Seattle-King County EMS

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January 2008

CBT/OTEP 425

Respiratory Emergencies

Print version of EMS Online Course
www.emsonline.net

Introduction

Patients with lung and heart diseases frequently call 9-1-1 because of breathing difficulty. This course reviews common disorders that can cause respiratory emergencies and prehospital management of these conditions.

Before You Begin

This is a continuing education and recertification course for EMTs. It covers fundamental EMT-Basic concepts and terminology as well as advanced material. We highly recommend completing the practice exam before attempting the exam.

We also recommend that you review an EMT textbook chapter covering this topic as a refresher before taking the exam, for example: Chapter 11 – Respiratory Emergencies in *Emergency Care and Transportation of the Sick and Injured*, 9th edition (AAOS).

Practical Skills

To receive CBT or OTEP credit for this course a trained skills evaluator must evaluate your ability to perform the following hands-on practical skills including:

- Airway management (airway maneuvers to include pediatric)
- Auscultation of breath sounds
- Assisted ventilation with a BVM
- Oropharyngeal/nasopharyngeal airway
- Suction
- Oxygen administration

Objectives

CBT425 is an EMT continuing education and recertification course. After completing this course you will be able to:

1. Identify the anatomic structures of the respiratory system.
2. Demonstrate an understanding of the physiology of the respiratory system and its relationship to BLS treatment.
3. Identify signs and symptoms of respiratory emergencies.
4. Identify treatment of respiratory emergencies.
5. Distinguish between normal and abnormal breath sounds.
6. Identify correct technique for auscultation of breath sounds.
7. Identify correct BVM technique and suctioning technique.

Terms

Terms You Should Know

chronic obstructive pulmonary disease (COPD) – A category of diseases characterized by a slow process of dilation and disruption of pulmonary alveoli.

dyspnea – A term for shortness of breath or breathing difficulty.

embolus – A blood clot or other substance that has formed in a blood vessel or the heart, that breaks off and travels to another blood vessel, where it may cause blockage.

flail chest – A condition in which three or more ribs are fractured in two or more places such that a section of the chest wall is detached from the rest of the chest wall.

gag reflex – A protective contraction of the muscles of the throat caused especially by stimulation of the pharynx that prevents food and liquids from entering the airway.

hypoxia – A condition in which the body's cells and tissue do not have enough oxygen.

pleuritic chest pain – A sharp, stabbing pain in the chest that is worsened by a deep breath; often caused by inflammation or irritation of the pleura.

pneumothorax – Condition where air enters the pleural space and is trapped during expiration. It can occur without trauma as in a spontaneous pneumothorax.

pulmonary edema – A buildup of fluid in the lungs, usually as a result of congestive heart failure.

rales – Crackling, rattling breath sounds signaling fluid in the air spaces of the lungs.

rhonchi – Coarse breath sounds heard in patients with mucus in the airways.

stridor – A harsh, high-pitched inspiratory sound often heard in acute laryngeal (upper airway) obstruction.

tension pneumothorax – A life-threatening condition in which air enters the pleural space and the pressure inside the lung cavity progressively increases and compresses the lung. It may displace the mediastinum and other structures toward the opposite side.

traumatic asphyxia – Condition characterized by distended neck veins, cyanosis in face and neck, and bleeding in the sclera of the eye that is caused by severe compression of the chest.

wheeze – A high-pitched, whistling breath sound, characteristically heard on expiration in patients with asthma or COPD.

New Terms

hypoxic drive – A condition in which the body's stimulus for taking a breath is low oxygen. Occurs in people with COPD.

metabolism – The process by which food molecules are broken down to provide material and energy for cellular function.

pH (potential of hydrogen) – A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale ranges from 0 to 14. Numbers from 7 and below represent increasing acidity.

perfusion – The movement of blood through an organ or tissue in order to supply nutrients and oxygen.

tidal volume – The volume of gas that is moved with each breath which is normally 500 ml in an adult.

ventilation – The rate at which gas enters or leaves the lungs. Generally it is described in terms of good or poor ventilation. Bluish or dusky skin can indicate poor ventilation.

Respiratory Structures

Airway protection and oxygen administration are perhaps the most important BLS skills you have. Therefore it is important to know the structures of the respiratory system and understand the basic physiology that is affected by BLS treatment.

Metabolism Produces Carbon Dioxide

Metabolism is the process by which the body breaks down or "burns" stored fuel to create energy. The cells use oxygen to transform stored glucose into energy. You can think of glucose as "fuel" and oxygen as the "match" that releases the energy. A byproduct of metabolism is carbon dioxide (CO2).

Carbon dioxide is produced by the cells and carried by the circulatory system to the lungs where it is expired. If respirations are impaired, carbon dioxide builds up in the blood. This excess carbon dioxide combines with water in the blood to produce an acid.

pH

Acidity in a solution such as blood is measured by what is called potential of hydrogen or pH. The body must maintain a relatively narrow pH range (neither too acidic, nor too basic). The respiratory system helps maintain a balanced acid level or pH in the blood.

