

# Chapter 9

## Airway Management

### Unit Summary

After students complete this chapter and the related course work, they will understand the need for proper airway management, including recognizing and measuring adequate and inadequate breathing, maintaining an open airway, and providing artificial ventilation. Students will be able to demonstrate basic competency in applying these concepts to appropriate care through the use of airway adjuncts, suction equipment, oxygen equipment and delivery systems, pulse oximetry, CPAP, and resuscitation devices.

### National EMS Education Standard Competencies

#### **Airway Management, Respiration, and Artificial Ventilation**

Applies knowledge of general anatomy and physiology to patient assessment and management in order to assure a patent airway, adequate mechanical ventilation, and respiration for patients of all ages.

#### ***Airway Management***

ÉAirway anatomy (pp 3196323)

ÉAirway assessment (pp 3316335)

ÉTechniques of assuring a patent airway (pp 3356336)

#### ***Respiration***

ÉAnatomy of the respiratory system (pp 3316335)

ÉPhysiology and pathophysiology of respiration

- Pulmonary ventilation (pp 3246327)
- Oxygenation (p 327)
- Respiration (pp 3276328)
  - External (pp 3276328)
  - Internal (p 328)
  - Cellular (p 328)

ÉAssessment and management of adequate and inadequate respiration (pp 3336335)

ÉSupplemental oxygen therapy (pp 3466353)

#### ***Artificial Ventilation***

ÉAssessment and management of adequate and inadequate ventilation (pp 3536361)

ÉArtificial ventilation (pp 3546361)

ÉMinute ventilation (pp 3256326)

ÉAlveolar ventilation (p 325)

ÉEffect of artificial ventilation on cardiac output (p 355)

#### **Pathophysiology**

Applies fundamental knowledge of the pathophysiology of respiration and perfusion to patient assessment and management.

## Knowledge Objectives

1. Describe the major structures of the respiratory system. (pp 3196323)
2. Discuss the physiology of breathing. (pp 3236328)
3. Give the signs of adequate breathing. (p 331)
4. Give the signs of inadequate breathing. (pp 3316333)
5. Describe the assessment and care of a patient with apnea. (pp 333, 3616364)
6. Understand how to assess for adequate and inadequate respiration, including the use of pulse oximetry. (pp 3336335)
7. Understand how to assess for a patent airway. (pp 3356336)
8. Describe how to perform the head tilt/chin lift maneuver. (p 337)
9. Describe how to perform the jaw-thrust maneuver. (pp 3376338)
10. Explain how to measure and insert an oropharyngeal (oral) airway. (pp 3386340)
11. Describe how to measure and insert a nasopharyngeal (nasal) airway. (pp 3406342)
12. Understand the importance and techniques of suctioning. (pp 3436345)
13. Explain the use of the recovery position to maintain a clear airway. (p 346)
14. Describe the importance of giving supplemental oxygen to patients who are hypoxic. (p 346)
15. Understand the basics of how oxygen is stored and the various hazards associated with its use. (pp 3466351)
16. Describe the use of a nonrebreathing mask, and state the oxygen flow requirements for its use. (pp 3516352)
17. Understand the indications for using a nasal cannula rather than a nonrebreathing face mask. (p 352)
18. Describe the indications for use of a humidifier during supplemental oxygen therapy. (p 353)
19. Explain the steps to take to perform mouth-to-mouth or mouth-to-mask ventilation. (pp 3556357)
20. Describe the use of a one-, two-, or three-person bag-mask device, and a manually triggered ventilation (MTV) device. (pp 3566361)
21. Describe the signs associated with adequate and inadequate artificial ventilation. (p 360)
22. Describe the use of continuous positive airway pressure (CPAP). (pp 3616364)
23. Understand how to recognize and care for a foreign body airway obstruction. (pp 3666368)

## Skills Objectives

1. Demonstrate use of pulse oximetry. (pp 3346335, Skill Drill 9-1)
2. Demonstrate how to position the unconscious patient. (pp 3356336, Skill Drill 9-2)
3. Demonstrate the steps in performing the head tilt/chin lift maneuver. (p 337)
4. Demonstrate the steps in performing the jaw-thrust maneuver. (pp 3376338)

5. Demonstrate the insertion of an oral airway. (pp 339-340, Skill Drill 9-3)
6. Demonstrate the insertion of an oral airway with a 90° rotation. (pp 340-341, Skill Drill 9-4)
7. Demonstrate the insertion of a nasal airway. (pp 341-342, Skill Drill 9-5)
8. Demonstrate how to operate a suction unit. (p 344)
9. Demonstrate how to suction a patient's airway. (pp 344-345, Skill Drill 9-6)
10. Demonstrate how to place a patient in the recovery position. (p 346)
11. Demonstrate how to place an oxygen cylinder into service. (pp 349-350, Skill Drill 9-7)
12. Demonstrate the use of a partial rebreathing mask in providing supplemental oxygen therapy to patients. (p 352)
13. Demonstrate the use of a Venturi mask in providing supplemental oxygen therapy to patients. (pp 352-353)
14. Demonstrate the use of a humidifier in providing supplemental oxygen therapy to patients. (p 353)
15. Demonstrate how to assist a patient with ventilations using the bag-mask device for one and two rescuers. (p 354)
16. Demonstrate mouth-to-mask ventilation. (pp 356-357, Skill Drill 9-8)
17. Demonstrate the use of a manually triggered ventilation device to assist in delivering artificial ventilation to the patient. (pp 360-361)
18. Demonstrate the use of an automatic transport ventilator to assist in delivering artificial ventilation to the patient. (p 361)
19. Demonstrate the use of CPAP. (pp 363-364, Skill Drill 9-9)

## Lecture

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### I. Introduction

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#### **A. When the ability to breathe is disrupted, oxygen delivery to tissues and cells is compromised.**

1. Cells require a constant supply of oxygen to survive.
2. Within seconds of being deprived of oxygen, vital organs such as the heart and the brain may not function normally.
  - a. Brain tissue will begin to die within 4 to 6 minutes.

#### **B. Oxygen reaches body tissues and cells through two separate, but related, processes: breathing and circulation.**

1. During inhalation, oxygen moves from the atmosphere into the lungs.
2. Oxygen then passes from the air sacs in the lungs into the capillaries to oxygenate the blood.
3. Through diffusion, carbon dioxide produced by the body's cells moves from the blood into the air sacs.
4. Oxygen-enriched blood is pumped through the body by the heart.
5. Carbon dioxide leaves the body during exhalation.

**C. As an EMT, you must be able to locate the parts of the respiratory system, understand how the system works, and recognize which patients are breathing adequately and which are not.**

## II. Anatomy of the Respiratory System

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**A. The respiratory system consists of all the structures that make up airway and help us breathe and ventilate.**

**B. The airway is divided into the upper and lower airway.**

**C. Structures that help us breathe include:**

1. Diaphragm
2. Chest wall muscles
3. Accessory muscles of breathing
4. Nerves from the brain and spinal cord to those muscles

**D. Ventilation is the exchange of air between the lungs and the environment.**

**E. Anatomy of the upper airway**

1. The upper airway consists of all anatomic airway structures above the vocal cords. This includes:
  - a. Nose
  - b. Mouth
  - c. Jaw
  - d. Oral cavity
  - e. Pharynx
  - f. Larynx
2. The main function of the upper airway is to warm, filter, and humidify air as it enters the body.
3. Pharynx
  - a. Muscular tube extending from nose and mouth to the level of esophagus and trachea
  - b. Composed, from top to bottom, of the nasopharynx, oropharynx, and laryngopharynx
4. Nasopharynx
  - a. Formed by union of facial bones
  - b. Lined with ciliated mucous membrane that filters out dust and small particles
  - c. Warms and humidifies air as it enters the body
5. Oropharynx
  - a. Posterior portion of the oral cavity
  - b. Lips and mouth form the entrance to oral cavity
    - i. Entrance for respiratory and digestive system
  - c. Superior to the larynx is the epiglottis.
    - i. Helps prevent food and liquid from entering the larynx during swallowing
6. Larynx
  - a. Complex structure formed by many independent cartilaginous structures
  - b. Marks where upper airway ends and lower airway begins
  - c. Thyroid cartilage forms a "V" shape anteriorly - the Adam's apple.

