

# Airway

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# 2

## Section

**7** Airway

210



## Objectives

### Cognitive

- 2-1.1** Name and label the major structures of the respiratory system on a diagram. (p 214)
- 2-1.2** List the signs of adequate breathing. (p 221)
- 2-1.3** List the signs of inadequate breathing. (p 221)
- 2-1.4** Describe the steps in performing the head tilt-chin lift maneuver. (p 224)
- 2-1.5** Relate mechanism of injury to opening the airway. (p 223)
- 2-1.6** Describe the steps in performing the jaw-thrust maneuver. (p 225)
- 2-1.7** State the importance of having a suction unit ready for immediate use when providing emergency care. (p 231)
- 2-1.8** Describe the techniques of suctioning. (p 232)
- 2-1.9** Describe how to artificially ventilate a patient with a pocket mask. (p 242)
- 2-1.10** Describe the steps in performing the skill of artificially ventilating a patient with a bag-valve-mask device while using the jaw-thrust maneuver. (p 242)
- 2-1.11** List the parts of a bag-valve-mask system. (p 244)
- 2-1.12** Describe the steps in performing the skill of artificially ventilating a patient with a bag-valve-mask device for one and two rescuers. (p 245)
- 2-1.13** Describe the signs of adequate artificial ventilation using the bag-valve-mask device. (p 247)
- 2-1.14** Describe the signs of inadequate artificial ventilation using the bag-valve-mask device. (p 246, 247)
- 2-1.15** Describe the steps in ventilating a patient with a flow-restricted, oxygen-powered ventilation device. (p 247)
- 2-1.16** List the steps in performing the actions taken when providing mouth-to-mouth and mouth-to-stoma artificial ventilation. (p 242)
- 2-1.17** Describe how to measure and insert an oropharyngeal (oral) airway. (p 227)
- 2-1.18** Describe how to measure and insert a nasopharyngeal (nasal) airway. (p 228)
- 2-1.19** Define the components of an oxygen delivery system. (p 235)
- 2-1.20** Identify a nonbreathing face mask and state the oxygen flow requirements needed for its use. (p 240)
- 2-1.21** Describe the indications for using a nasal cannula versus a nonbreathing face mask. (p 241)
- 2-1.22** Identify a nasal cannula and state the flow requirements needed for its use. (p 241)

### Affective

- 2-1.23** Explain the rationale for basic life support, artificial ventilation, and airway protective skills taking priority over most other basic life support skills. (p 214)
- 2-1.24** Explain the rationale for providing adequate oxygenation through high inspired oxygen concentrations to patients who, in the past, may have received low concentrations. (p 246)

### Psychomotor

- 2-1.25** Demonstrate the steps in performing the head tilt-chin lift maneuver. (p 224)
- 2-1.26** Demonstrate the steps in performing the jaw-thrust maneuver. (p 225)
- 2-1.27** Demonstrate the techniques of suctioning. (p 232)
- 2-1.28** Demonstrate the steps in providing mouth-to-mouth artificial ventilation with body substance isolation (barrier shields). (p 242)
- 2-1.29** Demonstrate how to use a pocket mask to artificially ventilate a patient. (p 242)
- 2-1.30** Demonstrate the assembly of a bag-valve-mask unit. (p 244)
- 2-1.31** Demonstrate the steps in performing the skill of artificially ventilating a patient with a bag-valve-mask device for one and two rescuers. (p 245)
- 2-1.32** Demonstrate the steps in performing the skill of artificially ventilating a patient with a bag-valve-mask device while using the jaw-thrust maneuver. (p 245)
- 2-1.33** Demonstrate artificial ventilation of a patient with a flow-restricted, oxygen-powered ventilation device. (p 247)
- 2-1.34** Demonstrate how to artificially ventilate a patient with a stoma. (p 248)
- 2-1.35** Demonstrate how to insert an oropharyngeal (oral) airway. (p 227)
- 2-1.36** Demonstrate how to insert a nasopharyngeal (nasal) airway. (p 228)
- 2-1.37** Demonstrate the correct operation of oxygen tanks and regulators. (p 238)
- 2-1.38** Demonstrate the use of a nonbreathing face mask and state the oxygen flow requirements needed for its use. (p 240)
- 2-1.39** Demonstrate the use of a nasal cannula and state the flow requirements needed for its use. (p 241)
- 2-1.40** Demonstrate how to artificially ventilate the infant and child patient. (p 242)
- 2-1.41** Demonstrate oxygen administration for the infant and child patient. (p 244)

## **Additional Objectives\***

### **Cognitive**

1. Describe how to perform the Sellick maneuver (cricoid pressure). (p 246)

### **Affective**

2. Explain the rationale for applying cricoid pressure. (p 246)

### **Psychomotor**

3. Demonstrate how to perform the Sellick maneuver (cricoid pressure). (p 247)

\*These are noncurriculum objectives.

# Airway

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### You are the Provider

It's a warm summer day outside, the temperatures are mild and rain is in the forecast. You are sitting with your partner when the call comes in "University Ambulance 2, respond to the lobby of the Plaza Hotel for a man with respiratory distress."

Approximately one out of every four EMS calls is either airway or respiratory related. This chapter will help prepare you for these frequently encountered calls and help you answer the following questions:

1. Why is it critical to maintain a patient's airway and ensure adequate breathing at all times?
2. How frequently should you assess the condition of a patient's airway and his or her ability to breathe?
3. What impact will inappropriate assessment and management of a patient's airway and breathing have on total patient care?

## Airway

The single most important step in caring for any patient is to make sure that he or she can breathe adequately. The patient who cannot breathe effectively is not delivering oxygen to body tissues and cells, which need a constant supply of oxygen to survive. Within seconds of being deprived of oxygen, vital organs such as the heart and brain may not function normally.

Oxygen reaches body tissues and cells through two separate but related processes: breathing and circulation. As we inhale, oxygen moves from the atmosphere into our lungs, then passes from the air sacs in the lungs into the capillaries to oxygenate the blood. At the same time, carbon dioxide, produced by cells in the tissues of the body, moves from the blood into the air sacs. The blood, enriched with oxygen, travels through the body by the pumping action of the heart. The carbon dioxide then leaves our bodies as we exhale.

As an EMT-B, you must be able to locate the parts of the respiratory system, understand how the system works, and be able to recognize which patients are breathing adequately and which ones are breathing inadequately. This will enable you to determine how best to treat your patients.

This chapter will review the anatomy and physiology of the respiratory system, that is, the parts of the system and how they work. It will then describe how to assess patients quickly and to carefully determine

their airway and ventilation status. The equipment, procedures, and guidelines that you will need to manage a patient's airway and breathing are described in detail. You will learn several ways to open a patient's airway and specific techniques for removing foreign objects or fluids that may be blocking the airway. Because airway management equipment can be dangerous if used improperly, the chapter will thoroughly discuss airway adjuncts, oxygen therapy devices, and artificial ventilation methods.

## Anatomy of the Respiratory System

The respiratory system consists of all the structures in the body that make up the airway and help us breathe, or ventilate [Figure 7-1](#). Structures that help us breathe include the diaphragm, the muscles of the chest wall, accessory muscles of breathing, and the nerves from the brain and spinal cord to those muscles. **Ventilation** is the exchange of air between the lungs and environment. The diaphragm and muscles of the chest wall are responsible for the regular rise and fall of the chest that accompany normal breathing.

### Structures of the Airway

The **airway** is divided into the upper and lower airways. The upper airway consists of the nose, mouth, throat (pharynx), and a structure called the epiglottis. The epiglottis is a leaf-shaped structure above the larynx that prevents food and liquid from entering the larynx during swallowing. The portion of the throat behind the nose is named the nasopharynx; the portion behind the mouth is the oropharynx.

The lower airway consists of the larynx, trachea, main bronchi, bronchioles (smaller bronchi), and alveoli.

The lower airway begins with the larynx (voice box, vocal cords). The cricoid cartilage is a firm cartilage ring that forms the lower part of the larynx. The trachea is connected to the larynx. The main bronchi and bronchioles branch off from the trachea, extending into each lung. Eventually the bronchioles end in the alveoli. The alveoli are small sacs where the actual exchange of oxygen and carbon dioxide occurs.

The chest (thoracic cage) contains the lungs, one on each side [Figure 7-2](#). The lungs hang freely within the chest cavity. Between the lungs is a space called the mediastinum, which is surrounded by tough connective tissue. This space contains the heart, the great vessels, the esophagus, the trachea, the major

## Technology

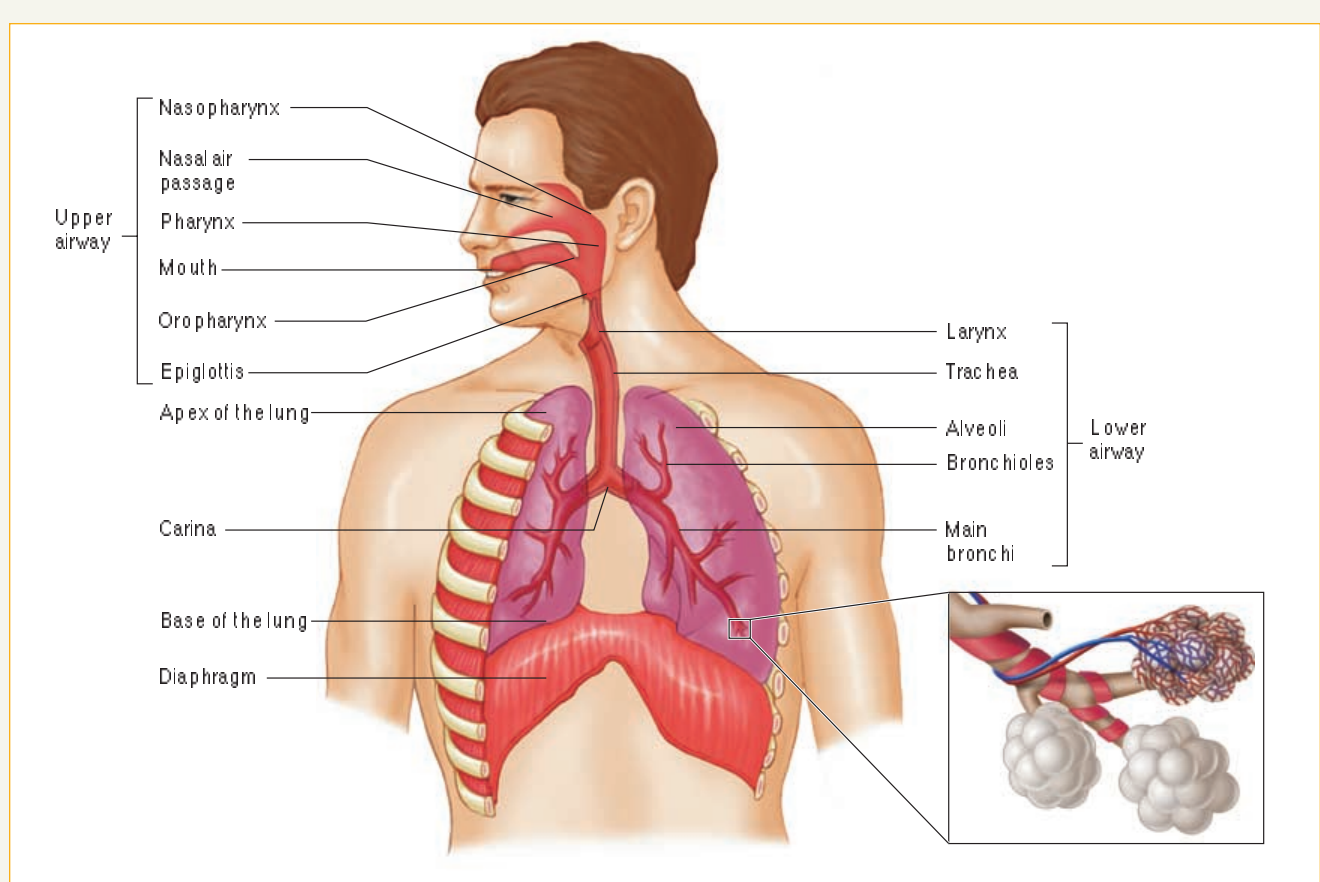
Interactivities

Vocabulary Explorer

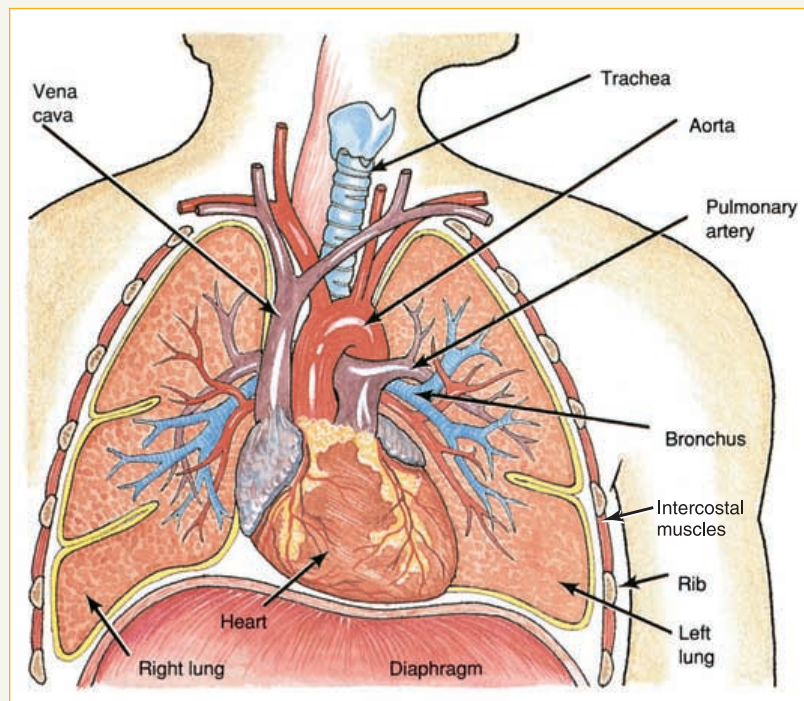
Anatomy Review

Web Links

Online Review Manual



**Figure 7-1** The upper and lower airways contain the structures in the body that help us to breathe. The upper airway contains the nose, mouth, throat, and epiglottis.



**Figure 7-2** The thoracic cage contains important anatomic structures for respiration, including the lungs, the heart, the great vessels (the vena cava and aorta), the trachea, and the major bronchi.

bronchi, and many nerves. The mediastinum effectively separates the right lung space from the left lung space. The boundaries of the thorax are the rib cage anteriorly, superiorly, and posteriorly and the diaphragm inferiorly.

## Structures of Breathing

The diaphragm is a skeletal muscle because it is attached to the costal arch and the vertebrae. It is considered a specialized muscle because it functions as a voluntary and an involuntary muscle. It acts as a voluntary muscle whenever we take a deep breath, cough, or hold our breath—all actions that we are able to control. However, unlike other skeletal or voluntary muscles, the diaphragm also performs an automatic function. Breathing continues while we sleep and at all other times. Even though we can hold our breath or temporarily breathe more quickly or slowly, we cannot continue these variations in breathing indefinitely. When the concentration of carbon dioxide rises within the blood, the automatic regulation of breathing resumes under the control of the brain stem.


The lungs, because they have no muscle tissue, cannot move on their own. They need the help of other structures to be able to expand and contract as we inhale and exhale. Therefore, the ability of the lungs to function properly is dependent on the movement of the chest and supporting structures. These structures include the thorax, the thoracic cage (chest), the diaphragm, the intercostal muscles, and the accessory muscles of breathing.

## Inhalation

The active, muscular part of breathing is called **inhalation**. As we inhale, air enters the body through the trachea. This air travels to and from the lungs, filling and emptying the alveoli. During inhalation, the diaphragm and intercostal muscles contract. When the diaphragm contracts, it moves down slightly and enlarges the thoracic cage from top to bottom. When the intercostal muscles contract, they lift the ribs up and out. As we inhale, the combined actions of these structures enlarge the thorax in all directions. Take a deep breath to see how your chest expands.

