed is moved away from the wall. Intubation occurs from the apex of the head.

1. Provide 2-3 minutes of ventilation with 100% oxygen by bag valve mask.

2. Bring the airway tray up to the right hand side of the patient, as the only free hand that the person intubating has is the right hand. The laryngoscope is always held in the left hand. Have endotracheal tubes available one size larger and smaller than requested.

3. Provide gloves as needed to the person intubating. They do not need to be sterile.

4. Take the endotracheal tube out of its package. Insert a stylet and shape into the hockey stick shape. Apply lubricant into empty package and replace tube into package moving it back and forth to lubricate.

5. Have Yankauer suction ready. Ask what size "Mac" blade they want and attach it to the handle of the laryngoscope and check the function of the bulb.

6. Help as needed to position the patient in a sniffing position (head extended, neck flexed)**.**

7. Applied cricoid pressure if requested during insertion. Cricoid pressure is accomplished by moving the cricoid cartilage posteriorly with your thumb and index finger. Additionally pulling slightly to the patient's right is also helpful. This will move the glottic opening posteriorly and to the right allowing for easier visualization during intubation.

9. Help to inflate the cuff, **ensure chest auscultation produces good air entry bilaterally at the apexes and bases and no sounds over the epigastrium on ventilating the patient.** Help secure the tube, preferably with a commercial tube securing device. **Ensure that the intubation does not take more than 30 seconds** or the attempt should be abandoned and the patient hyperventilated with 100% oxygen again for 30-60 seconds.

10. Confirm tube placement with a chest X-ray, and monitor on an ongoing basis with end-tidal $C0_2$ monitoring.

Summary

Managing a cardiovascular emergency often involves the delivery of supplemental oxygen and, in some cases, the skills of airway management. This chapter explored the various methods and equipment necessary to maintain oxygenation, beginning with a brief account of respiratory basics: respiratory structures, functions and a short list of assessment techniques to evaluate respiratory status.

For the patient who is providing spontaneous breaths, several modalities were examined to provide supplemental oxygen. The use of nasal prongs, the simple face mask, the rebreather mask and the star wars high flow system provide oxygen in escalating concentrations respectively. Attention to both the severity of the patient's hypoxemia and the response to each type of oxygen delivery system aids in the evaluation of each system's situational effectiveness.

The roles of CPAP and BiPap was addressed. Both devices reduce the work of breathing. The BiPap machine also is advantageous for those experiencing pulmonary edema. Many patients benefiting from BiPap would have been intubated without it.

For the patient with a compromised airway, advanced airway techniques are necessary. The use of the oral airway, the BVM, the combitube, the laryngeal mask airway and tracheal intubation are all potential interventions in airway management. Tips and techniques were provided for each modality.

Chapter Quiz (A Case Study)

Frank, a 56 year old man, arrives at your local emergency department complaining of crushing chest pain. You connect him to an ECG monitor, start an IV and get a full set of vital signs including an oxygen saturation. His oxygen saturation is 88% on room air. This indicates that Frank is suffering from (hypoxemia, hypercarbia).

You place him on (simple face mask, nasal prongs) at 4 LPM and his oxygen saturation rises to 96%. A focused history and physical exam along with diagnostic tests show Frank is having a large anterior MI and has signs of failure with bilateral crackles to his bases. As he is receiving his thrombolytics, he develops progressive shortness of breath and appears to be going into cardiogenic shock. You decide to switch his oxygen over to simple face mask. The minimum flow rate for this mask is (3, 5, 6, 8, 10) LPM.

Answers: *hypoxemia, nasal prongs, 6*

At 10 LPM his oxygen saturations are holding at 92%. Pharmacological treatment fails to stabilize Frank and a fellow worker suggests that BiPAP would be worth trying for the pulmonary edema he is experiencing. You assess Frank's (zodiac, breathing rate, level of consciousness) because you know that if he is too confused he may not tolerate the mask used with BiPAP.

The rationale for using BiPAP is to deliver (positive, negative) pressure ventilation to the awake patient. It seems that after 10 minutes of coaching Frank to use BiPAP, he is becoming too confused. He quickly becomes semiconscious and hypotensive moving rapidly into respiratory arrest. You roll the head of the bed flat and insert an oral airway. You measure it from the (eye brow, angle of the jaw) to the corner of his mouth.

Using a BVM you start bagging Frank. A sign that the oxygen regulator flow rate is too low is the complete (expansion, collapse) of the reservoir bag during the ventilatory cycle. You ensure that the flow rate is at least (5, 6, 8, 10, 12) LPM. You are aware of the complications of insufflation of air into the stomach, so you deliver each breath over a minimum of (1, 1.5, 2) seconds. The addition of (cricoid, sphygmoid) pressure can further diminish the risk of air going into the stomach.

The decision is made to intubate Frank. You are going to assist the attending physician. You bring the airway tray up to the patient's (right, left) hand side. You expect to use a (Miller, Macintosh) blade for adult intubation. You encourage the use of a stylet as this adds (weight, rigidity) to the tube making intubation easier in most cases.

Upon intubation you inflate the endotracheal cuff with (5, 10, 15, 20) ml of air. Immediate confirmation of proper placement in the trachea is done by bilateral expansion of the chest. Frank stabilizes.

Suggested Reading and Resources

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Haridas, Rajesh P. (2000). The Virtual Anaesthesia Textbook. Found at http://www.virtual-anaesthesia-textbook.com/vat/intubation.html

Kinney, M. et al. (1998). AACN Clinical Reference for Critical Care Nursing. 4th ed. Toronto: Mosby

Lingappa, V.R. and Farey, K. (2000). Physiological Medicine. New York: McGraw-Hill

Answers: *level of consciousness, positive, angle of the jaw, collapse, 12, 2, cricoid, right, Macintosh, rigidity, 10*

What's Next?

This chapter completes the foundational work that was started with the inquiry into the heart and cardiac output. Before moving on to the application of these skills with the pulseless, unstable or stable patient, the next chapter provides a practical framework to respond appropriately to any cardiac emergency.