- d. Cricoid cartilage (or cricoid ring) forms lowest portion of larynx.
- e. Glottis is the area between the vocal cords.
  - i. Narrowest part of an adult's airway
- f. Vocal cords are white bands of thin muscle tissue.
  - i. Partially separated at rest
  - ii. Produce speech
  - iii. Protect trachea from the entry of substances like water and vomitus

## **F. Anatomy of the lower airway**

1. The function of the lower airway is to exchange oxygen and carbon dioxide.
2. The lower airway includes:
  - a. Trachea (windpipe)
    - i. This is the conduit for air entry into the lungs.
    - ii. Begins directly below the cricoid cartilage
    - iii. Descends anteriorly down the midline of the neck into the thoracic cavity
  - b. In the thoracic cavity, the trachea divides at the carina into two main stem bronchi, right and left.
    - i. The bronchi are supported by cartilage.
    - ii. They distribute oxygen to the two lungs.
      - (a) Lung tissue is covered with the visceral pleura, a slippery outer membrane.
      - (b) The parietal pleura line the inside of the thoracic cavity.
    - iii. On entering the lungs, each bronchus divides into ever-smaller bronchi, which divide into bronchioles.
    - iv. Bronchioles are made of smooth muscle; they dilate and constrict as oxygen passes through them.
    - v. Smaller bronchioles connect to alveoli.
      - (a) This is where oxygen and carbon dioxide are exchanged.
      - (b) Alveoli are millions of thin-walled, balloon-like sacs.
      - (c) Alveoli are surrounded by blood vessels (pulmonary capillaries).
      - (d) Oxygen is diffused across the alveolar membrane into pulmonary capillaries.
    - vi. Oxygen in pulmonary capillaries is transported back to the heart and distributed to the rest of the body.
    - vii. Carbon dioxide (waste) diffuses from the pulmonary capillaries into the alveoli where it is exhaled and removed from the body.
3. Also contained in the thoracic cavity, and important for respiration, are the heart and great vessels (the vena cava and aorta).
  - a. The mediastinum is the area between the lungs. It contains:
    - i. Heart
    - ii. Great vessels
    - iii. Esophagus
    - iv. Trachea
    - v. Major bronchi
    - vi. Many nerves
  - b. The phrenic nerve is also found in the thorax.
    - i. Important structure of the nervous system
    - ii. It allows the diaphragm to contract, which is necessary for breathing to occur.

## **III. Physiology of Breathing**

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### **A. The respiratory and cardiovascular systems work together.**

1. Ensure that a constant supply of oxygen and nutrients are delivered to all of the cells of the body
2. Remove carbon dioxide and waste products from the cells

**B. The processes involved are ventilation, oxygenation, and respiration.**

**C. Ventilation**

1. The physical act of moving air into and out of the lungs. It is necessary for oxygenation and respiration to occur.
2. Inhalation
  - a. The active, muscular part of breathing
  - b. Diaphragm and intercostal muscles contract during inhalation.
  - c. Diaphragm acts as a voluntary and involuntary muscle.
    - i. Voluntary actions (actions that are under our control): taking a deep breath, coughing, or holding your breath
    - ii. Involuntary actions (automatic function): constant breathing
  - d. Lungs require the movement of the chest and supporting structures to expand and contract during inhalation and exhalation.
  - e. Partial pressure is the amount of gas in air or dissolved in fluid, such as blood.
    - i. Measured in millimeters of mercury (mm Hg)
    - ii. The amount of gas in the oxygen (partial pressure) that resides in the alveoli is 104 mm Hg.
    - iii. Carbon dioxide enters alveoli from the blood and causes a carbon dioxide partial pressure of 40 mm Hg.
    - iv. Oxygenated arterial blood from the heart has a partial pressure of oxygen that is lower than the partial pressure of carbon dioxide in the pulmonary capillaries.
    - v. The body attempts to equalize the partial pressure, which results in oxygen diffusion across the membrane into the blood.
    - vi. Oxygen and carbon dioxide both diffuse until partial pressure in the air and blood is equal.
  - f. Inspiration is focused on delivering oxygen to alveoli.
    - i. Not all inspired air reaches the alveoli for gas exchange.
  - g. Tidal volume is a measure of depth of breathing.
    - i. It is the amount of air in milliliters that is moved into or out of the lungs during a single breath.
    - ii. Average tidal volume is 500 mL.
  - h. Dead space is the portion of tidal volume that does not reach the alveoli and does not participate in gas exchange.
  - i. Minute ventilation (minute volume) is the amount of air moved through the lungs in 1 minute minus the dead space.
  - j. Vital capacity is the amount of air that can be forcibly expelled from the lungs after breathing deeply.
  - k. Residual volume refers to air that remains after maximal expiration.
3. Exhalation
  - a. Unlike inhalation, exhalation does not normally require muscular effort. It is a passive process.
  - b. The diaphragm and the intercostal muscles relax. This decreases the thorax in size.
  - c. The smaller thorax compresses air in the lungs into a smaller space.
    - i. The air pressure in the thorax is then higher than the outside pressure.
    - ii. Air is then pushed out through the trachea.
  - d. Air can enter and leave the lungs only if it travels through the trachea.
    - i. This is why clearing and maintaining a patent airway is so important.

4. Regulation of ventilation is primarily by the pH of cerebrospinal fluid, which is directly related to the amount of carbon dioxide dissolved in the plasma portion of the blood.
  - a. The body's need for oxygen is constantly changing.
  - b. Failure to meet the need may result in hypoxia, an extremely dangerous condition.
    - i. The tissues and cells do not get enough oxygen.
    - ii. If not corrected, patients may die quickly.
  - c. For most people, the drive to breathe is based on pH changes in the blood and cerebrospinal fluid.
    - i. Patients with chronic obstructive pulmonary disease (COPD) have difficulty eliminating carbon dioxide through exhalation.
    - ii. Thus, they always have higher levels of carbon dioxide.
    - iii. This potentially alters their drive for breathing.
    - iv. Respiratory centers in the brain gradually accommodate to high levels of carbon dioxide.
    - v. In COPD patients, the body uses a "backup system" known as the hypoxic drive to control breathing.
  - d. Caution should be taken when administering high concentrations of oxygen to patients with obstructive pulmonary disease.
    - i. However, you must remember that high concentrations of oxygen should never be withheld from any patient who needs it.
    - ii. Patients with severe respiratory and/or circulator compromise should receive high concentrations of oxygen regardless of their underlying medical conditions.
  - e. Early signs of hypoxia:
    - i. Restlessness
    - ii. Irritability
    - iii. Apprehension
    - iv. Tachycardia
    - v. Anxiety
  - f. Late signs of hypoxia:
    - i. Mental status changes
    - ii. Weak (thready) pulse
    - iii. Cyanosis
    - iv. Conscious patients will complain of dyspnea, or shortness of breath.
  - g. The best time to give a patient oxygen is before signs and symptoms of hypoxia appear.

#### **D. Oxygenation**

1. The process of loading oxygen molecules onto hemoglobin molecules in the bloodstream
2. Required in order for internal respiration to take place
  - a. Oxygenation does not guarantee, however, that internal respiration is taking place. For example, oxygen levels in the breathing air may be low, as in a mine or confined space.