The air pressure outside the body, called the atmospheric pressure, is normally higher than the air pressure within the thorax. As we inhale and the thoracic cage expands, the air pressure within the thorax decreases, creating a slight vacuum. This pulls air in

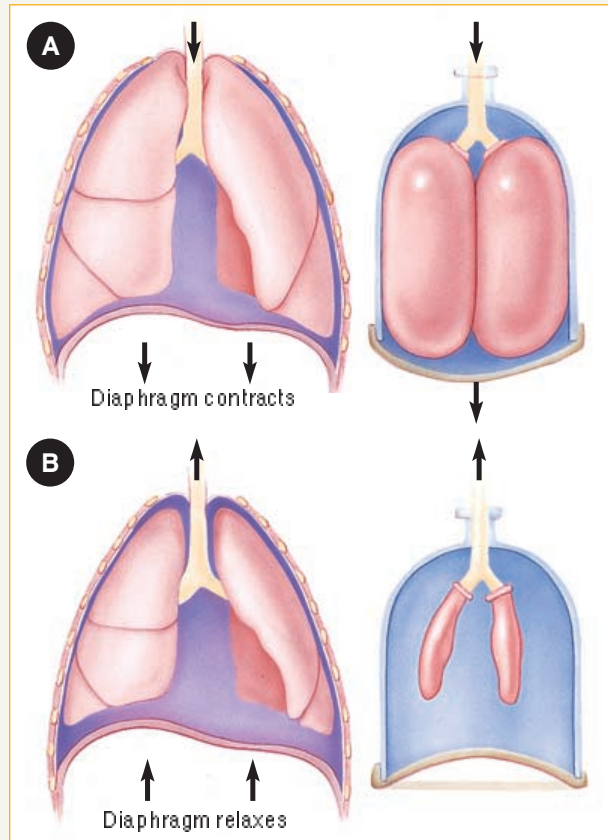
through the trachea, causing the lungs to fill. When the air pressure outside equals the air pressure inside, air stops moving. Gases, such as oxygen, will move from an area of high pressure to an area of lower pressure until the pressures are equal. At this point, the air stops moving, and we stop inhaling. **Tidal volume**, a measure of the depth of breathing, is the amount of air in milliliters (mL) that is moved into or out of the lungs during a single breath. The average tidal volume for a man is approximately 500 mL. **Minute volume** is the amount of air moved through the lungs in 1 minute and is calculated by multiplying tidal volume and respiratory rate. Therefore, if a patient is breathing at a rate of 12 breaths/min and has a tidal volume of 500 mL per breath, his minute volume would be 6,000 mL (6 L). It is important to note that variations in tidal volume, respiratory rate, or both, will affect minute volume. For example, if a patient is breathing at a rate of 12 breaths/min, but his tidal volume is reduced (shallow breathing), minute volume will decrease. Likewise, if a patient is breathing at a rate of 12 breaths/min and his tidal volume is increased (deep breathing), minute volume will increase.

It may help you to understand this if you think of the thoracic cage as a bell jar in which balloons are suspended. In this example, the balloons are the lungs. The base of the jar is the diaphragm, which moves up and down slightly with each breath. The ribs, which are the sides of the jar, maintain the shape of the chest. The only opening into the jar is a small tube at the top, similar to the trachea. During inhalation, the bottom of the jar moves down slightly, causing a decrease in pressure in the jar and creating a slight vacuum. As a result, the balloons fill with air .

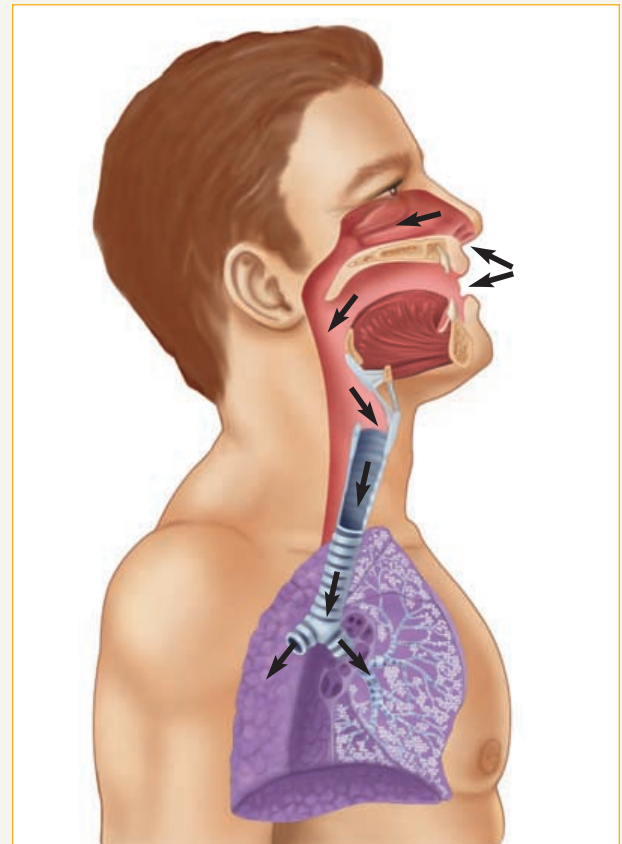
## Exhalation

Unlike inhalation, **exhalation** does not normally require muscular effort; therefore, it is a passive process. During exhalation, the diaphragm and the intercostal muscles relax. In response, the thorax decreases in size, and the ribs and muscles assume a normal resting position. When the size of the thoracic cage decreases, air in the lungs is compressed into a smaller space. The air pressure within the thorax then becomes higher than the pressure outside, and air is pushed out through the trachea.

Let's return to the example of the bell jar. During exhalation, the bottom of the jar (the diaphragm) moves



**Figure 7-3** The mechanisms of respiration can be illustrated by using a bell jar. **A.** Inhalation and chest expansion, anatomic (left) and bell jar (right). **B.** Exhalation and chest contraction, anatomic (left) and bell jar (right).



**Figure 7-4** Air reaches the lungs only if it travels through the trachea. Maintaining the airway means keeping the airway patent so that air can enter and leave the lungs freely.

up, returning to its normal resting position. This movement increases air pressure within the jar. With this increase in pressure, the sides of the jar contract, and the balloons empty.

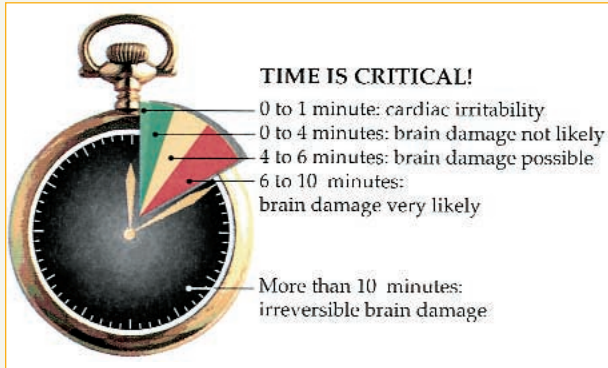
Remember that air will reach the lungs only if it travels through the trachea. This is why clearing and maintaining an open airway are so important. Clearing the airway means removing obstructing material, tissue, or fluids from the nose, mouth, or throat. Maintaining the airway means keeping the airway **patent** so that air can enter and leave the lungs freely (Figure 7-4 ▶).

Air may also pass into the chest cavity through an abnormal opening in the throat or chest wall as a result of trauma, remaining outside of the bronchi and never reaching the alveoli. In Chapter 27, Chest Injuries, you will learn how to recognize and manage these dangerous conditions.

## Physiology of the Respiratory System

All living cells need energy to survive. Cells take energy from nutrients through a series of chemical processes. The name given to these processes as a whole is **metabolism**. During metabolism, each cell combines nutrients and oxygen and produces energy and waste products, primarily water and carbon dioxide.

Each living cell in the body requires a supply of oxygen and a regular means of disposing of waste (carbon dioxide). The body provides these through respiration. Some cells need a constant supply of oxygen to survive. Other cells in the body can tolerate short periods without oxygen and still survive. For example, after 4 to 6 minutes without oxygen, brain cells and



**Figure 7-5** Cells need a constant supply of oxygen to survive. Some cells may be severely or permanently damaged after 4 to 6 minutes without oxygen.

cells in the nervous system may be severely or permanently damaged and may even die [Figure 7-5 ▲](#). Dead brain cells can never be replaced. However, cells in the kidney may be without oxygen for 45 minutes or more and still survive. This is why certain organ transplants are possible.

Normally, the air that we breathe contains 21% oxygen and 78% nitrogen. Small amounts of other gases make up the remaining 1%.

## The Exchange of Oxygen and Carbon Dioxide

As blood travels through the body, it supplies oxygen and nutrients to various tissues and cells. Oxygen passes from blood in the arteries through the capillaries to tissue cells, while carbon dioxide and cell waste pass in the opposite direction: from tissue cells through capillaries and into the veins [Figure 7-6 ►](#).

Each time we inhale, the alveoli receive a supply of oxygen-rich air. The alveoli are surrounded by a network of tiny pulmonary capillaries. These capillaries are, in fact, located in the walls of the alveoli. This means that the air in the alveoli and the blood in the capillaries are separated only by two very thin layers of tissue. Each time we exhale, the carbon dioxide from the bloodstream travels across the same two layers of tissue to the alveoli and is expelled into the atmosphere.

Oxygen and carbon dioxide pass rapidly across the walls of the alveoli and the capillaries through diffusion. **Diffusion** is a passive process in which molecules move from an area of higher concentration to an area of lower concentration. For example, an entire kitchen can smell like a rotten egg because the molecules of hydrogen sulfide gas have moved spontaneously from an

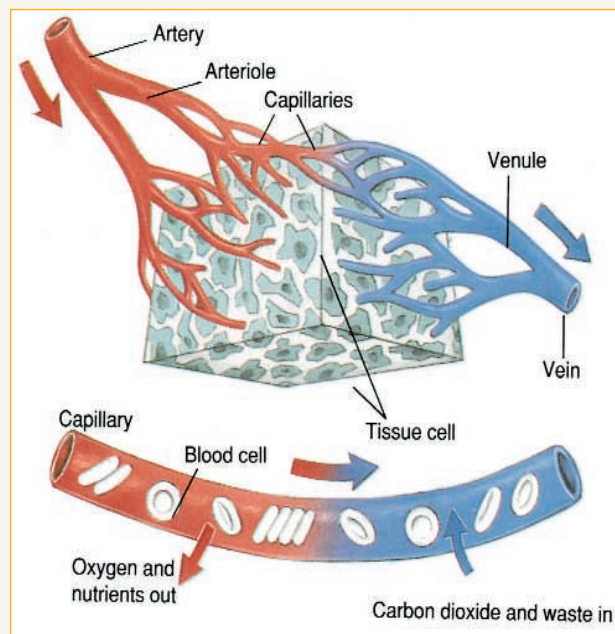
area of high concentration near the egg to fill the whole space. Molecules of oxygen move from the alveoli into the blood because there are fewer oxygen molecules in the pulmonary capillaries. In the same way, molecules of carbon dioxide move from the blood into the alveoli because there are fewer carbon dioxide molecules in the alveoli [Figure 7-7 ►](#).

The alveoli normally produce a chemical, called surfactant, that helps keep the alveoli open. By keeping the alveoli open, diffusion is more efficient. Anything that removes or destroys surfactant (such as water from drowning) will cause acute respiratory distress.

The blood does not distribute all of the inhaled oxygen as it passes through the body. Therefore, the air that we exhale contains 16% oxygen and 3% to 5% carbon dioxide; the rest is nitrogen [Figure 7-8 ►](#). When you provide artificial ventilations with a pocket mask to a patient who is not breathing, that patient is receiving a 16% concentration of oxygen with each of your exhaled breaths.

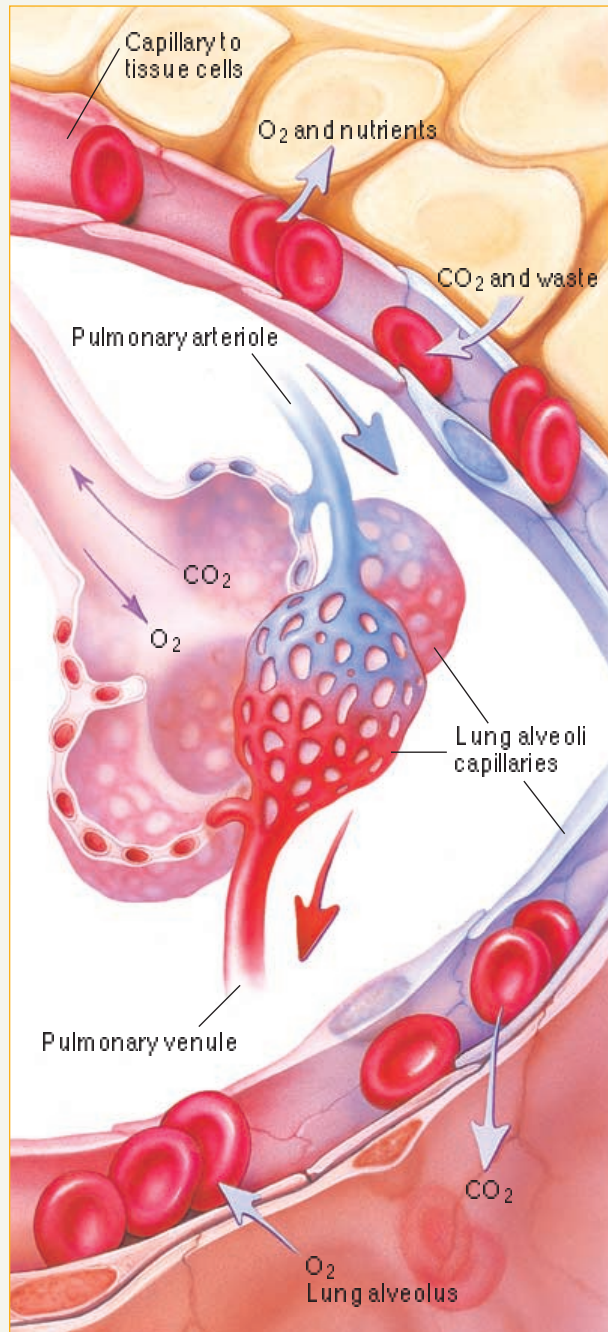
## The Control of Breathing

The area of the brain stem that controls breathing is deep within the skull, in one of the best-protected parts of the nervous system. The nerves in this area act as

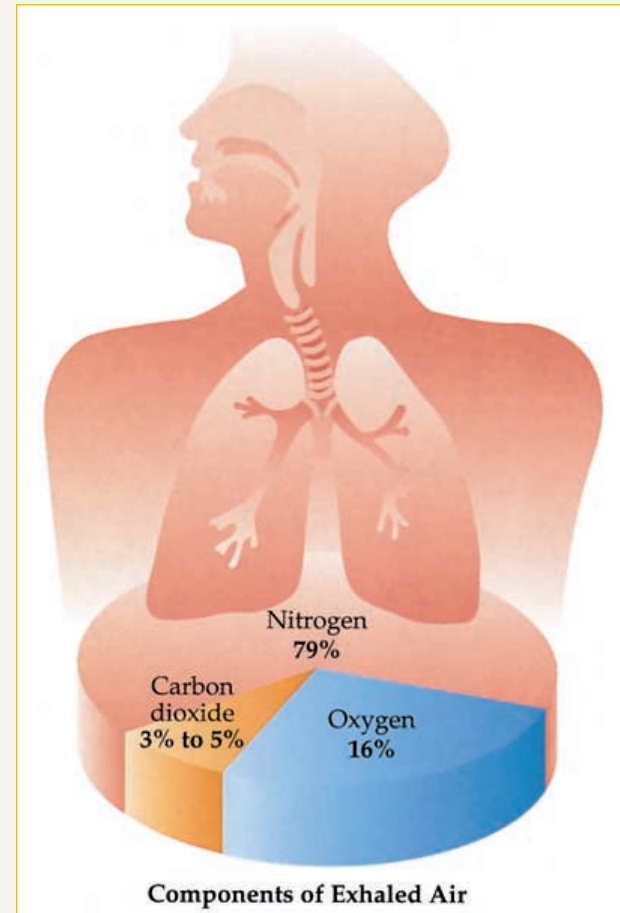


**Figure 7-6** Oxygen passes from blood in the arteries through capillaries to tissue cells. Carbon dioxide passes from tissue cells through capillaries and into the veins.

sensors, reacting primarily to the level of carbon dioxide in the arterial blood. If the levels of carbon dioxide become too high or too low, the brain automatically adjusts breathing accordingly. This happens very quickly, after every breath. Again, this is why you cannot hold



**Figure 7-7** With diffusion, molecules of oxygen move from the alveoli into the blood because there are fewer oxygen molecules in the blood. Similarly, molecules of carbon dioxide diffuse from the blood into the alveoli because there are fewer carbon dioxide molecules in the alveoli.



**Figure 7-8** Exhaled air contains 16% oxygen and 3% to 5% carbon dioxide; 79% is nitrogen.

your breath indefinitely or breathe rapidly and deeply for very long. In a healthy person, this stimulus to breathe is referred to as the primary respiratory drive.

When the level of carbon dioxide becomes too high, the brain stem sends nerve impulses down the spinal cord that cause the diaphragm and the intercostal muscles to contract. This increases our breathing, or respirations. The higher the level of carbon dioxide in the blood, the stronger the impulse is to breathe. Once the carbon dioxide returns to an acceptable level, the strength and frequency of respirations decrease.

### Hypoxia

Hypoxia is an extremely dangerous condition in which the body's tissues and cells do not have enough oxygen; unless it is reversed, patients may die in a matter of moments. **Hypoxia** develops quickly in the vital organs of patients who are not breathing or who are

breathing inadequately. Inadequate breathing means that the person cannot move enough air into the lungs with each breath to meet the body's metabolic needs. Hypoxia can have a profound effect on breathing. If the brain senses that there is not enough oxygen in the blood, it will send messages via the spinal cord to the diaphragm and respiratory muscles, thus increasing the patient's respiratory rate and depth.

Patients with chronic respiratory diseases (eg, emphysema) maintain a low oxygen level in their blood, and the sensors in the brain become accustomed to this low level. Unlike a healthy person whose primary respiratory drive is influenced by increasing the carbon dioxide level in the blood, the primary respiratory drive of a patient with a chronic respiratory disease is influenced by a low oxygen level in the blood, a condition called the **hypoxic drive**.

Patients who are breathing inadequately will show varying signs and symptoms of hypoxia. The onset and the degree of tissue damage caused by hypoxia often depend on the quality of ventilations. Early signs of hypoxia include restlessness, irritability, apprehension, fast heart rate (tachycardia), and anxiety. Late signs of hypoxia include mental status changes, a weak (thready) pulse, and cyanosis. Conscious patients will complain of shortness of breath (**dyspnea**) and may not be able to talk in complete sentences. The best time to give a patient oxygen is before any signs and symptoms of hypoxia appear.

The following conditions are commonly associated with hypoxia:

- **Heart attack (myocardial infarction).** **Ischemia** within the heart muscle from myocardial infarction occurs when there is inadequate circulation

of oxygen-carrying blood to the tissues of the heart. The weakened heart then pumps oxygenated blood to the remainder of the body less efficiently, resulting in systemic hypoxia.

- **Pulmonary edema.** Fluid accumulates in the lungs, making the exchange of oxygen and carbon dioxide in the alveoli less efficient.
- **Acute narcotic or sedative overdose.** Respirations may become decreased and shallow (reduced tidal volume).
- **Inhalation of smoke and/or toxic fumes.** These substances cause pulmonary edema and destroy lung tissue, causing problems with gas exchange.
- **Stroke (cerebrovascular accident).** The cause of hypoxia in a stroke may be due to facial paralysis leading to potential airway compromise or poor control of respirations if the respiratory center in the brain is affected.
- **Chest injury.** Pain interferes with full chest wall expansion, thus limiting effective ventilation. Lung damage itself secondary to pulmonary contusion can also prevent efficient gas exchange.
- **Shock (hypoperfusion).** Shock often occurs as a result of injuries that affect the circulatory system. When the circulatory system fails to deliver adequate amounts of oxygen, the tissues begin to die.
- **Chronic obstructive pulmonary disease (COPD; for example, chronic bronchitis and emphysema).** Chronic irritation of the lungs and air passages produces alveolar damage and poor gas exchange.
- **Asthma.** Narrowing of respiratory passages and buildup of mucus causes air trapping and poor gas exchange.

## You are the Provider

## Part 2

En route to the hotel, you consider the potential causes of your patient's respiratory distress. Could it be an asthma attack or a heart attack? Could there be some sort of trauma preventing him from breathing well? You are pleased you thoroughly checked your respiratory equipment and the oxygen cylinders before you left the station that morning. You begin putting on your latex gloves.

4. What are the specific causes of respiratory distress? Which are serious and which are not?
5. What type of equipment would you anticipate needing to treat a patient with difficulty breathing?

- **Premature birth.** Pulmonary surfactant is decreased in some premature infants, and, therefore, prematurity is often associated with hypoxia. The more premature the infant, the worse the hypoxia.

All hypoxic patients, whatever the cause of their condition, should be treated with high-flow supplemental oxygen. The method of oxygen delivery will vary, depending on the severity of the hypoxia and the adequacy of breathing.

## Patient Assessment

### Recognizing Adequate Breathing

Earlier, we compared breathing to a bell jar with a movable bottom. You can also think of a normal breathing pattern as a bellows system. Breathing should appear easy, not labored. As with a bellows used to move air to start a fire, breathing should be a smooth flow of air moving into and out of the lungs. As a general rule, unless directly assessing the patient's airway, you should not be able to see or hear a patient breathe. Signs of normal (adequate) breathing for adult patients are as follows:

- A normal rate (between 12 and 20 breaths/min for adults)
- A regular pattern of inhalation and exhalation
- Clear and equal lung sounds on both sides of the chest (**bilateral**)
- Regular and equal chest rise and fall (chest expansion)
- Adequate depth (tidal volume)

### Recognizing Inadequate Breathing

An adult who is awake, alert, and talking to you generally has no immediate airway or breathing problems. However, you should always have supplemental oxygen and a bag-valve-mask (BVM) device or pocket mask close at hand to assist with breathing if this becomes necessary. An adult who is breathing normally will have respirations of 12 to 20 breaths/min (Table 7-1). The adult patient who is breathing slower (fewer than 12 breaths/min) or faster (more than 20 breaths/min) than normal should be evaluated for inadequate breathing by assessing the depth of his or her respirations. A patient with a shallow depth of breathing (reduced tidal volume) may require assisted ventilations, even if his or her respiratory rate is within normal limits.

A patient with inadequate breathing may appear to be working hard to breathe. This type of breathing pattern is called **labored breathing**. It requires effort and, especially among children, may involve the use of accessory muscles. Accessory muscles are secondary

**TABLE 7-1 Normal Respiratory Rate Ranges**

Adults	12 to 20 breaths/min
Children	15 to 30 breaths/min
Infants	25 to 50 breaths/min

**Note:** These ranges are per the US DOT 1994 EMT-Basic National Standard Curriculum. Ranges presented in other courses may vary.

## You are the Provider

### Part 3

As you arrive at the hotel you are greeted by the hotel security, who report the man was attending a conference when he suddenly began complaining of difficulty breathing and confusion. He then passed out in his chair. The security officer informs you the ushers have carefully moved him into the aisle and are trying to keep his airway open. As you walk into the room you notice the conference session is on break so few people are around and there are no immediate hazards. You see only one large patient who appears to be unresponsive. You ask your partner to call dispatch to send some ALS help.

6. How does the information given by first responders and bystanders help you prepare for your patient?
7. While this may seem to be an obvious situation, what are some potential hazards?

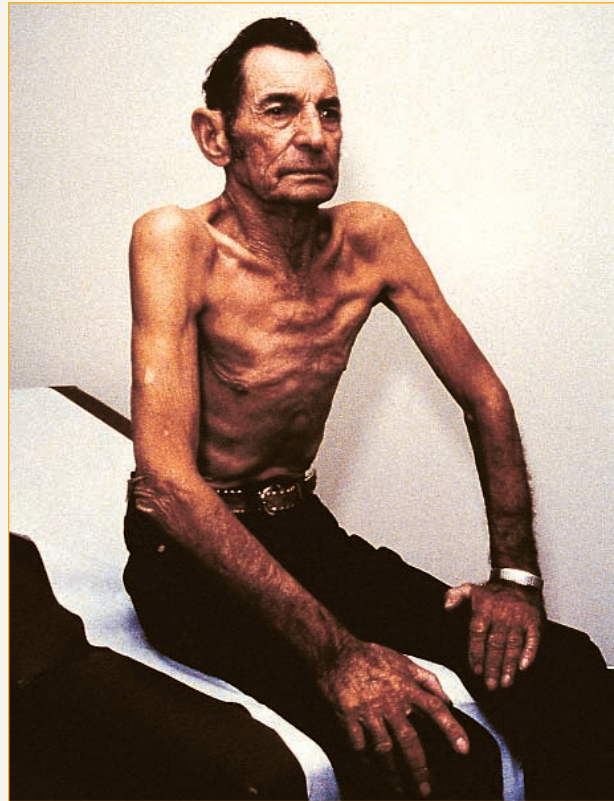
## Documentation Tips

The respiratory status of a patient is so important that it should be noted at the beginning of your radio report, after mental status. Any changes during treatment or transport should be immediately reported to the receiving hospital. Respiratory status along with any changes should also be clearly documented in your patient care report.

muscles of respiration. They include the neck muscles (sternocleidomastoid), the chest pectoralis major muscles, and the abdominal muscles (Figure 7-9). These muscles are not used during normal breathing. More information about recognizing labored breathing and respiratory distress in children may be found in Chapters 31 and 32. Signs of inadequate breathing in adult patients are as follows:

- Respiratory rate of fewer than 12 breaths/min or more than 20 breaths/min
- Irregular rhythm, such as a patient taking a series of deep breaths followed by periods of apnea
- Auscultated breath sounds are diminished, absent, or noisy
- Reduced flow of expired air at the nose and mouth
- Unequal or inadequate chest expansion, resulting in reduced tidal volume
- Increased effort of breathing—use of accessory muscles
- Shallow depth (reduced tidal volume)
- Skin that is pale, cyanotic (blue), cool, or moist (clammy)
- Skin pulling in around the ribs or above the clavicles during inspiration (**retractions**)

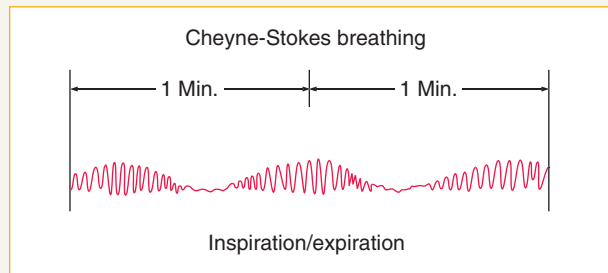
You should be aware that a patient may appear to be breathing after his heart has stopped. These occasional, gasping breaths are called **agonal respirations**. They occur when the respiratory center in the brain continues to send signals to the respiratory muscles. These respirations are not adequate because they are slow and generally shallow. You will need to provide artificial ventilations to patients with agonal respirations.



**Figure 7-9** The accessory muscles of breathing are used when a patient is having difficulty breathing, but not during normal breathing. The accessory muscles include the sternocleidomastoid, pectoralis major, and abdominal muscles.

Some patients may have irregular respiratory breathing patterns that are related to a specific condition. For example, Cheyne-Stokes respirations are often seen in patients with a stroke and patients with serious head injuries (Figure 7-10). Cheyne-Stokes respirations are an irregular respiratory pattern in which the patient breathes with an increasing rate and depth of respiration that is followed by a period of **apnea** or lack of spontaneous breathing, followed again by a pattern of increasing rate and depth of respiration. Serious head injuries may also cause changes in the normal respiratory rate and pattern of breathing. The result may be irregular, ineffective respirations that may or may not have an identifiable pattern (**ataxic respirations**).

Patients with inadequate breathing have inadequate minute volume and need to be treated immediately. This is most easily recognized in patients who are unable to speak in complete sentences when at rest or who



**Figure 7-10** Cheyne-Stokes breathing shows irregular respirations followed by a period of apnea.

have a fast or slow respiratory rate, both of which may result in a reduction in tidal volume. Emergency medical care includes airway management, supplemental oxygen, and ventilatory support.

## Opening the Airway

Emergency medical care begins with ensuring an open airway. The patient's airway and breathing status are the first steps in your initial assessment for a very good reason: Unless you can immediately open and maintain a patent airway, you cannot provide effective patient care. Regardless of the patient's condition, the airway must remain patent at all times.

When you respond to a call and find an unconscious patient, you need to assess and determine immediately whether the patient has an open airway and breathing

is adequate. To most effectively open the airway and assess breathing, the patient should be in the supine position. However, if your patient is in a position that delays placement in a supine position (for example, entrapped in the vehicle), the patient's airway must be opened and assessed in the position in which you find the patient. If your patient is found in the prone position (lying face down), he or she must be repositioned to allow for assessment of airway and breathing and to begin CPR should it become necessary. The patient should be log rolled as a unit so the head, neck, and spine all move together without twisting (**Skill Drill 7-1**). Unconscious patients, especially when there are no witnesses who can rule out trauma, should be moved as a unit because of the potential for spinal injury.

- 1. Kneel beside the patient.** Have your partner kneel far enough away so that the patient, when rolled toward you, does not come to rest in your lap. Place your hands behind the patient's head and neck to provide in-line stabilization of the cervical spine as your partner straightens the patient's legs (**Step 1**).
- 2. Have your partner** place his or her hands on the patient's far shoulder and hip (**Step 2**).
- 3. As you call the count** to control movement, have your partner turn the patient toward you by pulling on the far shoulder and hip. Control the head and neck so that they move as a unit with the rest of the torso. In this way, the head and neck stay in the same vertical plane as the back. This single motion will minimize aggravation of any potential spinal injury. At this point, you

## You are the Provider

### Part 4

The ushers step out of the way as you immediately kneel by the patient. You confirm with the ushers that the patient, in fact, did not fall off his chair but that they lifted him out carefully without hurting him. You then open his airway using a head tilt–chin lift technique and listen for breathing. You hear snoring respirations that persist even after adjusting his head position. You decide to use an oropharyngeal airway to keep his tongue out of the way.

8. What is the most appropriate method to open an unresponsive patient's airway when you are considering a chief complaint of difficulty breathing?
9. How do adventitious (abnormal) sounds help you in evaluating your patient's airway status?

## Positioning the Unconscious Patient



- 1** Support the head while your partner straightens the patient's legs.



- 2** Have your partner place his or her hand on the patient's far shoulder and hip.



- 3** Roll the patient as a unit with the person at the head calling the count to begin the move.



- 4** Open and assess the patient's airway and breathing status.

should apply a cervical collar. Place the patient's arms at his or her side (**Step 3**).

- 4.** Once the patient is positioned, maintain an open airway and check for breathing (**Step 4**).

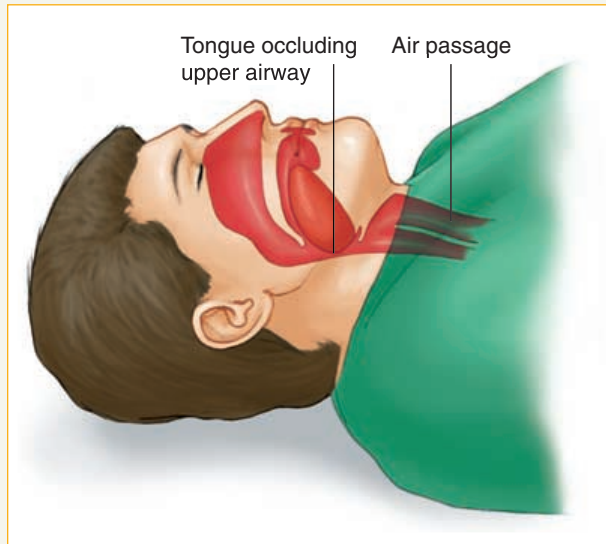
In an unconscious patient, the most common airway obstruction is the patient's own tongue, which falls back into the throat when the muscles of the throat and tongue relax (**Figure 7-11**). Dentures (false teeth), blood, vomitus, mucus, food, and other foreign objects may also create an airway obstruction. Therefore, you should always be prepared to help clear and maintain a patent (open) airway.

### Head Tilt–Chin Lift Maneuver

Opening the airway to relieve an obstruction can often be done quickly and easily by simply tilting the patient's head back and lifting the chin in what is known as the **head tilt–chin lift maneuver**. For patients who have not sustained trauma, this simple maneuver is sometimes all that is needed for the patient to resume breathing.

To perform the head tilt–chin lift maneuver, follow these steps:

1. With the patient in a supine position, position yourself beside the patient's head.
2. Place one hand on the patient's forehead, and apply firm backward pressure with your palm to



**Figure 7-11** The most common airway obstruction is the patient's own tongue, which falls back into the throat when the muscles of the throat and tongue relax.



**Figure 7-12** The head tilt–chin lift maneuver is a simple technique for opening the airway in a patient without a suspected cervical spine injury.

tilt the patient's head back. This extension of the neck will move the tongue forward, away from the back of the throat, and clear the airway if the tongue is blocking it.

3. Place the tips of the fingers of your other hand under the lower jaw near the bony part of the chin. Do not compress the soft tissue under the chin, as this may block the airway.
4. Lift the chin upward, bringing the entire lower jaw with it, helping to tilt the head back. Do not use your thumb to lift the chin. Lift so that the teeth are nearly brought together, but avoid closing the mouth completely. Continue to hold the forehead to maintain the backward tilt of the head [Figure 7-12 ▶](#).