#### **E. Respiration**

1. The actual exchange of oxygen and carbon dioxide in the alveoli and in tissues of the body
2. Cells take energy from nutrients through a series of chemical processes.
3. Metabolism, or cellular respiration, is the name given to these processes.
  - a. Each cell combines nutrients and oxygen, producing energy and waste products (mainly water and carbon dioxide).
4. External respiration (pulmonary respiration)

- a. Breathes fresh air into the respiratory system
  - b. Exchanges oxygen and carbon dioxide between the alveoli and blood in the pulmonary capillaries
    - i. Surfactant keeps alveoli expanded, making it easier for gas exchange.
5. Internal respiration
- a. Exchange of oxygen and carbon dioxide between the systemic circulatory system and the cells of the body.
  - b. Oxygen passes from blood in capillaries to tissue cells.
  - c. Carbon dioxide and cell waste travel in the other direction, from the cells through capillaries and into the veins.
  - d. All cells need a constant supply of oxygen to survive.
  - e. Time is critical! Without oxygen:
    - i. 0 to 1 minute, cardiac irritability occurs
    - ii. 0 to 4 minutes, brain damage is not likely
    - iii. 4 to 6 minutes, brain damage is possible
    - iv. 6 to 10 minutes, brain damage is very likely
    - v. Over 10 minutes, irreversible brain damage occurs
  - f. When there is enough oxygen, cells convert glucose into energy through aerobic metabolism.
    - i. Adenosine triphosphate (ATP) is produced through processes known as the Krebs cycle and oxidative phosphorylation.
  - g. Without adequate oxygen, anaerobic metabolism takes place, which is less efficient than aerobic metabolism.

## IV. Pathophysiology of Respiration

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### A. Factors in the nervous system

1. Chemoreceptors monitor levels of oxygen, carbon dioxide, hydrogen ions, and the pH of cerebrospinal fluid and provide feedback to the respiratory centers.

### B. Ventilation/perfusion ratio and mismatch.

1. Air and blood flow are meant to be directed to the same place at the same time.
2. This means that ventilation and perfusion must be matched.
3. A failure to match ventilation and perfusion is the cause of most abnormalities of oxygen and carbon dioxide exchange.
  - a. This is called V/Q ratio mismatch.
4. Normal resting minute ventilation is about 6 L/min.
  - a. One third of this volume fills dead space; therefore, resting alveolar ventilation is about 4 L/min.
5. Pulmonary artery blood flow is approximately 5 L/min.
6. This gives a ventilation to perfusion ratio of 4/5 L/min or 0.8 L/min.
7. When ventilation is compromised but perfusion continues, less oxygen goes into the blood, and less carbon dioxide is removed.

### C. Factors affecting pulmonary ventilation

1. Maintaining a patent airway is critical.
2. Intrinsic factors that can cause airway obstruction:



- a. Infections
- b. Allergic reactions
- c. Unresponsiveness (eg, tongue obstruction)
3. Extrinsic factors that can cause airway obstruction:
  - a. Trauma
  - b. Foreign body airway obstruction

#### **D. Factors affecting respiration**

1. External factors such as decreased atmospheric pressure at high altitudes
2. Internal factors such as pneumonia or COPD, which reduce the surface area for gas exchange

#### **E. Circulatory compromise**

1. Trauma emergencies typically obstruct blood flow to individual cells and tissue.
2. These conditions include:
  - a. Pulmonary embolism
  - b. Tension pneumothorax
  - c. Open pneumothorax (sucking chest wound)
  - d. Hemothorax
  - e. Hemopneumothorax
3. Other causes of circulatory compromise include:
  - a. Blood loss
  - b. Anemia
  - c. Hypovolemic shock—abnormal decrease in blood volume
  - d. Vasodilatory shock—abnormal increase in blood vessel diameter, decreasing blood pressure
4. Any patient suspected of being in shock should be treated aggressively to prevent further interruptions to tissue perfusion.

## **V. Patient Assessment**

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#### **A. Recognizing adequate breathing**

1. Unless you are directly assessing a patient's airway, you should not be able to see or hear the patient breathe.
2. Signs of normal breathing for adults are:
  - a. Between 12 and 20 breaths/min
  - b. Regular pattern of inhalation and exhalation
  - c. Bilateral clear and equal lung sounds
  - d. Regular, equal chest rise and fall
  - e. Adequate depth (tidal volume)

#### **B. Recognizing abnormal breathing**

1. An awake, alert adult who is talking to you usually has no immediate airway or breathing problems.
2. Always have supplemental oxygen and a bag-mask device or pocket mask close at hand to assist with breathing if this becomes necessary.

### 3. Signs of abnormal breathing:

- a. Fewer than 12 breaths/min
  - b. More than 20 breaths/min
  - c. Irregular rhythm
  - d. Diminished, absent, or noisy auscultated breath sounds
  - e. Reduced flow of expired air at nose and mouth
  - f. Unequal or inadequate chest expansion
  - g. Increased effort of breathing use of accessory muscles
  - h. Shallow depth
  - i. Skin that is pale, cyanotic (blue), cool, or moist (clammy)
  - j. Skin pulling in around ribs or above clavicles during inspiration (called retractions)
4. A patient may appear to be breathing after the heart has stopped.
    - a. These occasional, gasping breaths are called agonal respirations.
  5. Cheyne-Stokes respirations are often seen in stroke and head injury patients.
    - a. Breathing with increasing rate and depth of respirations followed by apnea (spontaneous breathing).
  6. Ataxic respirations have an irregular or unidentifiable pattern and may follow serious head injuries.
  7. Kussmaul respirations are deep, gasping respirations associated with metabolic or toxic disorders.
  8. Patients with inadequate breathing need to be treated immediately.
    - a. Airway management
    - b. Supplemental oxygen
    - c. Ventilatory support

## C. Assessment of respiration

1. Respiration is the actual exchange of oxygen and carbon dioxide at the tissue level.
2. Even though the patient may be ventilating appropriately, respiration may still be compromised by factors such as:
  - a. High altitudes
  - b. Poisonous gases, including carbon monoxide
    - i. Some EMS services carry hand-held carbon monoxide detectors.
  - c. Enclosed spaces
3. Skin color and the level of consciousness are excellent indicators of respiration.
4. Also consider proper oxygenation when assessing patients.
  - a. Oxygenation is the process of loading oxygen molecules onto hemoglobin molecules in the bloodstream.
  - b. Can be assessed by:
    - i. Skin color
    - ii. Mental status
    - iii. Pulse oximetry
  - c. A pulse oximeter measures the percentage of hemoglobin saturation (see *Skill Drill 9-1*).
    - i. Should be 98% to 100% while breathing room air
    - ii. Can be used as part of any patient assessment
  - d. Inaccurate pulse oximetry readings may be caused by:
    - i. Hypovolemia

- ii. Anemia
- iii. Severe peripheral vasoconstriction
- iv. Time delay in detecting respiratory insufficiency
- v. Dark or metallic nail polish
- vi. Dirty fingers
- vii. Carbon monoxide poisoning
- e. Pulse oximeters do not replace a complete assessment.

## VI. Opening the Airway

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### A. Emergency medical care begins with ensuring an open airway.

1. Rapidly assess whether an unconscious patient has an open airway and is breathing adequately.
2. Remember that airway and breathing are two closely related, but separate, components.
3. Position the patient correctly:
  - a. The supine position is most effective.
  - b. Sometimes the airway must be opened and assessed in the position in which you find the patient, as in a vehicle entrapment.
  - c. A patient found in the prone position (lying face down) must be repositioned.
    - i. Log roll the patient as a unit so the head, neck, and spine all move together without twisting.
  - d. Unconscious patients should be moved as a unit because of the potential for spinal injury (see *Skill Drill 9-2*).
  - e. In an unconscious patient, the most common airway obstruction is the patient's tongue, which falls back into the throat when the muscles of the throat and tongue relax.
  - f. Other causes of airway obstruction include:
    - i. Dentures
    - ii. Blood
    - iii. Vomitus
    - iv. Mucus
    - v. Food
    - vi. Other foreign objects

### B. Head tilt–chin lift maneuver

1. This maneuver will open the airway in most patients.
2. For patients who have not sustained or are not suspected of having sustained trauma, this simple maneuver is sometimes all that is needed for the patient to resume breathing.
3. Follow these steps:
  - a. With the patient supine, position yourself beside the patient's head.
  - b. Place the heel of one hand on the patient's forehead, and apply firm backward pressure with the palm.
  - c. Place the fingertips of the other hand under the patient's lower jaw.
  - d. Lift the chin upward, with the entire lower jaw, helping to tilt the head back.