## Jaw-Thrust Maneuver

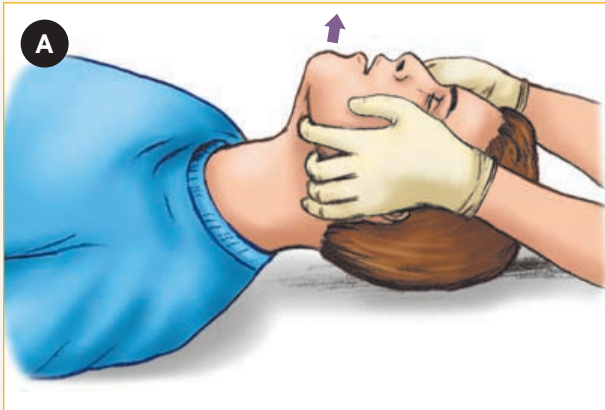
The head tilt–chin lift will open the airway in most patients. If you suspect a cervical spine injury, use the jaw-thrust maneuver. The **jaw-thrust maneuver** is a technique to open the airway by placing the fingers behind the angle of the jaw and lifting the jaw upward. You can easily seal a mask around the mouth while doing the jaw-thrust maneuver. This is the method of choice for patients with suspected cervical spine injury. See Chapter 30, Head and Spine Injuries, for a more detailed discussion of these types of injuries.

Perform the jaw-thrust maneuver in an adult in the following manner [Figure 7-13 ▶](#):

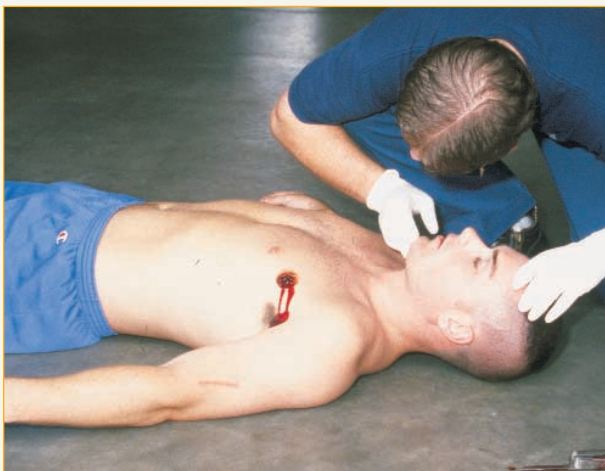
1. Kneel above the patient's head. Place your fingers behind the angles of the lower jaw, and move the jaw upward. Use your thumbs to help position the lower jaw to allow breathing through the mouth and the nose.
2. The completed maneuver should open the airway with the mouth slightly open and the jaw jutting forward.

It should be noted that if the jaw-thrust maneuver does not adequately open the airway, you should carefully perform the head tilt–chin lift maneuver. The patient's airway must be patent—regardless of the situation. Once the airway has been opened, the patient may start to breathe on his or her own. Assess whether breathing has returned by using the look, listen, and feel technique [Figure 7-14 ▶](#).

If the patient has a severe airway obstruction, there will be no movement of air. However, you may see the chest and abdomen rise and fall considerably with the patient's frantic attempts to breathe. This is why the presence of chest wall movement alone does not indicate breathing is present. Regular chest wall movement indicates a respiratory effort is present. Observing chest and abdominal movement is often difficult with a fully clothed patient. You may see little, if any, chest movement even with normal breathing. This is particularly



**Figure 7-13** Performing the jaw-thrust maneuver. **A.** Kneeling above the patient's head, place your fingers behind the angles of the lower jaw, and move the jaw upward. Use your thumbs to help position the lower jaw. **B.** The completed maneuver should look like this.



**Figure 7-14** The look, listen, and feel technique is used to assess whether breathing has spontaneously returned.

true in some patients with chronic lung disease. You must begin artificial ventilation immediately if you use the three-part approach—look, listen, and feel—and discover that there is no movement of air.

## Basic Airway Adjuncts

The primary function of an airway adjunct is to prevent obstruction of the upper airway by the tongue and allow the passage of air and oxygen to the lungs.

### Oropharyngeal Airways

An **oropharyngeal (oral) airway** has two principal purposes. The first is to keep the tongue from blocking the upper airway. The second is to make it easier to suction the oropharynx if necessary. Suctioning is possible through an opening down the center or along either side of the oropharyngeal airway [Figure 7-15 ▶](#).

Indications for the oropharyngeal airway include the following:

- Unconscious patients without a gag reflex (breathing or apneic)
- Any apneic patient being ventilated with a BVM device

Contraindications for the oropharyngeal airway include the following:

- Conscious patients
- Any patient (conscious or unconscious) who has an intact gag reflex

The **gag reflex** is a protective reflex mechanism that prevents food and other particles from entering the airway. If you try to insert an oral airway in a patient with a gag reflex, the result may be vomiting or a spasm of the vocal cords. If the patient gags while you are attempting to insert an oral airway, immediately remove the oral airway and be prepared to suction the oropharynx, should vomiting occur. An oral airway is also a safe, effective way to help maintain the airway of a patient with a possible spinal injury. The use of an oral airway may make manual airway maneuvers such as the head tilt–chin lift and the jaw-thrust easier to maintain; however, manual maneuvers are often still needed to assure that the airway remains patent.

You must clearly understand when and how this device is used. If the oropharyngeal airway is too large, it could actually push the tongue back into the pharynx, blocking the airway. Conversely, an oral airway that is too small could block the airway directly, just like any other foreign body obstruction. The following



**Figure 7-15** An oral airway is used for unconscious patients who have no gag reflex. It keeps the tongue from blocking the airway and makes suctioning the airway easier.

steps should be used when inserting an oropharyngeal airway **Skill Drill 7-2** ▶:

1. To select the proper size, measure from the patient's earlobe or angle of the jaw to the corner of the mouth on the side of the face (**Step 1**).
2. Open the patient's mouth with the cross-finger technique. Hold the airway upside down with your other hand. Insert the airway with the tip facing the roof of the mouth and slide it in until it touches the roof of the mouth (**Step 2**).
3. Rotate the airway 180°. When inserted properly, the airway will rest in the mouth with the curvature of the airway following the contour of the airway. The flange should rest against the lips or teeth, with the other end opening into the pharynx (**Step 3**).

Take care to avoid injuring the hard palate (roof of the mouth) as you insert the airway. Roughness can

## Geriatric Needs

When managing the airway of an older patient, you must be aware of the presence of dentures or other dental appliances. If dentures are tight-fitting and allow for effective airway management, they should be left in place. However, if the dentures are loose, they must be removed to avoid potential airway obstruction.

cause bleeding, which may aggravate airway problems or even cause vomiting.

If you encounter difficulty while inserting the oral airway, the following alternative method may be used

**Skill Drill 7-3** ▶:

1. Use a tongue blade to depress the tongue, ensuring that the tongue remains forward (**Step 1**).
2. Insert the oral airway sideways from the corner of the mouth, until the flange reaches the teeth (**Step 2**).
3. Rotate the oral airway at a 90° angle, removing the tongue blade as you exert gentle backward pressure on the oral airway, until it rests securely in place against the lips and teeth (**Step 3**).

In some cases, a patient may become responsive and regain the gag reflex after you have inserted an oral airway. If this occurs, gently remove the airway by pulling it out, following the normal curvature of the mouth and throat. Be prepared for the patient to vomit. Have suction available, and log roll the patient onto his or her side to allow any fluids to drain out.

## Nasopharyngeal Airways

A **nasopharyngeal (nasal) airway** is usually used with a patient who has an intact gag reflex and is not able to maintain his or her airway spontaneously **Figure 7-16** ▶. Patients with an altered mental status or those who have just had a seizure may also benefit from this type of airway. If a patient has sustained severe trauma to the head or face, you should consult medical control before inserting a nasopharyngeal airway. Extreme care must be used with such trauma patients. If the airway is accidentally pushed through the hole caused by a fracture of the base of the skull, it may penetrate through the cranium and into the brain.

## Pediatric Needs

In children, the alternative method of inserting an oral airway, using a tongue blade to hold the tongue down while inserting the airway, is the only acceptable method. Because the airways of children are undeveloped, rotating an oropharyngeal airway in the posterior pharynx may cause damage. For more discussion on pediatric airways, see Chapter 31.

## Inserting an Oral Airway

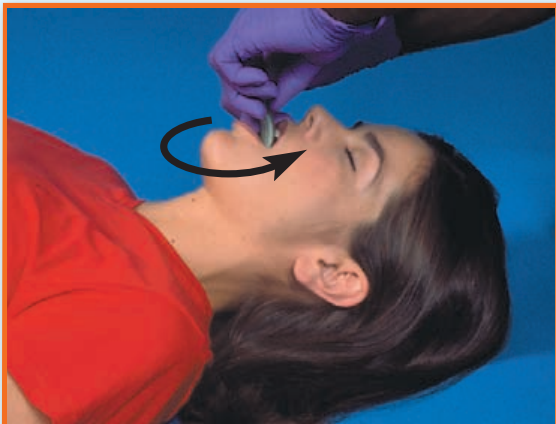
7-2



- 1** Size the airway by measuring from the patient's earlobe to the corner of the mouth.



- 2** Open the patient's mouth with the cross-finger technique. Hold the airway upside down with your other hand. Insert the airway with the tip facing the roof of the mouth and slide it in until it touches the roof of the mouth.



- 3** Rotate the airway 180°. Insert the airway until the flange rests on the patient's lips and teeth. In this position, the airway will hold the tongue forward.

This type of airway is usually better tolerated by patients who have an intact gag reflex. It is not as likely as the oropharyngeal airway to cause vomiting. You should coat the airway well with a water-soluble lubricant before it is inserted. Be aware that slight bleeding may occur even when the airway is inserted properly. However, you should never force the airway into place.

Indications for the nasopharyngeal airway include the following:

- Semiconscious or unconscious patients with an intact gag reflex

- Patients who otherwise will not tolerate an oropharyngeal airway

Contraindications for the nasopharyngeal airway include the following:

- Severe head injury with blood draining from the nose
- History of fractured nasal bones

Follow these steps to ensure correct placement of the nasopharyngeal airway **Skill Drill 7-4** ▶:

1. **Before inserting the airway**, be sure you have selected the proper size. Measure from the tip of the

## Inserting an Oral Airway With a 90° Rotation



- 1** Depress the tongue so the tongue remains forward.



- 2** Insert the oral airway sideways from the corner of the mouth, until the flange reaches the teeth.



- 3** Rotate the oral airway at a 90° angle. Remove the tongue blade as you exert gentle backward pressure on the oral airway, until it rests securely in place against the lips and teeth.

7-3

Skill Drill

patient's nose to the earlobe. In almost all individuals, one nostril is larger than the other (**Step 1**).

2. The airway should be placed in the larger nostril, with the curvature of the device following the curve of the floor of the nose. If using the right nare, the bevel should face the septum (**Step 2**). If using the left nare, insert the airway with the tip of the airway pointing upward, which will allow the bevel to face the septum.
3. Advance the airway gently (**Step 3**). If using the left nare, insert the nasopharyngeal airway until resistance is met. Then rotate the nasopharyn-



**Figure 7-16** A nasal airway is better tolerated than is an oral airway by patients who have an intact gag reflex.

## Inserting a Nasal Airway



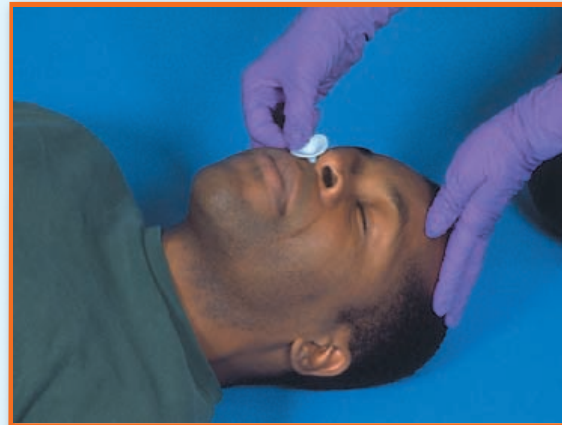
- 1** Size the airway by measuring from the tip of the nose to the patient's earlobe. Coat the tip with a water-soluble lubricant.



- 2** Insert the lubricated airway into the larger nostril with the curvature following the floor of the nose. If using the right nare, the bevel should face the septum. If using the left nare, insert the airway with the tip of the airway pointing upward, which will allow the bevel to face the septum.



- 3** Gently advance the airway. If using the left nare, insert the nasopharyngeal airway until resistance is met. Then rotate the nasopharyngeal airway 180° into position. This rotation is not required if using the right nostril.



- 4** Continue until the flange rests against the skin. If you feel any resistance or obstruction, remove the airway and insert it into the other nostril.

geal airway 180° into position. This rotation is not required if using the right nostril.

- 4.** When completely inserted, the flange rests against the nostril. The other end of the airway opens into the posterior pharynx (**Step 4**).

If the patient becomes intolerant of the nasal airway, you may have to remove it. Gently withdraw the airway from the nasal passage. Precautions similar to those used when removing an oral airway should be followed.



## EMT-B Safety

A mask and protective eyewear should be worn whenever airway management involves suctioning. Body fluids can become aerosolized, and exposure to the mucous membranes of your mouth, nose, and eyes can easily occur.

## Suctioning

You must keep the airway clear so that you can ventilate the patient properly. If the airway is not clear, you will force the fluids and secretions into the lungs and possibly cause a complete airway obstruction. Therefore, suctioning is your next priority. If you have any doubt about the situation, remember this rule: If you hear gurgling, the patient needs suctioning!

### Suctioning Equipment

Portable, hand-operated, and fixed (mounted) suctioning equipment is essential for resuscitation [Figure 7-17 ▶](#). A portable suctioning unit must provide enough vacuum pressure and flow to allow you to suction the mouth and nose effectively. Hand-

operated suctioning units with disposable chambers are reliable, effective, and relatively inexpensive. A fixed suctioning unit should generate airflow of more than 40 L/min and a vacuum of more than 300 mm Hg when the tubing is clamped.

A portable or fixed suctioning unit should be fitted with the following:

- Wide-bore, thick-walled, nonkinking tubing
- Plastic, rigid pharyngeal suction tips, called **tonsil tips** or Yankauer tips
- Nonrigid plastic catheters, called French or whistle-tip catheters
- A nonbreakable, disposable collection bottle
- A supply of water for rinsing the tips

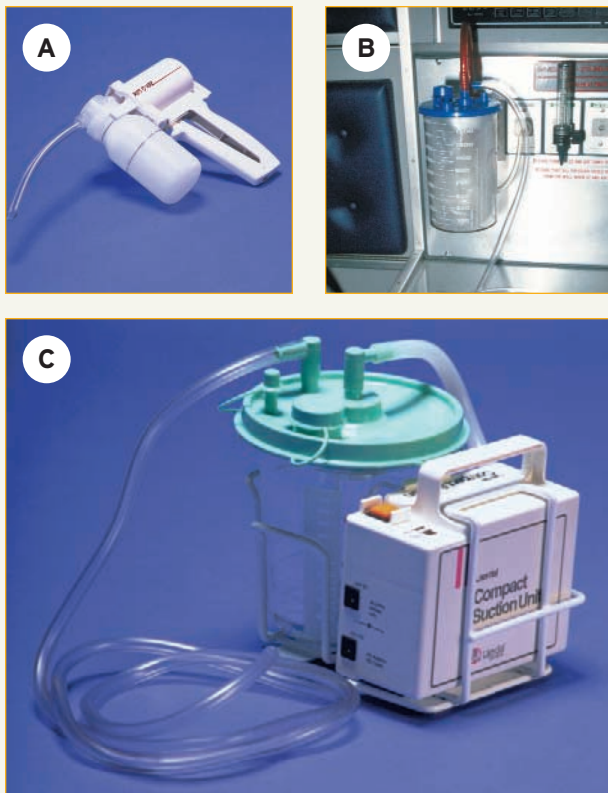
A **suction catheter** is a hollow, cylindrical device that is used to remove fluids from the patient's airway. A tonsil-tip catheter is the best kind of catheter for suctioning the oropharynx in adults and is preferred for infants and children. The plastic tips have a large diameter and are rigid, so they do not collapse [Figure 7-18 ▶](#). Tips with a curved contour allow for easy, rapid placement in the oropharynx. Soft plastic, nonrigid catheters, sometimes called French or whistle-tip catheters, are used to suction the nose and liquid secretions in the back of the mouth and in situations in which you cannot use a rigid catheter, such as for a patient with a **stoma** [Figure 7-19 ▶](#). For example, a rigid catheter could break off a patient's tooth, whereas a flexible catheter may be inserted along the

## You are the Provider

### Part 5

Several minutes after inserting the oral airway, your patient begins to gag and vomits. You immediately remove the OPA and roll the patient to his side. When he finishes vomiting, you clean the large debris from his face and mouth. Your partner has set up the portable suction for you. As you reevaluate the patient's breathing and airway, you now hear gurgling sounds. You grab a rigid tipped catheter, turn on the suction machine, and open his mouth using a cross-finger technique. After measuring the depth of the catheter against the patient's face, you insert the catheter into the patient's mouth and begin counting the seconds you suction. After about 10 seconds, the mouth appears clear of fluids and the gurgling has stopped.

10. How important is it to reevaluate the interventions you use to treat your patient?
11. If your suction catheter does not remove the large debris from the patient's mouth, how would you remove it?