### C. Jaw-thrust maneuver

1. If you suspect a cervical spine injury, use the jaw-thrust maneuver.
2. Follow these steps:

- a. Kneel above the patient's head.
  - b. Place your fingers behind the angles of the lower jaw.
  - c. Move the jaw upward.
  - d. Use your thumbs to help position the lower jaw.
3. Once the airway has been opened, use the look, listen, and feel technique to assess whether breathing has returned.
4. With complete airway obstruction, there will be no movement of air.
  - a. Chest and abdomen may rise and fall with patient's frantic attempts to breathe.
  - b. Chest wall movement alone does not indicate that adequate breathing is present.
  - c. Begin artificial ventilation immediately.

## VII. Basic Airway Adjuncts

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**A. An airway adjunct prevents obstruction of the upper airway by the tongue and allows for passage of air and oxygen to the lungs.**

**B. Oropharyngeal airways**

1. These keep the tongue from blocking the upper airway.
2. They make it easier to suction the oropharynx if necessary.
  - a. Suctioning is possible through an opening down the center or along either side of the oropharyngeal airway.
3. Indications include the following:
  - a. Unresponsive patients with a gag reflex
  - b. Apneic patients being ventilated with a bag-mask device
4. Contraindications include the following:
  - a. Conscious patients
  - b. Any patient (conscious or unconscious) who has an intact gag reflex
5. The gag reflex is a protective reflex mechanism that keeps food from entering the airway.
  - a. Attempting to insert an oral airway in a patient with an intact gag reflex may result in vomiting or spasm of the vocal cords.
6. An oral airway is a good way to help maintain the airway of a spinal injury patient.
7. An oral airway may make the head tilt/chin lift and jaw-thrust maneuvers easier to perform.
8. An oral airway that is too large could push the tongue back into the pharynx, blocking the airway.
9. An oral airway that is too small could block the airway directly, like any foreign body obstruction.
10. To insert the airway properly, see ***Skill Drill 9-3***.
11. If you encounter difficulty inserting the oral airway, an alternative method may be used: inserting with a 90° rotation (see ***Skill Drill 9-4***).

**C. Nasopharyngeal airways**

1. Used with a patient who:
  - a. Is unresponsive or has an altered level of consciousness
  - b. Has an intact gag reflex

- c. Is unable to maintain his or her own airway spontaneously
2. Patients with an altered mental status or who have just had a seizure may benefit from this type of airway.
3. Consult medical control before inserting a nasopharyngeal airway in a patient who has sustained severe trauma to the head or face.
  - a. It may penetrate into the brain.
4. This type of airway is usually better tolerated by patients who have an intact gag reflex.
  - a. It is not as likely as the oropharyngeal airway to cause vomiting.
5. Indications include the following:
  - a. Semiconscious or unconscious patients with an intact gag reflex
  - b. Patients who otherwise will not tolerate an oropharyngeal airway
6. Contraindications include the following:
  - a. Severe head injury with blood draining from the nose
  - b. History of fractured nasal bone
7. To insert the airway correctly, see ***Skill Drill 9-5***.

## VIII. Suctioning

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### A. You must keep the airway clear in order to ventilate properly.

1. If the airway is not clear, you will force the fluids and secretions into the lungs and possibly cause a complete airway obstruction.
2. Remember this rule: If you hear gurgling, the patient needs suctioning!

### B. Suctioning equipment

1. Portable, hand-operated, and fixed equipment is essential for resuscitation.
  - a. A portable suctioning unit must provide enough vacuum pressure and flow to allow you to suction the mouth and nose effectively.
  - b. Hand-operated suctioning units with disposable chambers are reliable, effective, and relatively inexpensive.
  - c. 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.
2. A portable or fixed unit should be fitted with the following:
  - a. Wide-bore, thick-walled, nonkinking tubing
  - b. Plastic, rigid pharyngeal suction tips, called tonsil tips or Yankauer tips
  - c. Nonrigid plastic catheters, called French or whistle-tip catheters
  - d. A nonbreakable, disposable collection bottle
  - e. Water supply for rinsing the tips
3. A suction catheter is a hollow, cylindrical device used to remove fluids from the airway.
4. A tonsil-tip catheter is the best for suctioning the oropharynx in adults and is preferred for children.
  - a. The large-diameter plastic tips are rigid and do not collapse.
5. Tips with a curved contour allow for easy, rapid placement in the oropharynx.

6. French or whistle-tip catheters are soft plastic, nonrigid catheters.
  - a. They are used to suction the nose and liquid secretions in the back of the mouth and in situations when you cannot use a rigid catheter.
  - b. Situations when you could not use a rigid catheter:
    - i. A patient who has a stoma
    - ii. A patient with clenched teeth
    - iii. If suctioning the nose is necessary
7. Before inserting any catheter, measure for the proper size.
  - a. Use the same technique as measuring for an oropharyngeal airway
  - b. Be careful not to touch the back of the airway with a suction catheter—this can activate the gag reflex, causing vomiting, and increase the possibility of aspiration.

### C. Techniques of suctioning

1. Inspect your suctioning equipment regularly to make sure it is in proper working condition.
2. Follow these general steps to operate the suction unit:
  - a. Check the unit for proper assembly of all its parts.
  - b. Turn on the suctioning unit and test it to ensure a vacuum pressure of more than 300 mm Hg.
  - c. Select and attach the appropriate suction catheter to the tubing.
3. 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.
  - a. Suctioning can result in hypoxia.
  - b. Rinse the catheter and tubing with water to prevent clogging.
  - c. Repeat suctioning only after the patient has been adequately ventilated and reoxygenated.
4. To properly suction a patient, see ***Skill Drill 9-6***.
5. Sometimes a patient may have secretions or vomitus that cannot be suctioned quickly and easily, and some units cannot remove teeth, foreign bodies, and food. In these cases:
  - a. Remove the catheter from the patient's mouth.
  - b. Log roll the patient to the side.
  - c. Clear the mouth carefully with a gloved finger.
6. If a patient who requires assisted ventilations produces frothy secretions as quickly as you can suction them:
  - a. Suction the airway for 15 seconds (less in infants and children).
  - b. Ventilate for 2 minutes.
  - c. Continue this alternating pattern of suctioning and ventilating until all secretions have been cleared from the airway.
7. Clean and decontaminate your suctioning equipment after each use.

## IX. Maintaining the Airway

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**A. The recovery position is used to help maintain a clear airway in an unconscious patient who is not injured and is breathing on his or her own with a normal respiratory rate and adequate tidal volume (depth of breathing).**

1. Take the following steps to put the patient in the recovery position:

- a. Roll the patient onto the left side so that the head, shoulders, and torso move at the same time without twisting.
- b. Place the patient's extended left arm and right hand under his or her cheek.
2. For patients who have resumed spontaneous breathing after being resuscitated, the recovery position will prevent aspiration of vomitus.
3. The position is not appropriate for patients with suspected spinal injuries who are unconscious and require ventilatory assistance.
4. Reposition such patients to provide adequate airway access while maintaining appropriate spinal stabilization.

## X. Supplemental Oxygen

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### A. Always give supplemental oxygen to patients who are hypoxic because they are not getting enough oxygen to the tissues and cells of the body.

1. Some tissues and organs, such as the heart, central nervous system, lungs, kidneys, and liver, need a constant supply of oxygen to function normally.
2. Never withhold oxygen from any patient who might benefit from it, especially if you must assist ventilations.
3. When ventilating any patient in cardiac or respiratory arrest, use high-concentration supplemental oxygen.

### B. Supplemental oxygen equipment

1. Become familiar with how oxygen is stored and the various hazards associated with its use.
2. Oxygen cylinders
  - a. The oxygen that you will give to patients is usually supplied as a compressed gas in green, seamless, steel or aluminum cylinders.
  - b. Some cylinders may be silver or chrome with a green area around the valve stem on top.
  - c. Newer cylinders are often made of aluminum or spun steel; older cylinders are much heavier.
  - d. Check that the cylinder is labeled for medical oxygen. Look for letters and numbers stamped into the metal on the collar of the cylinder.
    - i. Check the month and year stamps for when the cylinder was last tested.
    - ii. Aluminum cylinders are tested every 5 years.
    - iii. Composite cylinders are tested every 3 years.
  - e. Most often the D (or super D) and M cylinder sizes will be used.
    - i. These can be carried from the unit to the patient.
  - f. The M tank remains on board the unit as a main supply tank.
  - g. Other sizes are A, E, G, H, and K.
  - h. The length of time you can use an oxygen cylinder depends on the pressure in the cylinder and the flow rate.
3. Liquid oxygen
  - a. Liquid oxygen is becoming a more commonly used alternative to compressed gas oxygen.
  - b. Liquid oxygen containers:
    - i. Tend to be more expensive than compressed oxygen tanks
    - ii. Hold a larger volume and therefore do not need to be filled as often

- iii. Weigh less than aluminum or steel tanks
- iv. Need to be kept upright
- v. Have special requirements for filling, large-volume storage, and cylinder transfer
- c. People who receive long-term oxygen therapy use liquid oxygen units.
- 4. Safety considerations
  - a. Handle gas cylinders carefully because their contents are under pressure.
  - b. Make sure the correct pressure regulator is firmly attached before transporting cylinders.
  - c. A puncture or hole in a tank can turn it into a deadly missile.
  - d. Secure tanks during transport.
- 5. Pin-indexing system
  - a. A pin-indexing system prevents such mistakes as an oxygen regulator being accidentally connected to a carbon dioxide cylinder.
  - b. When preparing to administer oxygen, check that the pinholes on the cylinder exactly match the corresponding pins on the regulator.
  - c. Each cylinder of a specific gas type has a given pattern and a given number of pins, following accepted national standards.
  - d. For large cylinders, the safety system is the American Standard System.
    - i. Oxygen cylinders are equipped with threaded gas outlet valves.
    - ii. Inside and outside thread sizes vary depending on the gas in the cylinder.
    - iii. Like the pin-indexing system, this prevents accidental attachment of a regulator to a wrong cylinder.
- 6. Pressure regulators
  - a. Pressure regulators reduce the cylinder's pressure to a useful therapeutic range for the patient—usually 40 to 70 psi.
  - b. After the pressure is reduced to a workable level, the final attachment for delivering the gas is one of the following:
    - i. A quick-connect female fitting that will accept a quick-connect male plug from a pressure hose or ventilator/resuscitator
    - ii. A flowmeter that will permit the regulated release of gas measured in liters per minute
- 7. Flowmeters
  - a. Flowmeters are usually permanently attached to pressure regulators on emergency medical equipment.
  - b. A pressure-compensated flowmeter incorporates a float ball within a tapered calibrated tube.
    - i. This type of flowmeter is affected by gravity and must always be upright.
  - c. The Bourdon-gauge flowmeter is a gauge calibrated to record flow rate.
    - i. It can be used in any position.
    - ii. It does not compensate for backpressure.
    - iii. It is generally considered outdated.

### C. Operating procedures

1. To place an oxygen cylinder in service, see *Skill Drill 9-7*.
2. Remember that you must be completely familiar with the equipment before attempting to use it on a patient.

### D. Hazards of supplemental oxygen

1. Oxygen does not burn or explode.



2. However, it does speed up the combustion process.
  - a. A small spark, such as a glowing cigarette, can become a flame.
3. Keep any possible source of fire away from the area while oxygen is in use.
4. Make sure the area is adequately ventilated, especially in industrial settings.
5. Sparks during vehicle extraction are a possible source of ignition.
6. Never leave an oxygen cylinder standing unattended.
  - a. It can be knocked over, injuring a patient or damaging equipment.

## **XI. Oxygen-Delivery Equipment**

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### **A. In general, oxygen-delivery equipment used in the field should be limited to nonrebreathing masks, bag-mask devices, and nasal cannulas.**

1. However, you may encounter other devices during transports between medical facilities.

### **B. Nonrebreathing masks**

1. The nonrebreathing mask is the preferred way to give oxygen in prehospital setting to patients who are breathing adequately but are suspected of having or showing signs of hypoxia.
  - a. With a good mask-to-face seal, it is capable of providing up to 90% inspired oxygen.
2. The nonrebreathing mask is a combination mask and reservoir bag system.
  - a. Oxygen fills a reservoir bag attached to a mask by a one-way valve.
  - b. Exhaled gas escapes through flapper valve ports at cheek areas of the mask.
  - c. These valves prevent the patient from rebreathing exhaled gases.
3. Make sure the reservoir bag is full before placing the mask on the patient.
4. Adjust the flow rate so the bag does not collapse when the patient inhales.
  - a. Usually 10 to 15 L/min
  - b. If the bag does collapse, increase the flow rate.
5. When oxygen therapy is discontinued, remove the mask from the patient's face.
6. Use a pediatric nonrebreathing mask for infants and children.
  - a. Has a smaller reservoir bag

### **C. Nasal cannulas**

1. A nasal cannula delivers oxygen through two small, tubelike prongs that fit into the patient's nostrils.
2. This device can provide 24% to 44% inspired oxygen when the flowmeter is set at 1 to 6 L/min.
  - a. For patient comfort, flow rates above 6 L/min are not recommended.
3. When you anticipate a long transport time, consider using humidification.
  - a. Over a prolonged period, a nasal cannula can dry or irritate the mucous membrane lining of the nose.
4. In the prehospital setting, a nasal cannula has limited use.
  - a. A patient who breathes through the mouth, or has a nasal obstruction, will get little or no benefit.
  - b. Always try to give high-flow oxygen through a nonrebreathing mask.

### **D. Partial rebreathing masks**

1. The partial rebreathing mask is similar to the nonrebreathing mask, except there is no one-way valve between the mask and the reservoir.
2. Consequently, patients rebreathe a small amount of their exhaled air.
3. This is advantageous if the patient is hyperventilating.
4. The oxygen enriches the air mixture and delivers about 80% to 90% oxygen and 2% to 3% carbon dioxide.
5. To convert a nonrebreathing mask to a partial rebreathing mask, remove the one-way valve between the mask and the reservoir bag.

#### **E. Venturi masks**

1. A number of settings can vary the percentage of oxygen while a constant flow is maintained from the regulator.
  - a. This is accomplished by the Venturi principle, which causes air to be drawn into the flow of oxygen as it passes a hole in the line.
2. The Venturi mask is a medium-flow device that delivers 24% to 40% oxygen, depending on the manufacturer.
3. Useful in long-term management of physiologically stable patients

#### **F. Tracheostomy masks**

1. Patients with tracheostomies do not breathe through their mouth and nose.
2. Tracheostomy masks cover the tracheostomy hole and have a strap that goes around the neck
  - a. These may not be available in an emergency setting, in which case you should improvise by using a face mask instead, placed at the tracheostomy opening.
    - i. Though the mask is shaped to fit the face, you can usually get an adequate fit over the patient's neck by adjusting the strap.

#### **G. Humidification**

1. Some EMS systems provide humidified oxygen.
  - a. During extended transport
  - b. For certain conditions such as croup
2. However, dry oxygen is not considered harmful for short-term use.
  - a. Therefore, many EMS systems do not use humidified oxygen in the prehospital setting.
3. Always refer to medical control or local protocols for guidance involving patient treatment issues.

## **XII. Assisted and Artificial Ventilation**

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**A. Assisted and artificial ventilation are probably the most important skills in EMS at any level.**

**B. Basic airway and ventilation techniques are extremely effective when administered appropriately.**

1. Mastery of these techniques at the EMT level is imperative.
2. Patients who are breathing inadequately (too fast or too slow, with reduced tidal volume) are usually unable to speak in complete sentences.
  - a. Keep in mind that fast, shallow breathing can be just as dangerous as very slow breathing.
3. Follow standard precautions as needed when managing a patient's airway.