**Figure 7-17** Suctioning equipment is essential for resuscitation. **A.** Hand-operated unit. **B.** Fixed unit. **C.** Portable unit.

cheeks without injury. Before you insert any catheter, make sure to measure for the proper size. Use the same technique as you would use when measuring for an oropharyngeal airway. Be careful not to touch the back of the airway with a suction catheter. This can activate the gag reflex, cause vomiting, and increase the possibility of **aspiration**.

## Techniques of Suctioning

You should inspect your suctioning equipment regularly to make sure it is in proper working condition. Turn on the suction, clamp the tubing, and make sure that the unit generates a vacuum of more than 300 mm Hg. Check that a battery-charged unit has charged batteries. Ensure that your suctioning equipment is at the patient's head and is easily accessible. Follow these general steps to operate the suction unit:

1. Check the unit for proper assembly of all its parts.
2. Turn on the suctioning unit and test it to ensure a vacuum pressure of more than 300 mm Hg.
3. Select and attach the appropriate suction catheter to the tubing.



**Figure 7-18** Tonsil-tip catheters are the best for suctioning because they have wide-diameter tips and are rigid.



**Figure 7-19** French, or whistle-tip, catheters are used in situations in which rigid catheters cannot be used, such as with a patient who has a stoma, patients whose teeth are clenched, or if suctioning the nose is necessary.

Never suction the mouth or nose for more than 15 seconds at one time for adult patients, 10 seconds for children, and 5 seconds for infants. Suctioning removes oxygen from the airway along with obstructive material and can result in hypoxia. Rinse the catheter and tubing with water to prevent clogging of the tube with dried vomitus or other secretions. Repeat suctioning only after the patient has been adequately ventilated and reoxygenated.

You should use extreme caution when suctioning a conscious or semiconscious patient. Put the tip of the suction catheter in only as far as you can visualize. Be aware that suctioning may induce vomiting in these patients.

To properly suction a patient **Skill Drill 7-5** ▶:

1. Turn on the assembled suction unit (**Step 1**).
2. Measure the catheter to the correct depth by measuring the catheter from the corner of the patient's mouth to the edge of the earlobe or angle of the jaw (**Step 2**).
3. Open the patient's mouth using the cross-finger technique or tongue-jaw lift, and insert

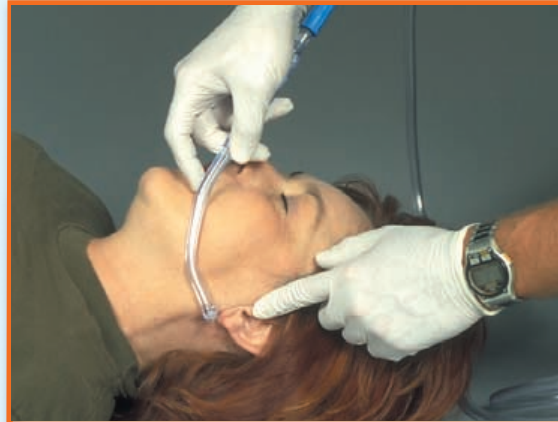
## Suctioning a Patient's Airway

7-5

Skill Drill



- 1** Make sure the suctioning unit is properly assembled and turn on the suction unit.



- 2** Measure the catheter from the corner of the mouth to the earlobe or angle of the jaw.



- 3** Open the patient's mouth and insert the catheter to the depth measured.



- 4** Apply suction in a circular motion as you withdraw the catheter. Do not suction an adult for more than 15 seconds.

the tip of the catheter to the depth measured (**Step 3**).

- 4.** Insert catheter to the premeasured depth and apply suction in a circular motion as you withdraw the catheter. Do not suction an adult for more than 15 seconds (**Step 4**).

At times, a patient may have secretions or vomitus that cannot be suctioned quickly and easily, and some suction units cannot effectively remove solid objects such as teeth, foreign bodies, and food. In these cases, you should remove the catheter from the patient's mouth, log roll the patient to the side, and then clear the mouth

carefully with your gloved finger. A patient who requires assisted ventilation may also produce frothy secretions as quickly as you can suction them from the airway. In this situation, you should suction the patient's airway for 15 seconds (less time in infants and children), and then ventilate the patient for 2 minutes. This alternating pattern of suctioning and ventilating should continue until all secretions have been cleared from the patient's airway. Continuous ventilation is not appropriate if vomitus or other particles are present in the airway.

You should clean and decontaminate your suctioning equipment after each use according to the


## EMT-B Tips

### Suctioning Time Limits

Adult	15 seconds
Child	10 seconds
Infant	5 seconds

manufacturer's guidelines. Place all disposable suctioning equipment (such as catheter, suction tubing) in a biohazard bag.

## Maintaining the Airway

The **recovery position** is used to help maintain a clear airway in a patient who is not injured and is breathing on his or her own with a normal rate and adequate tidal volume (depth of breathing) . Take the following steps to put the patient in the recovery position on the left side:

1. Roll the patient onto the left side so that head, shoulders, and torso move at the same time without twisting.
2. Place the patient's extended left arm and right hand under his or her cheek.

Once patients have resumed spontaneous breathing after being resuscitated, the recovery position will prevent the aspiration of vomitus. However, this position is not appropriate for patients with suspected spinal trauma, nor is it adequate for patients who are uncon-



**Figure 7-20** In the recovery position, the patient is rolled onto his or her side.

scious and require ventilatory assistance. You must reposition such patients to provide adequate access to the airway while maintaining appropriate spinal immobilization.

## Supplemental Oxygen

You should always give supplemental oxygen to patients who are hypoxic because they are not getting enough oxygen to the tissues and cells of the body.

Some tissues and organs, such as the heart, central nervous system, lungs, kidneys, and liver, need a constant supply of oxygen to function normally. **Never withhold oxygen from any patient who might benefit from it, especially if you must assist ventilations.**

When ventilating any patient in cardiac or respiratory arrest, you must always use high-concentration supplemental oxygen.

## You are the Provider

## Part 6

Now that you have cleared your patient's airway by suctioning, you place the patient in the recovery position and continue with your assessment of the ABCs. You find his breathing to be present and adequate. A pulse is present, and there is no evidence of bleeding. Findings from your focused history and physical exam are normal except for a low pulse oximeter reading of 88%. You place your patient on a nonbreathing mask at 15 L/min and prepare the patient for transport to the hospital. Dispatch reports that the ALS unit is delayed in traffic due to construction.

12. This patient needs oxygen. What type of patients should not receive oxygen?
13. Earlier in your assessment you called for additional help, but now that help is delayed. How does that change your immediate decisions toward patient care?



**Figure 7-21** Oxygen tanks for medical use will have a series of letters and numbers stamped into the metal on the collar of the cylinder.

## Supplemental Oxygen Equipment

In addition to knowing when and how to give supplemental oxygen, you must understand how oxygen is stored and the various hazards associated with its use.

### Oxygen Cylinders

The oxygen that you will give to patients is usually supplied as a compressed gas in green, seamless, steel or aluminum cylinders. Some cylinders may be silver or chrome with a green area around the valve stem on top. Newer cylinders are often made of lightweight aluminum or spun steel; older cylinders are much heavier.

Check to make sure that the cylinder is labeled for medical oxygen. You should look for letters and numbers stamped into the metal on the collar of the cylinder (Figure 7-21 ▲). Of particular importance are the month and year stamps, which indicate when the cylinder was last tested.

Oxygen cylinders are available in several sizes. The two sizes that you will most often use are the D (or super D) and M cylinders (Figure 7-22 ►). The D (or super D) cylinder can be carried from your unit to the patient. The M tank remains on board your unit as a main supply tank. Other sizes that you will see are A, E, G, H, and K (Table 7-2 ►). The length of time you can use an oxygen cylinder depends on the pressure in the cylin-



**Figure 7-22** The cylinders that are most commonly found on an ambulance are the D (or super D) and M size cylinders.

der and the flow rate. A method of calculating cylinder duration is shown in (Table 7-3 ►).

## Safety Considerations

Compressed gas cylinders must be handled carefully because their contents are under pressure. Cylinders are fitted with pressure regulators to make sure that patients receive the right amount and type of gas. Make sure that the correct pressure regulator is firmly attached before you transport the cylinders. A puncture or hole in the tank can cause the cylinder to become a deadly missile. Do not handle a cylinder by the neck assembly alone. Cylinders should be secured with mounting brackets when they are stored on the ambulance. Oxygen cylinders that are in use during transport should

**TABLE 7-2** Oxygen Cylinder Sizes Carried on the Ambulance

Size	Volume, L
D	350
Super D	500
E	625
M	3,000
G	5,300
H, A, K	6,900

**TABLE 7-3 Oxygen Cylinders: Duration of Flow****Formula**

$$\frac{(\text{Gauge pressure in psi} - \text{the safe residual pressure}) \times \text{constant}}{\text{Flow rate in L/min}} = \text{duration of flow in minutes}$$

SAFE RESIDUAL PRESSURE = 200 psi

CYLINDER CONSTANT

D = 0.16                      G = 2.41

E = 0.28                      H = 3.14

M = 1.56                      K = 3.14

Determine the life of an M cylinder that has a pressure of 2,000 psi and a flow rate of 10 L/min.

$$\frac{(2,000 - 200) \times 1.56}{10} = \frac{2,808}{10} = 281 \text{ min, or } 4 \text{ h } 41 \text{ min}$$

**Note:** psi indicates pounds per square inch.

be positioned and secured to prevent the tank from falling and to prevent damage to the valve-gauge assembly.

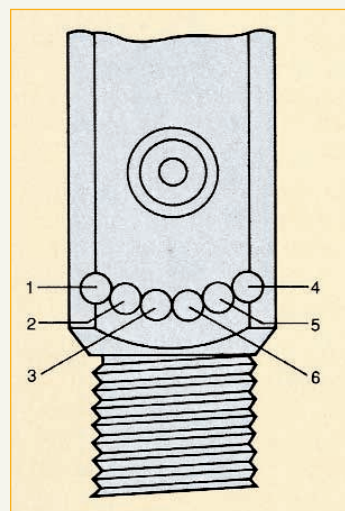
### Pin-Indexing System

The compressed gas industry has established a **pin-indexing system** for portable cylinders to prevent an oxygen regulator from being connected to a carbon dioxide cylinder, a carbon dioxide regulator from being connected to an oxygen cylinder, and so on. In preparing to administer oxygen, always check to be sure that the pinholes on the cylinder exactly match the corresponding pins on the regulator.

The pin-indexing system features a series of pins on a yoke that must be matched with the holes on the valve stem of the gas cylinder. The arrangement of the pins and holes varies for different gases according to accepted national standards (Figure 7-23). Other gases that are supplied in portable cylinders, such as acetylene, carbon dioxide, and nitrogen, use regulators and flowmeters that are similar to those used with oxygen. Each cylinder of a specific gas type has a given pattern and a given number of pins. These safety measures make it impossible for you to attach a cylinder of nitrous oxide to an oxygen regulator. The oxygen regulator will not fit.

The outlet valves on portable oxygen cylinders are designed to accept yoke-type pressure-reducing gauges, which conform to the pin-indexing system

(Figure 7-24). The safety system for large cylinders is known as the **American Standard System**. In this system, oxygen cylinders are equipped with threaded gas outlet valves. The inside and outside thread sizes of these outlets vary depending on the gas in the cylinder. The cylinder will not accept a regulator valve unless it is properly threaded to fit that regulator. The purpose of these safety devices is the same as in the pin-indexing system: to prevent the accidental attachment of a regulator to a wrong cylinder.



**Figure 7-23** The locations of the pin-indexing safety system holes in a cylinder valve face. Each cylinder of a specific gas has a given pattern and a given number of pins.



**Figure 7-24** A yoke-type pressure-reducing gauge is used with a portable oxygen cylinder.



**Figure 7-25** Giving humidified oxygen may be preferred with long transport times. However, the use of this type of oxygen-delivery system is not universal in all EMS systems.

## Pressure Regulators

The pressure of gas in a full oxygen cylinder is approximately 2,000 psi. This is far too much pressure to be safe or useful for your purposes. Pressure regulators reduce the pressure to a more useful range, usually 40 to 70 psi. Most pressure regulators in use today reduce the pressure in a single stage, although multistage regulators exist. A two-stage regulator will reduce the pressure first to 700 psi and then to 40 to 70 psi.

After the pressure is reduced to a workable level, the final attachment for delivering the gas to the patient is usually one of the following:

- A quick-connect female fitting that will accept a quick-connect male plug from a pressure hose or ventilator or resuscitator
- A flowmeter that will permit the regulated release of gas measured in liters per minute

## Humidification

Some EMS systems provide humidified oxygen to patients during transport (Figure 7-25). However, humidified oxygen is usually indicated only for long-term oxygen therapies. Dry oxygen is not considered harmful for short-term use. Therefore, many EMS systems do not use humidified oxygen in the prehospital setting. Always refer to medical control or local protocols for guidance involving patient treatment issues.

## Flowmeters

Flowmeters are usually permanently attached to pressure regulators on emergency medical equipment. The two types of flowmeters that are commonly used

are pressure-compensated flowmeters and Bourdon-gauge flowmeters.

A pressure-compensated flowmeter incorporates a float ball within a tapered calibrated tube. The float rises or falls according to the gas flow within the tube. The flow of gas is controlled by a needle valve located downstream from the float ball. This type of flowmeter is affected by gravity and must always be maintained in an upright position for an accurate flow reading

(Figure 7-26).



**Figure 7-26** A pressure-compensated flowmeter contains a float ball that rises or falls according to the gas flow within the tube. It must be maintained in an upright position for an accurate reading.



**Figure 7-27** The Bourdon-gauge flowmeter is not affected by gravity and can be used in any position.

The Bourdon-gauge flowmeter is commonly used because it is not affected by gravity and can be used in any position (Figure 7-27 ▲). It is actually a pressure gauge that is calibrated to record flow rate. The major disadvantage of this flowmeter is that it does not compensate for backpressure. Therefore, it will usually record a higher flow rate when there is any obstruction to gas flow downstream.

## Operating Procedures

Before placing an oxygen cylinder into service

### Skill Drill 7-6 ▶:

1. **Inspect the cylinder and its markings.** If the cylinder was commercially filled, it will have a plastic seal around the valve stem covering the opening in the stem. Remove the seal, and inspect the opening to make sure that it is free of dirt and other debris. The valve stem should not be sealed or covered with adhesive tape or any petroleum-based substances. These can contaminate the oxygen and can contribute to spontaneous combustion when mixed with the pressurized oxygen.

“Crack” the cylinder by slowly opening and then reclosing the valve to help make sure that dirt particles and other possible contaminants do not enter the oxygen flow. Never face the tank toward yourself or others when cracking the cylinder. Open the tank by attaching a tank key to the valve and rotating the valve counter-clockwise. You should be able to hear clearly the

rush of oxygen coming from the tank. Close the tank by rotating the valve clockwise (Step 1).

2. **Attach the regulator/flowmeter** to the valve stem after clearing the opening. On one side of the valve stem, you will find three holes. The larger one, on top, is a true opening through which the oxygen flows. The two smaller holes below it do not extend to the inside of the tank. They provide stability to the regulator. Following the design of a pin-indexing system, these two holes are very precisely located in positions that are unique to oxygen cylinders.

Above the pins on the inside of the collar is the actual port through which oxygen flows from the cylinder to the regulator. A metal or plastic O-ring is placed around the oxygen port to optimize the airtight seal between the collar of the regulator and the valve stem (Step 2).

3. **Place the regulator collar** over the cylinder valve, with the oxygen port and pin-indexing pins on the side of the valve stem that has the three holes. Open the screw bolt just enough to allow the collar to fit freely over the valve stem. Move the regulator so that the oxygen port and the pins fit into the correct holes on the valve stem. The screw bolt on the opposite side should be aligned with the dimpled depression. As you hold the regulator securely against the valve stem, tighten the screw bolt until the regulator is firmly attached to the cylinder. At this point, you should not see any open spaces between the sides of the valve stem and the interior walls of the collar (Step 3).

4. **With the regulator firmly attached**, open the cylinder, check for air leaking from the regulator-oxygen cylinder connection, and read the pressure level on the regulator gauge. Most portable cylinders have a maximum pressure of approximately 2,000 psi. Most EMS services consider a cylinder with less than 500 to 1,000 psi to be too low to keep in service. Learn your department’s policies in this regard and follow them.