**C. Assisting ventilation in respiratory distress/failure**

1. Intervene quickly to prevent further deterioration.
2. Two treatment options are available in these situations: assisted ventilation and continuous positive airway pressure (CPAP).
  - a. The purpose of assisted ventilations is to improve the overall oxygenation and ventilatory status of the patient.
3. Signs and symptoms of inadequate ventilation:
  - a. Altered mental status
  - b. Inadequate minute volume
  - c. Excessive accessory muscle use and fatigue
4. To assist a patient with ventilations using a bag-mask device:
  - a. Explain the procedure to the patient.
  - b. Place the mask over the patient's nose and mouth.
  - c. Squeeze the bag each time the patient breathes, maintaining the same rate as the patient.
  - d. After the initial 5 to 10 breaths, slowly adjust the rate and deliver an appropriate tidal volume.
  - e. Adjust the rate and tidal volume to maintain an adequate minute volume.

**D. Artificial ventilation**

1. Patients in respiratory arrest need immediate treatment to live.
2. Once you determine that a patient is not breathing, begin artificial ventilation immediately.
3. Available methods:
  - a. The mouth-to-mask technique
  - b. A one-, two-, or three-person bag-mask device
  - c. The manually triggered ventilation device
4. Normal ventilation versus positive-pressure ventilation
  - a. Artificial ventilations are necessary to sustain life, but are not the same as normal breathing.
    - i. In normal breathing, the diaphragm contracts and negative pressure is generated in the chest cavity, which sucks air into the chest.
    - ii. Positive-pressure ventilation generated by a device forces air into the chest cavity.
  - b. With positive-pressure ventilation:
    - i. Increased intrathoracic pressure reduces the amount of blood pumped by the heart.
    - ii. More volume is required to have the same effects as normal breathing, which pushes the airway walls out of their normal anatomic shape.
    - iii. Air is forced into the stomach, causing gastric distention that could result in vomiting and aspiration.
  - c. The EMT must regulate the rate and volume of artificial ventilations to help prevent the drop in cardiac output.
    - i.  $\text{Cardiac output} = \text{stroke volume} \times \text{heart rate}$
  - d. Ventilation rates (for apneic patients with a pulse)
    - i. Adult: 1 breath per 5 to 6 seconds
    - ii. Child: 1 breath per 3 to 5 seconds
    - iii. Infant: 1 breath per 3 to 5 seconds
5. Mouth-to-mouth and mouth-to-mask ventilation
  - a. A barrier device is routinely used in mouth-to-mouth ventilations.

- i. 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.
  - ii. Mouth-to-mouth ventilations without a barrier device should be provided only in extreme situations.
  - b. A mask with an oxygen inlet provides oxygen during mouth-to-mask ventilation.
    - i. Supplements the air supplied by your lungs
    - ii. The gas you exhale contains 16% oxygen.
    - iii. With the mouth-to-mask system, patients get the benefit of significant oxygen enrichment.
    - iv. This system also frees both your hands to help keep the airway open and provide a better seal between the mask and face.
  - c. To provide mouth-to-mask ventilation, see **Skill Drill 9-8**.
  - d. You know that you are providing adequate ventilations if:
    - i. Patient's color improves
    - ii. Chest rises adequately
    - iii. You do not meet resistance when ventilating
    - iv. You hear and feel air escape as the patient exhales
  - e. To increase the oxygen concentration, administer high-flow oxygen at 15 L/min through the oxygen inlet valve of the mask.
    - i. Combined with your exhaled breath, this will deliver about 55% oxygen.
6. The bag-mask device
- a. A bag-mask device is the most common method used to ventilate patients in the field.
  - b. With an oxygen flow rate of 15 L/min, a bag-mask device can deliver nearly 100% oxygen.
    - i. However, it can deliver only as much volume as you can squeeze by hand.
  - c. The device provides less tidal volume than mouth-to-mask ventilation but delivers a much higher concentration of oxygen.
    - i. An experienced EMT can provide adequate tidal volume.
    - ii. As a new EMT, develop proficiency by ventilating airway-training manikins before using on a patient.
  - d. If you have difficulty adequately ventilating a patient with a bag-mask device, switch immediately to another method, such as the mouth-to-mask technique
  - e. Bag-mask device components:
    - i. Disposable self-refilling bag
    - ii. No pop-off valve, or a disabled pop-off valve
    - iii. Nonrebreathing outlet valve
    - iv. Oxygen reservoir that allows for delivery of high-concentration oxygen
    - v. One-way, no-jam inlet valve with a flow of up to 15 L/min
    - vi. Transparent face mask
  - f. Offers the capability of performing under extreme heat or cold
  - g. Total volume
    - i. Adult: 1,200 to 1,600 mL
    - ii. Pediatric: 500 to 700 mL
    - iii. Infant: 150 to 240 mL
  - h. The volume of oxygen delivered is based on observing chest rise and fall.
    - i. This is the only means of assessing tidal volume in the field.
  - i. Whenever possible, work together with your partner to provide bag-mask device ventilation.
    - i. One EMT maintains a good mask seal by securing the mask to the patient's face with two hands.
    - ii. The other EMT squeezes the bag.

- j. To use the two-person bag-mask device technique, follow these steps:
  - i. Kneel above the patient's head. If possible, your partner should be at the side of the head to squeeze the bag.
  - ii. Maintain the patient's neck in an extended position unless you suspect a cervical spine injury. For a cervical spine injury, immobilize head and neck and use the jaw-thrust maneuver.
  - iii. Open the patient's mouth.
  - iv. Suction as needed.
  - v. Insert an oral or nasal airway to maintain airway patency.
  - vi. Select the proper mask size.
  - vii. Place the mask on the patient's face.
  - viii. Hold the mask in position with the thumbs over the top part and the index fingers over the bottom part.
  - ix. Bring the lower jaw up to the mask with the last three fingers of your hand. This helps maintain an open airway.
  - x. Connect the bag to the mask.
  - xi. Hold the mask in place while your partner squeezes it with two hands until the patient's chest rises.
- k. For a patient who is breathing too slowly (hypoventilation) with reduced tidal volume:
  - i. Squeeze the bag as the patient tries to breathe in.
  - ii. For the next 5 to 10 breaths, slowly adjust the rate and delivered tidal volume until adequate minute volume is achieved.
- l. For a patient who is breathing too fast (hyperventilation) with reduced tidal volume:
  - i. Explain the procedure to the patient if the patient is coherent.
  - ii. Initially assist respirations at a rate the patient has been breathing, squeezing the bag each time the patient inhales.
  - iii. Then, for the next 5 to 10 breaths, slowly adjust the rate and the delivered tidal volume until an adequate minute volume is achieved.
- m. If the patient's chest does not rise and fall, you may need to reposition the head or use an airway adjunct.
- n. As with any ventilation device, be alert for gastric distention (inflation of the stomach with air). To prevent or alleviate distention:
  - i. Ensure that the patient's airway is appropriately positioned.
  - ii. Ventilate at the appropriate rate.
  - iii. Ventilate with the appropriate volume.

## 7. Manually triggered ventilation devices

- a. These devices, also known as flow-restricted, oxygen-powered ventilation devices, are widely available.
- b. They allow a single rescuer to use both hands to maintain a mask-to-face seal while providing positive-pressure ventilation.
- c. This reduces rescuer fatigue associated with using a bag-mask device on extended transports.
- d. Disadvantages:
  - i. May be difficult to maintain adequate ventilation without assistance
  - ii. Should not be used routinely because of high incidence of gastric distention and possible damage to structures within the chest cavity
  - iii. Special unit and additional training are required for infants and children.
  - iv. Should not be used with COPD or suspected cervical spine or chest injuries
- e. Manually triggered ventilation device features:
  - i. Peak flow rate of 100% oxygen at up to 40 L/min
  - ii. Inspiratory pressure safety release valve

- iii. Audible alarm that sounds when you exceed the relief valve pressure
  - iv. Ability to function satisfactorily under normal and varying environmental conditions
  - v. 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
  - f. Proper training and considerable practice are required.
  - g. As with bag-mask devices, you must make sure there is an effective seal between the patient's face and mask.
  - h. The amount of pressure required varies according to patient size, lung volume, and lung condition.
    - i. A COPD patient will need greater pressure.
    - ii. Pressures that are too great can cause a pneumothorax.
8. Automatic transport ventilator (ATV)
- a. The ATV is a manually triggered ventilation device attached to a control box that allows the variables of ventilation to be set.
  - b. It lacks the sophisticated control of a hospital ventilator.
  - c. It frees the EMT to perform tasks such as maintaining the mask seal or ensuring continued airway patency.
  - d. A bag-mask device and mask should always be prepared and ready for use should an ATV malfunction.
  - e. Most models have adjustments for respiratory rate and tidal volume.
    - i. Estimate tidal volume at 6 to 7 mL/kg.
  - f. The pressure relief valve may lead to hypoventilation in patients with:
    - i. Poor lung compliance (ability of alveoli to expand when air is drawn in during inhalation)
    - ii. Increased airway resistance
    - iii. Airway obstruction
  - g. Constant reassessment of the patient is necessary.
    - i. Assess for full chest recoil.

## XIII. Continuous Positive Airway Pressure

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### A. Continuous positive airway pressure (CPAP) is noninvasive ventilatory support for patients experiencing respiratory distress.

- 1. Many people diagnosed with obstructive sleep apnea wear a CPAP unit at night to maintain their airways while they sleep.
- 2. The CPAP is becoming widely used at the EMT level.

### B. Mechanism

- 1. CPAP increases pressure in the lungs, opens collapsed alveoli, pushes more oxygen across the alveolar membrane, and forces interstitial fluid back into the pulmonary circulation.
- 2. Studies of this treatment have shown positive results in patients with obstructive pulmonary diseases and those with acute pulmonary edema.
- 3. The therapy is typically delivered through a face mask held to the head with a strapping system.
  - a. A good seal with minimal leakage between the face and mask is essential.
- 4. Many CPAP systems use oxygen as the driving force to deliver the positive ventilatory pressure to the patient.
- 5. Use caution with patients with potentially low blood pressure, because CPAP causes a drop in cardiac output.

**C. Indications**

1. Patient is alert and able to follow commands.
2. Patient displays obvious signs of moderate to severe respiratory distress from a condition such as pulmonary edema or obstructive pulmonary disease (asthma, COPD).
3. Patient is breathing rapidly, such that it affects overall minute volume (greater than 26 breaths/min).
4. Pulse oximetry reading is less than 90%.

**D. Contraindications**

1. Patient in respiratory arrest
2. Signs and symptoms of pneumothorax or chest trauma
3. Patient who has a tracheostomy
4. Active gastrointestinal bleeding or vomiting
5. Patient is unable to follow verbal commands
6. In addition to these contraindications, always reassess the patient for signs of deterioration and/or respiratory failure.

**E. Application**

1. CPAP units are generally composed of:
  - a. Generator
  - b. Mask
  - c. Circuit containing corrugated tubing
  - d. Bacteria filter
  - e. One-way valve
2. During the expiratory phase, the patient exhales against a resistance called positive end-expiratory pressure (PEEP).
  - a. PEEP values of 8.0 to 10.0 cm H<sub>2</sub>O is generally an acceptable therapeutic range.
3. Since most CPAP units are powered by oxygen, it is important to have a full cylinder of oxygen when using CPAP.
4. To use a CPAP, see *Skill Drill 9-9*.

**F. Complications**

1. Some patients may find CPAP claustrophobic and will resist the application.
  - a. Coach patients through the process rather than forcing the mask on them.
2. Due to the high volume of pressure generated by CPAP, there is the possibility of causing a pneumothorax.
3. High pressure in the chest can also lower a patient's blood pressure.
4. If the patient shows signs of deterioration, remove CPAP and begin positive-pressure ventilation using a bag-mask device attached to high-flow oxygen.

## XIV. Special Considerations

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**A. Gastric distention**

1. Gastric distention occurs when artificial ventilation fills the stomach with air.
2. It most commonly affects children, but also affects adults.
3. It is most likely to occur when you ventilate the patient too forcefully or too rapidly with a bag-mask or pocket mask device.
4. It may also occur when the airway is obstructed by a foreign body or improper head position.
5. Slight gastric distention is not of concern.
6. Severe inflation of the stomach is dangerous.
  - a. May cause vomiting and increase aspiration risk during CPR
  - b. Can significantly reduce lung volume by elevating the diaphragm, especially in infants and children
7. Gastric distention is a common complication with manually triggered ventilation devices.
8. Recheck and reposition the airway.
9. Continue slow rescue breathing without attempting to expel the stomach contents.
10. If gastric distention makes it impossible to ventilate the patient and an ALS provider is not available to perform decompression, consider applying pressure over the upper abdomen (last resort).
  - a. If vomiting occurs as a result, turn the patient's entire body to the side, suction and/or wipe out the mouth with your gloved hand, return the patient to a supine position, and continue rescue breathing.

## **B. Stomas and tracheostomy tubes**

1. Patients who have had a laryngectomy (surgical removal of the larynx) have a permanent tracheal stoma, which is an opening in the neck that connects the trachea directly to the skin.
  - a. This type of stoma is known as a tracheostomy.
2. Patients may have other openings in the neck, depending on the type of operation performed.
  - a. Ignore any opening other than the midline tracheal stoma.
  - b. This is the only one that can be used to put air into the patient's lungs.
3. Neither the head tilt/chin lift nor the jaw-thrust maneuver is required to ventilate a patient with a stoma.
4. If the patient has a tracheostomy tube, ventilate through the tube with a bag-mask device.
  - a. A standard 22/15 adapter on the bag-mask device will fit onto the tube in the tracheal stoma.
  - b. Use 100% oxygen attached directly to the bag-mask device.
5. If the patient has a stoma but no tube is in place:
  - a. Use an infant or child mask with your bag-mask device to make a seal over the stoma.
6. 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.
  - a. Release the seal of the patient's mouth and nose for exhalation.
  - b. This allows the air to exhale through the upper airway.
7. If you cannot ventilate a patient with a stoma:
  - a. Try suctioning the stoma and the mouth with a French or soft-tip catheter.
  - b. Seal the stoma while giving mouth-to-mouth ventilation.

## **XV. Foreign Body Airway Obstruction**

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**A. If an obstruction *completely* blocks the airway, it is a true emergency.**

1. It will result in death if not treated immediately.
2. In an adult, foreign body airway obstruction usually occurs during a meal.
3. In a child, it can occur while eating, playing with small toys, or crawling around the house.
4. By far, the most common airway obstruction in an unconscious patient is the tongue, which relaxes and falls back into the throat.
5. Causes of airway obstruction that do not involve foreign bodies include:
  - a. Swelling, from infection or acute allergic reaction
    - i. Repeated attempts to clear the airway could be dangerous.
    - ii. These patients require specific emergency medical care.
    - iii. Rapid transport to the hospital is crucial.
  - b. Trauma (tissue damage from injury)