The flowmeter will have a second gauge or a selector dial that indicates the oxygen flow rate. Several popular types of devices are widely used. Attach the selected oxygen device to the flowmeter by connecting the universal oxygen connective tubing to the “Christmas tree” nipple on the flowmeter. Most oxygen-delivery devices come

## Placing an Oxygen Cylinder Into Service

7-6

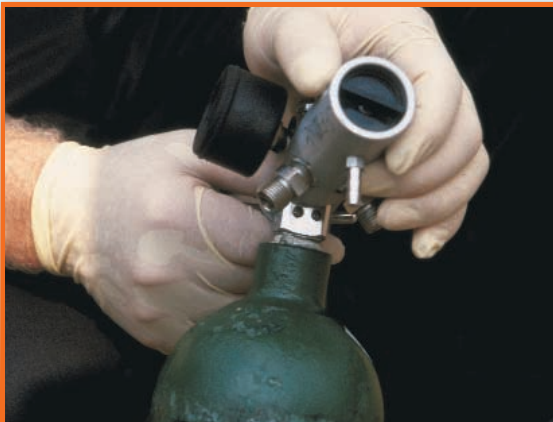
Skill Drill



- 1** Using an oxygen wrench, turn the valve counterclockwise to slowly “crack” the cylinder.



- 2** Attach the regulator/flowmeter to the valve stem using the two pin-indexing holes and make sure that the washer is in place over the larger hole.



- 3** Align the regulator so that the pins fit snugly into the correct holes on the valve stem, and hand tighten the regulator.



- 4** Attach the oxygen connective tubing to the flowmeter.

with this tubing permanently attached. Some oxygen masks do not. You must add this tubing to the oxygen-delivery device if it is not attached (**Step 4**).

Open the flowmeter to the desired flow rate. Flow rates will vary based on the oxygen-delivery device being used. Remember that you must be completely familiar with the equipment before attempting to use it on a patient. Once the oxygen is flowing at the desired rate, apply the oxygen device to the patient and make

any necessary adjustments. Monitor the patient's response to the oxygen and to the oxygen device, and periodically recheck the regulator gauge to make sure there is sufficient oxygen in the cylinder. Disconnect the tubing from the flowmeter nipple and turn off the cylinder valve when oxygen therapy is complete or when the patient has been transferred to the hospital and is using the hospital's oxygen system. In a few seconds, the sound of oxygen flowing from the nipple will cease. This indicates that all the pressurized oxygen has



## EMT-B Safety

Slowly open the oxygen tank after attaching the regulator and check for leaks. Remember that although oxygen itself is not combustible, it supports combustion, and any ignition source may cause fire or an explosion in an oxygen-rich environment—especially if oxygen is being released too quickly from the cylinder at the time or if the seal between the regulator and oxygen cylinder is not secure.



## EMT-B Tips

### Oxygen-Delivery Devices

Device	Flow Rate	Oxygen Delivered
Nasal cannula	1 to 6 L/min	24% to 44%
Nonbreathing mask	10 to 15 L/min	Up to 90%
BVM device	15 L/min-flush with reservoir	Nearly 100%

been removed from the flowmeter. Turn off the flowmeter. The gauge on the regulator should read zero with the tank valve closed. This confirms that there is no pressure left above the valve stem. As long as there is a pressure reading on the regulator gauge, it is not safe to remove the regulator from the valve stem.

### Hazards of Supplemental Oxygen

Oxygen does not burn or explode. However, it does support combustion. The more oxygen is around, the faster the combustion process. A small spark, even a glowing cigarette, can become a flame in an oxygen-rich atmosphere. Therefore, you must keep any possible source of fire away from the area while oxygen is in use. Make sure the area is adequately ventilated, especially in industrial settings where hazardous materials may be present and where sparks are easily generated. Be extremely cautious in any enclosed environment in which oxygen is being administered, as an oxygen-rich environment increases the chance of fire if a spark or flame is introduced. A bystander who is smoking or sparks generated during vehicle extrication are possible ignition sources. Never leave an oxygen cylinder standing unattended. The cylinder can be knocked over, injuring the patient or damaging the equipment.

## Oxygen-Delivery Equipment

In general, the oxygen-delivery equipment that is used in the field should be limited to nonbreathing masks, BVM devices, and nasal cannulas, depending on local protocol. However, you may encounter other devices during transports between medical facilities.

### Nonbreathing Mask

The **nonbreathing mask** is the preferred way of giving oxygen in the prehospital setting to patients who are breathing adequately but are suspected of having or are showing signs of hypoxia. With a good mask-to-face seal, it is capable of providing up to 90% inspired oxygen.

The nonbreathing mask is a combination mask and reservoir bag system. Oxygen fills a reservoir bag that is attached to the mask by a one-way valve. The system is called a nonbreathing mask because the exhaled gas escapes through flapper valve ports at the cheek areas of the mask (Figure 7-28 ▼). These valves prevent the patient from rebreathing exhaled gases.

In this system, you must be sure that the reservoir bag is full before the mask is placed on the patient.



**Figure 7-28** The nonbreathing mask contains flapper valve ports at the cheek areas of the mask to prevent the patient from rebreathing exhaled gases.

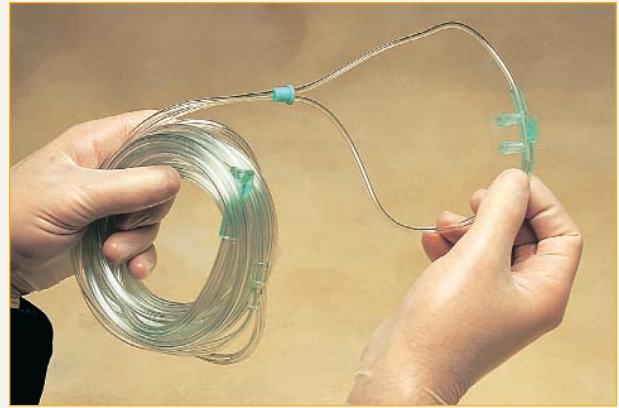
Adjust the flow rate so that the bag does not fully collapse when the patient inhales, to about two thirds of the bag volume, or 10 to 15 L/min. Use a pediatric non-rebreathing mask, which has a smaller reservoir bag, with infants and children, as they will inhale a smaller volume.

## Nasal Cannula

A **nasal cannula** delivers oxygen through two small, tubelike prongs that fit into the patient's nostrils **Figure 7-29**. This device can provide 24% to 44% inspired oxygen when the flowmeter is set at 1 to 6 L/min. For the comfort of your patient, flow rates above 6 L/min are not recommended with the nasal cannula.

The nasal cannula delivers dry oxygen directly into the nostrils, which, over prolonged periods, can cause dryness or irritate the mucous membrane lining of the nose. Therefore, when you anticipate a long transport time, you should consider the use of humidification.

A nasal cannula has limited use in the prehospital care setting. For example, a patient who breathes through the mouth or who has a nasal obstruction will get little or no benefit from a nasal cannula. Always try to give high-flow oxygen through a nonrebreathing mask if you suspect that a patient may have hypoxia, coaching him or her as necessary. If the patient will not tolerate a nonrebreathing mask, you will have to use a nasal cannula, which some patients find more comfortable. As always, a good assessment of your patient will guide your decision.



**Figure 7-29** The nasal cannula delivers oxygen directly through the nostrils.

## Assisted and Artificial Ventilation

Obviously, a patient who is not breathing needs artificial ventilation and 100% supplemental oxygen. Patients who are breathing inadequately, such as those who are breathing too fast or too slow with reduced tidal volume, are unable to speak in complete sentences, or have an irregular pattern of breathing, will also require artificial ventilation to assist them in maintaining adequate minute volume. Keep in mind that fast, shallow breath-

## You are the Provider

## Part 7

Despite supplemental oxygen therapy, your patient's condition has deteriorated. He is more cyanotic and has shallow, slow respirations. You insert a nasopharyngeal airway and begin assisting his ventilations at 1 breath every 5 seconds with a BVM device attached to 100% supplemental oxygen. He does not resist your attempts to ventilate, and his chest rises and falls with each ventilation. He tolerates the NPA without a problem. Dispatch reports that paramedics will rendezvous in 5 minutes.

14. Is an airway adjunct needed to provide assisted ventilations with a BVM? How does it help?
15. The patient's condition is deteriorating and you have begun ventilations at 1 every 5 seconds. Is this enough? How do you know if your ventilations are effective?

## EMT-B Tips

### Methods of Ventilation (listed in order of preference)

- Mouth-to-mask with one-way valve
- Two-person BVM device with reservoir and supplemental oxygen
- Flow-restricted, oxygen-powered ventilation device (manually triggered ventilator)
- One-person BVM device with oxygen reservoir and supplemental oxygen

**Note:** This order of preference has been stated because research has shown that personnel who infrequently ventilate patients have great difficulty maintaining an adequate seal between the mask and the patient's face.

ing can be as dangerous as very slow breathing. Fast, shallow breathing moves air primarily in the larger airway passages (dead air space) and does not allow for adequate exchange of air and carbon dioxide in the alveoli. Patients with inadequate breathing require assisted ventilations with some form of positive-pressure ventilation. Remember to follow body substance isolation (BSI) precautions as needed when managing the patient's airway.

Once you determine that a patient is not breathing or is breathing inadequately, you should begin artificial ventilation immediately. The methods that an EMT-B may use to provide artificial ventilation include the mouth-to-mask technique, a one- or two-person BVM device, and the flow-restricted, oxygen-powered ventilation device.

Ventilation with a flow-restricted, oxygen-powered ventilation device is not commonly performed because the device is not carried on most ambulances. In addition, it may not be used with all types of patients, especially children.

## EMT-B Tips

### Ventilation Rates\*

<b>Adult</b>	1 breath per 5 to 6 seconds
<b>Child</b>	1 breath per 3 to 5 seconds
<b>Infant</b>	1 breath per 3 to 5 seconds

\*For apneic patients with a pulse.



**Figure 7-30** Barrier devices such as a plastic shield or a pocket mask with a one-way valve provide adequate BSI.

## Mouth-to-Mouth and Mouth-to-Mask Ventilation

As you learned in your CPR course, mouth-to-mouth ventilations are now routinely done with a barrier device, such as a mask or face shield. A **barrier device** is a protective item that features a plastic barrier placed on a patient's face with a one-way valve to prevent the backflow of secretions, vomitus, and gases. Barrier devices provide adequate BSI (Figure 7-30 ▲). Mouth-to-mouth ventilations without a barrier device should be provided only in extreme conditions. Performing mouth-to-mask ventilations with a pocket mask with a one-way valve is a safer method of ventilation to prevent possible disease transmission.

A mask with an oxygen inlet provides oxygen during mouth-to-mask ventilation to supplement the air from your own lungs. Remember that the gas you exhale contains 16% oxygen. With the mouth-to-mask system, however, the patient gets the additional benefit of significant oxygen enrichment with inspired air. This system also frees both your hands to help keep the airway open and helps you to provide a better seal between the mask and the face, thus delivering adequate tidal volume.

The mask may be shaped like a triangle or a doughnut, with the apex (top) placed across the bridge of the nose. The base (bottom) of the mask is placed in the groove between the lower lip and the chin. In the center of the mask is a chimney with a 15-mm connector.

Follow these steps to use mouth-to-mask ventilation (Skill Drill 7-7 ▶):

1. **Kneel at the patient's head.** Open the airway using the head tilt–chin lift maneuver or the jaw-

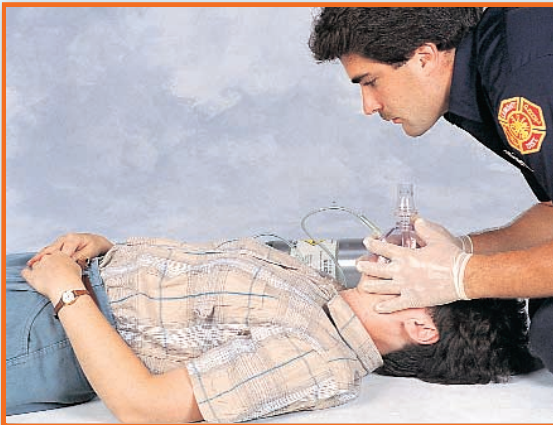
## Performing Mouth-to-Mask Ventilation



- 1 Once the patient's head is properly positioned and an airway adjunct is inserted, place the mask on the patient's face. Seal the mask to the face using both hands (EC clamp).



- 2 Breathe into the one-way valve until you note visible chest rise.



- 3 Remove your mouth and watch the patient's chest fall during exhalation.

thrust maneuver if indicated. Insert an oral or nasal airway to help maintain airway patency. Connect the one-way valve to the face mask. Place the mask on the patient's face. Make sure the top is over the bridge of the nose and the bottom is in the groove between the lower lip and the chin. Hold the mask in position by placing your thumbs over the top part of the mask and your index fingers over the bottom half. Grasp the lower jaw with the remaining three fingers on each hand. Make an airtight

seal by pulling the lower jaw into the mask. Maintain an upward and forward pull on the lower jaw with your fingers to keep the airway open. This method of securing the mask to the patient's face is known as the EC clamp method (**Step 1**).

2. Take a deep breath and exhale through the open port of the one-way valve until you note visible chest rise (**Step 2**).
3. Remove your mouth, and watch for the patient's chest to fall during passive exhalation (**Step 3**).

7-7

Skill Drill

You know that you are providing adequate ventilations if you see the patient's chest rise adequately and do not meet resistance when ventilating. You should also hear and feel air escape as the patient exhales. Make sure that you are providing the correct number of breaths per minute for the patient's age.

To increase the oxygen concentration, connect high-flow oxygen at 15 L/min through the oxygen inlet valve of the mask. This, when combined with your exhaled breath, will deliver approximately 55% oxygen to the patient. Each breath should be given over a period of 1 second—just enough to produce visible chest rise—whether supplemental oxygen is attached to the mask or not. In most adults, a delivered tidal volume of 500 to 600 mL (6 to 7 mL/kg) per breath will produce visible chest rise.

## The BVM Device

With an oxygen flow rate of 15 L/min and an adequate mask-to-face seal, a **bag-valve-mask (BVM) device** with an oxygen reservoir can deliver nearly 100% oxygen (Figure 7-31 ▼). Most BVM devices on the market today include modifications or accessories (reservoirs) that permit the delivery of oxygen concentrations approaching 100%. However, the device can deliver only as much volume as you can squeeze out of the bag by hand. The BVM device provides less tidal volume than mouth-to-mask ventilation; however, it delivers a much higher oxygen concentration. The BVM device is the most common method used to ventilate patients in the field. An experienced EMT-B will be able to supply adequate tidal volumes with a BVM device. Be sure



**Figure 7-31** A BVM device with an oxygen reservoir can deliver nearly 100% oxygen if a good seal between the mouth and mask is achieved and if supplemental oxygen is used.

## EMT-B Tips

### Volume Capabilities of the BVM Device

Size	Amount, mL
Adult	1,200 to 1,600
Pediatric	500 to 700
Infant	150 to 240

to practice on ventilation manikins several times before using a BVM device on a patient. If you have difficulty adequately ventilating a patient with the BVM, you should immediately switch to an alternate method of ventilation, such as the mouth-to-mask technique.

A BVM device should be used when you need to deliver high concentrations of oxygen to patients who are not ventilating adequately. The device is also used for patients in respiratory arrest, cardiopulmonary arrest, and respiratory failure. The BVM device may be used with or without oxygen. However, to ensure the highest concentration of delivered oxygen, you must attach supplemental oxygen and a reservoir. You should use an oral or nasal airway adjunct in conjunction with the BVM device.

## Components

All adult BVM devices should have the following components:

- A disposable self-refilling bag
- No pop-off valve, or if one is present, the capability of disabling the pop-off valve
- An outlet valve that is a true valve for nonrebreathing
- An oxygen reservoir that allows for delivery of high-concentration oxygen
- A one-way, no-jam inlet valve system that provides an oxygen inlet flow at a maximum of 15 L/min with standard 15/22-mm fittings for face mask and endotracheal tube (or other advanced airway adjunct) connection
- A transparent face mask
- Ability to perform under extreme environmental conditions, including extreme heat or cold

The total volume in the bag of an adult BVM device is usually 1,200 to 1,600 mL. The pediatric bag contains 500 to 700 mL, and the infant bag holds 150 to 240 mL.

The volume of air (oxygen) that you should deliver to the patient is based on one key observation, visible chest rise. When using a BVM device, whether supplemental oxygen is attached to it or not, you should deliver each breath over a period of 1 second—just enough to produce visible chest rise—at the appropriate rate. Breaths that are delivered too forcefully or too fast can result in two negative effects: gastric distention (and the associated risks of vomiting and aspiration) and decreased blood return to the heart secondary to increased intrathoracic pressure.

As noted earlier, a delivered tidal volume of 500 to 600 mL (6 to 7 mL/kg) per breath will produce visible chest rise in most adults. However, because it is not possible for the EMT-B to accurately measure tidal volumes in milliliters per kilogram for each patient ventilated in the field, the key is to watch for visible rise and fall of the chest—let these observations determine the appropriate amount of volume to deliver.

### Technique

Whenever possible, you and your partner should work together to provide BVM device ventilation. One EMT-B can maintain a good mask seal by securing the mask to the patient's face with two hands while the other EMT-B squeezes the bag. Ventilation using a BVM device is a challenging skill: it may be very difficult for one EMT-B to maintain a proper seal between the mask and the face with one hand while squeezing the bag well enough to deliver an adequate volume to the patient. This skill can be difficult to maintain if you do not have many opportunities to practice. Effective one-person BVM device ventilation requires considerable experience. Also, performance of this skill depends on having enough personnel to carry out other actions that need to be done at the same time, such as chest compressions, putting the stretcher in place, or helping to lift the patient onto the stretcher.

Follow these steps to use the two-person BVM device technique:

1. Kneel above the patient's head. If possible, your partner should be at the side of the head to squeeze the bag while you hold a seal between the mask and the patient's face with two hands.
2. Maintain the patient's neck in an extended position unless you suspect a cervical spine injury. In that case, you should immobilize the patient's head and neck and use the jaw-thrust maneuver. Have your partner hold the head, or, if you are alone, use your knees to immobilize the head.
3. Open the patient's mouth, and suction as needed. Insert an oropharyngeal or nasopharyngeal airway to maintain an open airway.
4. Select the proper mask size.
5. Place the mask on the patient's face. Make sure the top is over the bridge of the nose and the bottom is in the groove between the lower lip and the chin. If the mask has a large, round cuff around the ventilation port, center the port over the patient's mouth. Inflate the collar to obtain a better fit and seal to the face if necessary.
6. Hold the mask in position by placing the thumbs over the top part of the mask and the index fingers over the bottom half.
7. Bring the lower jaw up to the mask with the last three fingers of your hand. This will help to maintain an open airway. Make sure you do not grab the fleshy part of the neck, as you may compress structures and create an airway obstruction. If you think the patient may have a spinal injury, make sure your partner immobilizes the cervical spine as you move the lower jaw.
8. Connect the bag to the mask if you have not already done so.
9. Hold the mask in place while your partner squeezes the bag with two hands until the patient's chest visibly rises (Figure 7-32 ▶). If a spinal injury is suspected, stabilize the patient's head and neck with your forearms while maintaining an adequate mask-to-face seal with your hands. Continue squeezing the bag once every 5 to 6 seconds for adults and once every 3 to 5 seconds for infants and children. Deliver each breath over a period of 1 second, just enough to produce visible chest rise.
10. If you are alone, hold your index finger over the lower part of the mask, your thumb over the upper part of the mask, and then use your remaining fingers to pull the lower jaw into the mask. This is known as the C-clamp and will maintain an effective face-to-mask seal (Figure 7-33 ▶). Use the head tilt–chin lift maneuver to make sure the neck is extended. If spinal injury is suspected, stabilize the patient's head in a neutral in-line position with your knees as you pull the patient's lower jaw into the mask. Squeeze the bag in a rhythmic manner once every 5 to 6 seconds for adults and once every 3 to 5 seconds for infants and children. Deliver each breath over a period of 1 second, just enough to produce visible chest rise.

When using the device to assist ventilations of a patient who is breathing too slowly (hypoventilation) with reduced tidal volume, you should squeeze the bag as the patient tries to breathe in. Then, for the next 5 to 10 breaths, slowly adjust the rate and the delivered tidal volume until an adequate minute volume is achieved.

To assist respirations of a patient who is breathing too fast (hyperventilating) with reduced tidal volume, you must first explain the procedure to the patient if the patient is coherent. Initially assist respirations at the rate at which the patient has been breathing, squeezing the bag each time the patient inhales. Then, for the next

5 to 10 breaths, slowly adjust the rate and the delivered tidal volume until an adequate minute volume is achieved.

As you are assisting ventilations with a BVM device, you should evaluate the effectiveness of your delivered ventilations. You will know that artificial ventilation is not adequate if the patient's chest does not rise and fall with each ventilation, the rate at which you are ventilating is too slow or too fast, or the heart rate does not return to normal. If the patient's chest does not rise and fall, you may need to reposition the head, use an airway adjunct, or use **cricoid pressure**.

When using a BVM device or any other ventilation device, be alert for **gastric distention**, inflation of the stomach with air. To prevent or alleviate distention, you should do the following: (1) ensure that the patient's airway is appropriately positioned, (2) ventilate the patient at the appropriate rate, and (3) ventilate the patient with the appropriate volume. If an additional rescuer is available, use the **Sellick maneuver** [Figure 7-34 ▼](#). To perform the Sellick maneuver, have an additional rescuer apply cricoid pressure on the patient by placing the thumb and index finger on either side of the cricoid cartilage (at the inferior border of the larynx) and pressing down. By occluding the esophagus, this will (1) inhibit the flow of air into the stomach, thus reducing gastric distention, and (2) reduce the chance of aspiration by helping block the regurgitation of gastric contents from the esophagus. Cricoid pressure should be performed only on unconscious patients.

If the patient's stomach appears to be distending, you should reposition the head and use cricoid pressure. In a patient with possible spinal injury, you should



**Figure 7-32** With two-person BVM device ventilation, you should hold the mask in place while your partner squeezes the bag with two hands until the patient's chest rises.



**Figure 7-33** Maintain the seal of the mask to the face using the C-clamp if you must ventilate alone.



**Figure 7-34** The Sellick maneuver will help prevent or alleviate gastric distention when artificial ventilations are being performed.

## EMT-B Tips

### Indications That Artificial Ventilation Is Adequate

Visible and equal chest rise and fall with ventilation  
 Ventilations delivered at the appropriate rate

- 10 to 12 breaths/min for adults\*
- 12 to 20 breaths/min for infants and children\*

Heart rate returns to normal range

### Indications That Artificial Ventilation Is Inadequate

Minimal or no chest rise and fall  
 Ventilations are delivered too fast or too slow for patient's age  
 Heart rate does not return to normal range

\*In apneic patients with a pulse.

reposition the jaw rather than the head (that is, use the jaw-thrust). If too much air is escaping from under the mask, reposition the mask for a better seal. If the patient's chest still does not rise and fall after you have made these corrections, check for an airway obstruction. If an obstruction is not present, you should attempt ventilations using an alternate method, such as the mouth-to-mask technique.

Advanced airway techniques are beneficial when a good seal is difficult to maintain, the patient has a cervical spine injury, or the patient's condition warrants. These techniques are described in Chapter 39, Advanced Airway Management.

The BVM device may also be used in conjunction with an endotracheal tube or with other airway advanced devices such as the esophageal-tracheal Combitube, the pharyngotracheal lumen airway, and the laryngeal mask airway.

## Flow-Restricted, Oxygen-Powered Ventilation Devices

Another method of providing artificial ventilation is with flow-restricted, oxygen-powered ventilation devices (Figure 7-35). These devices are widely available and have been used in EMS for several years. However, recent findings suggest that they should not be used routinely because of the high incidence of gastric distention and possible damage to structures within the chest cavity. Flow-restricted, oxygen-powered devices *should not* be used on infants and children or on

patients with COPD or suspected cervical spine or chest injuries. Cricoid pressure must be maintained whenever flow-restricted, oxygen-powered ventilation devices are used to ventilate a patient. This will help to reduce the amount of gastric distention, the most common and significant complication of the device.

## Components

Flow-restricted, oxygen-powered ventilation devices should have the following components:

- A peak flow rate of 100% oxygen at up to 40 L/min
- An inspiratory pressure safety release valve that opens at approximately 60 cm of water and vents any remaining volume to the atmosphere or stops the flow of oxygen
- An audible alarm that sounds whenever you exceed the relief valve pressure
- The ability to operate satisfactorily under normal and varying environmental conditions
- A trigger (or lever) positioned so that both your hands can remain on the mask to provide an airtight seal while supporting and tilting the patient's head and keeping the jaw elevated

Learning how to use these devices correctly requires proper training and considerable practice. As with BVM devices, you must make sure there is an effective seal between the patient's face and mask. The amount of pressure that is necessary to ventilate a patient adequately will vary according to the size of the patient,



**Figure 7-35** A flow-restricted, oxygen-powered ventilation device can provide up to 100% oxygen.

the patient's lung volume, and the condition of the lungs. A patient with COPD will need greater pressure to receive adequate volume than would be necessary for a patient with normal lungs. Pressures that are too great can cause a **pneumothorax**. Flow-restricted, oxygen-powered ventilation devices are not recommended for use on patients with COPD or suspected cervical spine or chest injuries or on infants and children. Always follow local medical protocols carefully when you use these devices.

## Special Considerations

### Gastric Distention

Gastric distention occurs when artificial ventilation fills the stomach with air. Although it most commonly affects children, it also affects adults. Gastric distention is most likely to occur when you ventilate the patient too forcefully or too often with a BVM or pocket mask device or when the airway is obstructed as a result of a foreign body or improper head position. For this reason, you should give slow, gentle breaths over 1 second when ventilating adults, children, and infants. Slight gastric distention is not of concern; however, severe distention is dangerous because it may cause vomiting and increase the risk of aspiration during CPR. Gastric distention can also significantly reduce the lung volume by elevating the diaphragm, especially in infants and children. Gastric distention is a common complication associated with the use of flow-restricted, oxygen-powered ventilation devices, a key reason why this device is not highly recommended.

If the patient's stomach becomes distended as a result of rescue breathing, you should recheck and reposition the airway, apply cricoid pressure, and watch for rise and fall of the chest wall as you perform rescue

breathing. Continue slow rescue breathing without attempting to expel the stomach contents. If adequate ventilation cannot be achieved because of gastric distention, immediately relieve the pressure in the stomach by applying pressure over the upper abdomen. Applying manual pressure over the patient's upper abdomen will likely result in vomiting; therefore, if vomiting occurs, turn the patient's entire body to the side, suction and/or wipe out the mouth with your gloved hand, and return the patient back to a supine position so that you can continue rescue breathing.

### Stomas and Tracheostomy Tubes

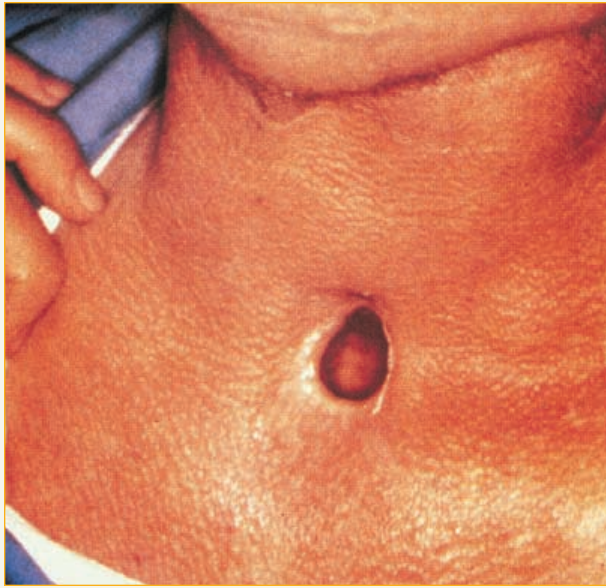
BVM device ventilation may also need to be used for patients who have had a laryngectomy (surgical removal of the larynx). These patients have a permanent tracheal stoma (an opening in the neck that connects the trachea directly to the skin) **Figure 7-36 ▶**. This type of stoma, known as a tracheostomy, is an opening at the center front and base of the neck. Many patients who have had a laryngectomy will have other openings in the neck, according to the type of operation performed. You should ignore any opening other than the midline tracheal stoma. The midline opening is the only one that can be used to put air into the patient's lungs.

Neither the head tilt–chin lift nor the jaw-thrust maneuver is required for ventilating a patient with a stoma. If the patient has a tracheostomy tube, you should ventilate through the tube with a BVM device (the standard 22/15 adapter on the BVM device will fit onto the tube in the tracheal stoma) and 100% oxygen attached directly to the BVM. If the patient has a stoma and no tube is in place, use an infant or child mask with your BVM device to make a seal over the stoma. Seal the patient's mouth and nose with one hand to prevent a leak of air through the upper airway when you ventilate through a stoma. Release the seal of the patient's mouth and nose for exhalation. This allows the air to exhale through the upper airway.

## You are the Provider

## Part 8

After approximately 2 minutes of assisted ventilation, the patient's cyanosis has resolved and his level of consciousness has improved. You continue BVM ventilations to maintain adequate tidal volume and rendezvous with the paramedics, who intubate the patient and assist you with transporting him to the hospital, where he is diagnosed with a stroke. Following a 2-day stay in the hospital, the patient was discharged to an extended-care facility for continued recovery.



**Figure 7-36** A tracheal stoma typically lies in the midline of the neck. The midline opening is the only one that can be used to deliver oxygen to the patient's lungs.

If you are unable to ventilate a patient who has a stoma, try suctioning the stoma and the mouth with a French or soft-tip catheter before giving the patient artificial ventilation through the mouth and nose. If you seal the stoma during mouth-to-mouth ventilation, the ability to ventilate the patient may be improved, or it may help to clear any obstructions.

## Foreign Body Airway Obstruction

A foreign body that *completely* blocks the airway in a patient is a true emergency that will result in death if not treated immediately. In an adult, sudden foreign body airway obstruction usually occurs during a meal. In a child, it occurs while eating, playing with small toys, or crawling around the house. An otherwise healthy child who has sudden difficulty breathing has probably aspirated a foreign object.

By far, the most common airway obstruction in an unconscious patient is the tongue, which relaxes and falls back into the throat. There are other causes of airway obstruction that do not involve foreign bodies in the airway. These include swelling (from infection or acute allergic reactions) and trauma (tissue damage from injury). With airway obstruction from medical conditions such as infection and acute allergic reactions, repeated

attempts to clear the airway as if there were a foreign body will be unsuccessful and potentially dangerous. These patients require specific emergency medical care for their condition; therefore, rapid transport to the hospital is critical.

### Recognition

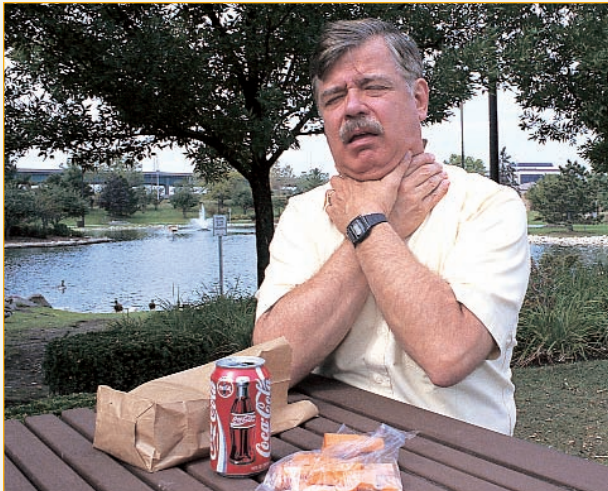
Early recognition of airway obstruction is crucial for the EMT-B to be able to provide emergency medical care effectively. Obstruction from a foreign body can result in a **mild airway obstruction** or a **severe airway obstruction**.

Patients with a mild airway obstruction (partially obstructed airway) are still able to exchange air but will have varying degrees of respiratory distress. Great care must be taken to prevent a mild airway obstruction from becoming a severe airway obstruction.

With a mild airway obstruction, the patient can cough forcefully, although you may hear wheezing in between coughs. As long as the patient can breathe, cough forcefully, or talk, you should not interfere with the patient's efforts to expel the foreign object on his or her own. Continue to monitor the patient closely and encourage the patient to continue coughing. Abdominal thrusts are not indicated for patients with a mild airway obstruction. Furthermore, attempts to remove the object manually could force the object farther down into the airway and cause a severe obstruction. Continually reassess the patient's condition and be prepared to provide immediate treatment if the mild obstruction becomes a severe obstruction.

Patients with a severe airway obstruction (completely obstructed airway) cannot breathe, talk, or cough. One sure sign of a severe obstruction is the sudden inability to speak or cough immediately after eating. The person may clutch or grasp his or her throat (universal distress signal), begin to turn cyanotic, and make frantic attempts to breathe (Figure 7-37 ▶). There is little or no air movement. Ask the conscious patient, "Are you choking?" If the patient nods "yes," provide immediate treatment. If the obstruction is not cleared quickly, the amount of oxygen in the patient's blood will decrease dramatically. If not treated, the patient will become unconscious and die.

Some patients with a severe airway obstruction will be unconscious during your initial assessment. You may not know that an airway obstruction is the cause of their condition. There are many other causes of unconsciousness and respiratory distress, including stroke, heart attack, trauma, seizures, and drug overdose. A complete and thorough patient assessment by you, therefore, is key in providing appropriate emergency medical care.



**Figure 7-37** The universal sign of choking is a person who grasps his or her throat and has difficulty breathing.



**Figure 7-38** Securing and maintaining the airway and ensuring adequate breathing are the first, most important steps in caring for an unconscious patient.

Any person found unconscious must be managed as if he or she has a compromised airway. You must first open the airway, assess breathing, and provide artificial breathing if the patient is not breathing or is breathing inadequately (Figure 7-38 ▶). If, after opening the airway, you are unable to ventilate the patient after two attempts (the chest does not visibly rise) or you feel resistance when ventilating, consider the possibility of an airway obstruction. Resistance to ventilation can also be due to poor lung compliance. **Compliance** is the ability of the alveoli to expand when air is drawn in during inhalation; poor lung compliance is the inability of the alveoli to expand fully during inhalation.