**B. Recognition**

1. Early recognition of airway obstruction is crucial.
2. Mild airway obstruction
  - a. Patients can still exchange air, but will have varying degrees of respiratory distress
  - b. The patient may have noisy breathing and may be coughing.
  - c. With good air exchange, the patient can cough forcefully, although you may hear wheezing between coughs (the production of whistling sounds during respiration).
    - i. Wheezing usually indicates a mild lower airway obstruction.
    - ii. 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.
    - iii. Continually reassess.
  - d. With poor air exchange, the patient has a weak, ineffective cough and may have increased difficulty breathing, stridor (high-pitched noise heard mainly on inspiration), and cyanosis.
    - i. Stridor indicates mild upper airway obstruction.
    - ii. Treat immediately as if there is a severe airway obstruction.
3. Severe airway obstruction
  - a. Patients cannot breathe, talk, or cough.
  - b. The patient may clutch or grasp the throat (which is known as the universal distress signal), begin to turn cyanotic, and have extreme difficulty breathing.
  - c. There is little or no air movement.
  - d. Ask the conscious patient, "Are you choking?"
    - i. If the patient nods "yes," provide immediate treatment.
  - e. If the obstruction is not cleared quickly, the amount of oxygen in the patient's blood will decrease dramatically.
  - f. If not treated, the patient will become unconscious and die.
  - g. Some patients will be unconscious as you form your general impression.
    - i. You may not know that an airway obstruction is the cause.
  - h. There are many other causes of unconsciousness and respiratory failure, including:
    - i. Stroke
    - ii. Heart attack
    - iii. Trauma

- iv. Seizures
- v. Drug overdoses
- i. Any person found unconscious must be managed as if he or she has a compromised airway.
  - i. Open the airway.
  - ii. Provide artificial ventilation if the patient is not breathing or is breathing inadequately.
  - iii. If there is no chest rise and fall after several attempts to ventilate, or if you feel resistance while ventilating, consider the possibility of an airway obstruction.

### **C. Emergency medical care for foreign body airway obstruction**

1. Perform a head tilt/chin lift maneuver to clear a tongue obstruction.
  - a. If spinal trauma is suspected, open the airway with a jaw-thrust maneuver.
2. When available, perform suctioning to maintain a clear airway.
3. Abdominal thrusts are the most effective method of dislodging and forcing an object from the airway of a conscious patient.
  - a. Residual air, always present in the lungs, is compressed upward and used to expel the object.
  - b. Use the abdominal thrusts until the object dislodges or the patient becomes unconscious.
4. For the unresponsive patient with a severe foreign body airway obstruction, reassess to confirm apnea and inability to ventilate.
5. Begin chest compression just as you would for CPR, following the 30 compressions to 2 breaths ratio.
6. At the completion of the 30 compressions, perform a tongue-jaw lift by grasping the jaw with your thumb and index finger.
  - a. Place your thumb onto the tip of the patient's lower teeth and tongue while placing your index finger under the bony portion of the chin.
  - b. Be careful not to compress the soft tissues under the chin.
  - c. Pull the jaw/mouth open and look at the back of the oropharynx for any foreign objects.
  - d. If you see an object, remove it with a gloved index finger or suction.
  - e. Never perform a blind sweep of the back of the oropharynx, which may push an object farther down in the airway, making the obstruction worse.
  - f. Once the object is removed, or if no object was seen, attempt to ventilate.
  - g. If you are still unable to ventilate, repeat the process.
7. If you are unsuccessful, begin rapid transport and continue abdominal thrusts on the way to the hospital.
8. Remember to treat patients with a mild airway obstruction and poor air exchange as if they have a severe airway obstruction.
9. Patients with a mild airway obstruction and good air exchange should be monitored closely for deterioration of their condition.
  - a. If the patient is unable to clear the obstruction and remains conscious, support (or let the patient control) the airway position that is most efficient and comfortable.
  - b. Provide supplemental oxygen and transport.

### **D. Dental appliances**

1. Many dental appliances can cause an airway obstruction.
  - a. Examples include a crown, a bridge, dentures, or a piece of braces.

2. Manually remove the dental appliance before providing ventilations.
3. Simple manual removal may relieve the obstruction and allow the patient to breathe on his or her own.
4. Leaving well-fitting dentures in place usually makes bag-mask device or mouth-to-mask ventilation much easier.
  - a. Provides more structure to the face
  - b. Helps you provide a good face-to-mask seal
5. Conversely, loose dentures interfere with the process and should be removed.
6. Appliances may loosen while you are providing care.
  - a. Periodically reassess to make sure they are firmly in place.
7. If possible, place dislodged dentures in a container and transport them with the patient.

#### **E. Facial bleeding**

1. Airway problems can be particularly challenging in patients with serious facial injuries.
2. The blood supply to the face is so rich, injuries can result in severe tissue swelling and bleeding into the airway.
3. Control bleeding with direct pressure and suction as necessary.

## **XVI. Summary**

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- A. The upper airway includes the nose, mouth, jaw, oral cavity, pharynx, and larynx. Its function is to warm, filter, and humidify air as it enters the nose and mouth.**
- B. The lower airway includes the trachea and lungs. Its function is to exchange oxygen and carbon dioxide.**
- C. 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.**
- D. 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.**
- E. 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.**
- F. Patients with inadequate breathing need to be treated immediately. Emergency medical care includes airway management, supplemental oxygen, and ventilatory support.**
- G. Basic techniques for opening the airway include the head tilt–chin lift maneuver or, if trauma is suspected, the jaw-thrust maneuver.**
- H. 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.**
- I. Another basic airway adjunct is the nasopharyngeal or nasal airway, which is usually used with patients who have a gag reflex; it is better tolerated than the oral airway.**

- J. Suctioning is the next priority after opening the airway. Rigid tonsil-tip catheters are the best to use when suctioning the pharynx; soft plastic catheters are used to suction the nose and liquid secretions in the back of the mouth.**
- K. The recovery position is used to help maintain the airway in patients without traumatic injuries who are unconscious and breathing adequately.**
- L. 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.**
- M. Handle compressed gas cylinders carefully; their contents are under pressure. Always make sure the correct pressure regulator is firmly attached before transporting a cylinder.**
- N. The pin-indexing safety system features a series of pins on a yoke that must be matched with holes on the valve stem of the gas cylinder.**
- O. Pressure regulators reduce the pressure of gas in an oxygen cylinder to between 40 and 70 psi.**
- P. When oxygen therapy is complete, disconnect the tubing from the flowmeter nipple and turn off the cylinder value, then turn off the flowmeter. Keep any possible source of fire away from the area while oxygen is in use.**
- Q. Nasal cannulas and nonrebreathing masks are used most often to deliver oxygen in the field. If the patient will not tolerate a nonrebreathing mask, apply a nasal cannula.**
- R. The methods of providing artificial ventilation include mouth-to-mask ventilation, two-person bag-mask device ventilation, manually triggered ventilation device, and one-person bag-mask ventilation.**
- S. CPAP is a noninvasive method of providing ventilatory support for patients in respiratory distress or for patients suffering from sleep apnea.**
- T. Patients with a tracheal stoma or tracheostomy tube need to be ventilated through the tube or stoma.**
- U. Foreign body airway obstruction usually occurs during a meal in an adult; in a child, it usually occurs while eating, playing with small objects, or crawling about the house.**
- V. The earlier you recognize an airway obstruction, the better.**
- W. Patients with a mild airway obstruction are able to move adequate amounts of air and should be left alone.**
- X. Patients with a severe airway obstruction cannot move any air at all and require immediate treatment.**
- Y. Check for loose dental appliances in a patient before assisting ventilations.**

## Post-Lecture

### ***Unit Assessment***

1. Fresh air that is inspired into the lungs contains about \_\_\_\_ percent oxygen when it is inhaled and \_\_\_\_ percent when it is exhaled.
2. What are some common causes of inaccurate pulse oximetry readings?
3. What airway maneuver should be used with a cervical spine injury?
4. List the procedure for inserting an oropharyngeal airway in an adult patient.
5. Adults should be suctioned for no longer than \_\_\_\_\_ seconds.
6. At what pressure is an oxygen tank considered full?
7. The flow rate for a nasal cannula should be set between \_\_\_\_\_ L/min.
8. What are some indications that artificial ventilation is adequate?
9. What are the indications and contraindications of CPAP?
10. List two problems that will cause gastric distention.

### Knowledge Objectives

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This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

### Knowledge Objectives

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small gaps between them. There are no vertical margin lines, text, or other markings on the page. It appears to be a standard piece of notebook paper or a template for writing practice.