### Emergency Medical Care for Foreign Body Airway Obstruction

Perform the head tilt-chin lift maneuver to clear an obstruction that has been caused by the tongue and throat muscles relaxing back into the airway in any person

who is found unconscious, is not breathing, or is breathing inadequately, and is not suspected of having spinal trauma. If spinal trauma is suspected, you should open the airway with a jaw-thrust maneuver. Remember, if the jaw-thrust maneuver does not adequately open the patient's airway, *carefully* perform a head tilt-chin lift maneuver, even if spinal trauma is suspected; *the airway must remain patent*. Large pieces of vomited food, mucus, loose dentures, or blood clots in the mouth should be swept forward and out of the mouth with your gloved index finger if they are visible. *Do not perform blind finger sweeps in any patient*; this may force an obstructing object farther down into the airway. When available, suctioning should be used to maintain a clear airway.

The Heimlich maneuver (abdominal thrusts) is the most effective method of dislodging and forcing an object out of the airway of a conscious adult or child. Residual air, which is always present in the lungs, is compressed upward and used to expel the object. Perform the Heimlich maneuver in the conscious adult or child with a severe airway obstruction until the object is expelled or the patient loses consciousness.

If the patient becomes unconscious, place him or her in a supine position on the ground and open the airway. Look in the mouth, remove any objects that are visible, and attempt to ventilate the patient. If your initial attempt to ventilate the patient does not produce visible chest rise, reposition the patient's head and reattempt to ventilate. If both breaths do not produce visible chest rise, perform chest compressions. If you are unable to relieve the obstruction with your initial attempts,

### EMT-B Tips

#### Possible Causes of Airway Obstruction

- Relaxation of the tongue in an unconscious patient
- Aspirated vomitus (stomach contents)
- Foreign objects—food, small toys, dentures
- Blood clots, bone fragments, or damaged tissue after an injury
- Airway tissue swelling—infection, allergic reaction

begin rapid transport and continue your efforts at relief of the obstruction with chest compressions, opening the airway and looking in the mouth, and attempts to ventilate en route to the hospital.

Patients with a mild airway obstruction who are exchanging adequate amounts of air should be monitored closely for signs of deterioration of their condition (ineffective cough, decreased level of consciousness, cyanosis). If the patient is unable to clear the obstruction and remains conscious with an effective cough, allow the patient to assume a position that is most comfortable for him or her. Provide supplemental oxygen and transport to the hospital.

### Dental Appliances

Many dental appliances can cause an airway obstruction. If a dental appliance, such as a crown or bridge, dentures, or even a piece or section of braces, has become loose, you should manually remove it before providing ventilations. Simple manual removal may relieve the obstruction and allow the patient to breathe on his or her own.

Providing BVM device or mouth-to-mask ventilation is usually much easier when dentures can be left in place. Leaving the dentures in place provides more “structure” to the face and will generally assist you in being able to provide a good face-to-mask seal, thus delivering adequate tidal volume. However, loose dentures make it much more difficult to perform artificial ventilation by any method and can easily obstruct the airway. Therefore, dentures and dental appliances that

do not stay firmly in place should be removed. Dentures and appliances may become loose or be completely out of place following an accident or as you are providing care. Periodically reassess the patient’s airway to make sure the devices are firmly in place.

### Facial Bleeding

Airway problems can be especially challenging in patients with serious facial injuries (Figure 7-39). Because the blood supply in the face is so rich, injuries to the face can result in severe tissue swelling and bleeding into the airway. Control bleeding with direct pressure and suction as necessary. Facial injuries are discussed in detail in Chapter 26.



**Figure 7-39** Airway problems can be especially challenging in patients with serious facial injuries.

## You are the Provider

## Summary

Many factors contribute to respiratory problems. Some are as simple as seasonal allergies and allergic reactions. Other factors are more complex, such as trauma, stroke, or an industrial exposure. Oftentimes the situation may be different on scene from what dispatch has reported. Keeping an open mind to all possibilities will help you prepare better. Few situations will require more equipment than a serious problem with an airway or breathing. Inspect your equipment often so you are prepared to use it when needed.

Many hazards may exist on a call. In particular, you should be cautious of unusual odors and the involvement of multiple people. Information from individuals on scene can help you to remain safe and understand the situation better. The assessment and treatment of airway and breathing problems always begin with securing an adequate airway. When treatment is provided, careful reevaluation of the patient is needed to ensure the treatment has been effective. You should be able to decide what is effective and what is not. In most situations, patients should receive oxygen even if it does not seem necessary.

# Prep Kit

## Ready for Review

- The term “airway” usually means the upper airway, which includes the respiratory structures above the vocal cords. Clearing the airway means removing obstructing material; maintaining the airway means keeping it open.
- Adequate breathing for an adult features a normal rate of 12 to 20 breaths/min, a regular pattern of inhalation and exhalation, adequate depth, bilaterally clear and equal lung sounds, and regular and equal chest rise and fall.
- Inadequate breathing for an adult features a respiratory rate of fewer than 12 breaths/min or more than 20 breaths/min, shallow depth (reduced tidal volume), an irregular pattern of inhalation and exhalation, and breath sounds that are diminished, absent, or noisy.
- Patients who are breathing inadequately show signs of hypoxia, a dangerous condition in which the body’s tissues and cells do not have enough oxygen.
- Patients with inadequate breathing need to be treated immediately. Emergency medical care includes airway management, supplemental oxygen, and ventilatory support.
- Basic techniques for opening the airway include the head tilt–chin lift maneuver or, if trauma is suspected, the jaw-thrust maneuver.
- One basic airway adjunct is the oropharyngeal or oral airway, which keeps the tongue from blocking the airway in unconscious patients with no gag reflex. If the oral airway is not the proper size or is inserted incorrectly, it can actually cause an obstruction.
- Another basic airway adjunct is the nasopharyngeal or nasal airway, which is usually used with patients who have a gag reflex and is better tolerated than the oral airway.
- Suctioning is the next priority after opening the airway. Rigid tonsil-tip catheters are the best catheters to use when suctioning the pharynx; soft plastic catheters are used to suction the nose and liquid secretions in the back of the mouth.
- The recovery position is used to help maintain the airway in patients without traumatic injuries who are unconscious and breathing adequately.
- You must provide immediate artificial ventilations with supplemental oxygen to patients who are not breathing on their own. Patients with inadequate breathing may also require artificial ventilations to maintain effective tidal volume.
- Handle compressed gas cylinders carefully; their contents are under pressure. Always make sure the correct pressure regulator is firmly attached before transporting a cylinder. The pin-indexing safety system features a series of pins on a yoke that must be matched with the holes on the valve stem of the gas cylinder. Pressure regulators reduce the pressure of gas in an oxygen cylinder to between 40 and 70 psi. Pressure-compensated flowmeters and Bourdon-gauge flowmeters permit the regulated release of gas measured in liters per minute.
- When oxygen therapy is complete, disconnect the tubing from the flowmeter nipple and turn off the cylinder valve, then turn off the flowmeter. As long as there is a pressure reading on the regulator gauge, it is not safe to remove the regulator from the valve stem. Keep any possible source of fire away from the area while oxygen is in use.
- Nasal cannulas and nonbreathing masks are used most often to deliver oxygen in the field. The nonbreathing mask is the delivery device of choice for providing supplemental oxygen to patients who are breathing adequately but are suspected of having or are showing signs of hypoxia. With a flow rate set at 15 L/min and the reservoir bag preinflated, the nonbreathing mask can provide more than 90% inspired oxygen. If the patient will not tolerate a nonbreathing mask, apply a nasal cannula.

## Technology

Interactivities

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Online Review Manual

- The methods of providing artificial ventilation include mouth-to-mask ventilation, two-person BVM ventilation, flow-restricted, oxygen-powered ventilation device, and one-person BVM ventilation. The flow-restricted, oxygen-powered ventilation device is not a recommended ventilation device by most standards. Combined with your own exhaled breath, mouth-to-mask ventilation will give your patient up to 55% oxygen; a BVM device with an oxygen reservoir and supplemental oxygen can deliver nearly 100% oxygen.
- When you are providing artificial ventilation, remember that ventilating too forcefully can cause gastric distention. Slow, gentle breaths during artificial ventilation and the use of cricoid pressure can help to prevent gastric distention. Patients who have a tracheal stoma or a tracheostomy tube need to be ventilated through the tube or the stoma.
- Foreign body airway obstruction usually occurs during a meal in an adult or while a child is eating, playing with small objects, or crawling about the house. The earlier you recognize an airway obstruction, the better. You must learn to recognize the difference between airway obstruction caused by a foreign object and that caused by a medical condition.
- Foreign body airway obstructions are classified as being mild or severe. Patients with a mild airway obstruction are able to move adequate amounts of air and should be left alone. Patients with a severe airway obstruction cannot move any air at all and require immediate treatment. Perform the Heimlich maneuver on conscious adults and children with a severe airway obstruction. If the patient becomes unconscious, open the airway and look in the mouth (do not perform blind finger sweeps), attempt to ventilate the patient, and perform chest compressions if ventilations are unsuccessful.
- Check for loose dental appliances in a patient before assisting ventilations. Loose appliances should be removed to prevent them from obstructing the airway. Tight-fitting appliances should be left in place.

## Vital Vocabulary

**agonal respirations** Occasional, gasping breaths that occur after the heart has stopped.

**airway** The upper airway tract or the passage above the larynx, which includes the nose, mouth, and throat.

**American Standard System** A safety system for oxygen cylinders, designed to prevent the accidental attachment of a regulator to a cylinder containing the wrong type of gas.

**apnea** A period of not breathing.

**aspiration** The introduction of vomitus or other foreign material into the lungs.

**ataxic respirations** Irregular, ineffective respirations that may or may not have an identifiable pattern.

**bag-valve-mask (BVM) device** A device with a one-way valve and a face mask attached to a ventilation bag; when attached to a reservoir and connected to oxygen, delivers more than 90% supplemental oxygen.

**barrier device** A protective item, such as a pocket mask with a valve, that limits exposure to a patient's body fluids.

**bilateral** A body part or condition that appears on both sides of the midline.

**compliance** The ability of the alveoli to expand when air is drawn in during inhalation.

**cricoid pressure** Pressure on the cricoid cartilage; applied to occlude the esophagus in order to inhibit gastric distention and regurgitation of vomitus in the unconscious patient.

**diffusion** A process in which molecules move from an area of higher concentration to an area of lower concentration.

**dyspnea** Difficulty breathing.

**exhalation** The passive part of the breathing process in which the diaphragm and the intercostal muscles relax, forcing air out of the lungs.

**gag reflex** A normal reflex mechanism that causes retching; activated by touching the soft palate or the back of the throat.

**gastric distention** A condition in which air fills the stomach, often as a result of high volume and pressure during artificial ventilation.

**head tilt-chin lift maneuver** A combination of two movements to open the airway by tilting the forehead back and lifting the chin; not used for trauma patients.

**hypoxia** A dangerous condition in which the body tissues and cells do not have enough oxygen.

**hypoxic drive** A condition in which chronically low levels of oxygen in the blood stimulate the respiratory drive; seen in patients with chronic lung diseases.

# Prep Kit continued...

**inhalation** The active, muscular part of breathing that draws air into the airway and lungs.

**ischemia** A lack of oxygen that deprives tissues of necessary nutrients.

**jaw-thrust maneuver** Technique to open the airway by placing the fingers behind the angle of the jaw and bringing the jaw forward; used for patients who may have a cervical spine injury.

**labored breathing** Breathing that requires greater than normal effort; may be slower or faster than normal and usually requires the use of accessory muscles.

**metabolism** The biochemical processes that result in production of energy from nutrients within the cells.

**mild airway obstruction** Occurs when a foreign body partially obstructs the patient's airway. The patient is able to move adequate amounts of air, but also experiences some degree of respiratory distress.

**minute volume** The volume of air moved through the lungs in 1 minute; calculated by multiplying tidal volume and respiratory rate.

**nasal cannula** An oxygen-delivery device in which oxygen flows through two small, tubelike prongs that fit into the patient's nostrils; delivers 24% to 44% supplemental oxygen, depending on the flow rate.

**nasopharyngeal (nasal) airway** Airway adjunct inserted into the nostril of a conscious patient who is unable to maintain airway patency independently.

**nonbreathing mask** A combination mask and reservoir bag system that is the preferred way to give oxygen in the prehospital setting; delivers up to 90% inspired oxygen and prevents inhaling the exhaled gases (carbon dioxide).

**oropharyngeal (oral) airway** Airway adjunct inserted into the mouth to keep the tongue from blocking the upper airway and to facilitate suctioning the airway.

**patent** Open, clear of obstruction.

**pin-indexing system** A system established for portable cylinders to ensure that a regulator is not connected to a cylinder containing the wrong type of gas.

**pneumothorax** A partial or complete accumulation of air in the pleural space.

**recovery position** A side-lying position used to maintain a clear airway in unconscious patients without injuries who are breathing adequately.

**retractions** Movements in which the skin pulls in around the ribs during inspiration.

**Sellick maneuver** A technique that is used to prevent gastric distention in which pressure is applied to the cricoid cartilage; also referred to as cricoid pressure.

**severe airway obstruction** Occurs when a foreign body completely obstructs the patient's airway. Patients cannot breathe, talk, or cough.

**stoma** An opening through the skin and into an organ or other structure; a stoma in the neck connects the trachea directly to the skin.

**suction catheter** A hollow, cylindrical device used to remove fluid from the patient's airway.

**tidal volume** The amount of air moved in or out of the lungs during one breath.

**tonsil tips** Large, semirigid suction tips recommended for suctioning the pharynx; also called Yankauer tips.

**ventilation** Exchange of air between the lungs and the environment, spontaneously by the patient or with assistance from another person, such as an EMT-B.

## Points to Ponder

You are dispatched to the local nursing home for an older man who "is difficult to wake." You arrive at the nursing home about 5 minutes after the initial call and find the patient to be lying supine in bed with oxygen flowing at 2 L/min via nasal cannula. The nurse states that the patient was fine last evening but they were unable to wake him this morning. They state he has a history of COPD and recent pneumonia. The patient has shallow gurgling respirations at a rate of about 8 breaths/min. You also note cyanosis around the lips. While you are assembling your suction unit, your partner is placing the patient on a pulse oximeter.

Why should this patient be placed on a pulse oximeter? Why is suctioning necessary for this patient? How would you manage this patient's airway and breathing? Would you change the position of the patient?

**Issues:** Oxygenation, Cricoid Pressure, Potential Elder Abuse.

# Assessment in Action

**You arrive on the scene of a cardiac arrest and find that bystanders have initiated CPR.** You take over the care of the patient, and your assessment reveals a 50-year-old man who is apneic.

- The bystanders report that the patient was not breathing for about 3 minutes before they started CPR. What does this time frame indicate about the patient's condition?
  - Cardiac irritability
  - Brain damage not likely
  - Brain damage possible
  - Brain damage very likely
- Upon your assessment you find the patient has occasional, gasping breaths. This condition is called:
  - Cheyne-Stokes respirations.
  - Retractions.
  - agonal respirations.
  - Kussmaul's respirations.
- You decide to open the patient's airway. You have no history of events leading up to the point of cardiac arrest. What is the preferred method of opening the airway?
  - Head tilt-chin lift
  - Jaw thrust
  - Nasal airway
  - None of the above
- You start ventilating the patient with a BVM device. What is important to remember during ventilation?
  - Squeeze the bag slowly; do not force air
  - Provide a good seal with mask
  - Be aware of the rate at which you are ventilating the patient
  - All of the above
- Approximately how much oxygen was being delivered to the patient using CPR?
  - 21%
  - 16%
  - 40%
  - 0%
- The initial CPR has caused some gastric distention and you are worried about possible aspiration. What is the best method to protect the patient's airway?
  - Cricoid pressure
  - Sellick maneuver
  - Recovery position
  - A and B only
- You decide to place an oral airway. How do you measure the size of the airway?
  - From the patient's earlobe to the corner of the mouth
  - From the patient's nose to the angle of the jaw
  - From the corner of the mouth to the angle of the jaw
  - From the corner of the mouth to the tip of the tongue
- You notice a buildup of fluid in the patient's airway and decide to suction the fluid. Which of the following is NOT correct when providing suctioning on an adult patient?
  - Suction as you withdraw the catheter
  - Insert the tip to the base of the tongue
  - Do not suction for more than 15 seconds
  - Repeat immediately after initial suctioning if needed

## Challenging Questions

- What are some indications that artificial ventilation is inadequate?
- You are ventilating a trauma patient with a BVM device and ventilation is becoming more and more ineffective. What are possible causes of this?
- You have a D cylinder with 1,500 psi. You have a patient who needs 15 L/min. How long will your tank last?