The pH Balancing Act

The respiratory system is a mirror for other changes that can happen in the body. If the blood pH becomes too low (acidic), the respiratory system will attempt to fix this by making the lungs breathe more deeply and rapidly, thus excreting more carbon dioxide. The body attempts to maintain a balance or homeostasis.

Because the respiratory system helps regulate carbon dioxide excretion or retention, it is an important mechanism for regulating pH.

Hypercarbia - Excess Carbon Dioxide

Hypercarbia is a state of excessive carbon dioxide in the body. This results in acidosis as the carbon dioxide causes a chemical reaction producing carbonic acid. Hypercarbia can occur through:

- Metabolic processes that form acids
- Muscle exertion
- Shivering

Hypercarbia also can occur through decreased elimination of carbon dioxide, for example with:

- Airway obstruction
- Inability to exhale fully (e.g., asthma or emphysema)
- Depressed respiratory drive (e.g., overdose of sedative drugs)

When hypercarbia occurs it affects the chemistry of the body causing a pH imbalance.

Hypercarbia can be treated by the BLS provider by improving ventilation.

Hypoxic Drive

The amount of carbon dioxide in the blood is the primary stimulus for breathing. A secondary stimulus for breathing is hypoxia, a decrease in oxygen.

While less important for regulation of breathing in the average person, in some individuals, this so-called hypoxic drive is the primary stimulus for respiration.

This occurs in a small percentage of COPD patients whose expirations are so inefficient that their bodies have become accustomed to higher than normal levels of carbon dioxide. A decrease in oxygen, rather than an increase in carbon dioxide, provides the primary stimulus for taking a breath.

Elaboration - Respiratory Drive

Respiratory drive, or the act of breathing, is an autonomic and involuntary function controlled by centers in the brain sensitive to the blood levels of oxygen and carbon dioxide.

Specialized brain cells constantly monitor and react to the levels of oxygen and carbon dioxide in the blood. For example, when the body is deprived of oxygen it attempts to compensate by increasing the rate and depth of respirations.

The body’s response to increased carbon dioxide in the blood is to "blow off” carbon dioxide by increasing the rate and depth of respirations.

Metabolic Problems Affect Respirations

Metabolic imbalances affect the chemistry of the body affecting pH and other measures of body chemistry. While this is not a respiratory problem, the respiratory system often tries to compensate to maintain equilibrium by changing the depth or rate of respirations or both.

Elaboration – Metabolic Problems

Ketoacidosis is the result of inefficient metabolism of sugars in a diabetic that causes the body to turn to other fuel sources for energy, namely fat and muscle. Byproducts of this inefficient metabolism are acids called ketoacids. The presence of ketoacids and related compounds in the blood will cause a lower pH. The respiratory system responds by increasing the depth or rate of respirations or both.

Aspirin overdose can cause metabolic problems. Aspirin is an acid (the chemical name is acetylsalicylic acid). When taken in large quantities, a person with an aspirin overdose can become acidotic. Again, the body compensates by increasing the depth or rate of respirations or both.

Fever and sepsis also can cause metabolic problems. Fever increases the metabolic rate, causing the production of more carbon dioxide that can lead to more acid in the blood. When tissue perfusion fails (as it can in sepsis) excess metabolic acids accumulate causing a metabolic acidosis with a low pH. The body in turn responds by increasing the depth or rate of respirations or both.

A person who is hyperventilating for psychological reasons is breathing deeply and rapidly. This is a very efficient way of ridding the body of carbon dioxide which in turn may alter the body's equilibrium and cause what is known as alkalosis (meaning very "basic"). Symptoms of respiratory alkalosis may include faintness and tingling in the extremities.

Airway Obstruction

EMS providers should intervene if a choking victim has signs of severe airway obstruction such as poor air exchange or increased breathing difficulty as indicated by a silent cough, cyanosis, or the inability to speak or breathe.

If the obstruction is mild and the victim is coughing forcefully, do not interfere with the efforts to relieve the obstruction. Attempt to relieve the obstruction only if it becomes severe.

Use a finger sweep only if you can see solid material obstructing the airway of an unresponsive patient.

Elaboration – Foreign Bodies, Many Ways

There are many ways a foreign object can lodge in an airway. For example, a stroke can damage swallowing reflexes, making the person more prone to choking. Consumption of alcohol and some drugs also suppresses the gag reflex.

Asthma

Asthma is a chronic, inflammatory disease of the airways. Asthma attacks are induced by many different factors including allergens, infections, exercise, and smoke.

During an asthma attack, the muscles around the bronchioles tighten, the lining of the bronchioles swells, and the inside of the bronchioles fills with thick mucous. This severely restricts expiration of air from the lungs.

Patients will often describe a history of asthma and have a prescription for a metered-dose inhaler. BLS treatment considerations include:

- Calming the patient
- Airway management
- Oxygen therapy
- Assisting with a prescribed inhaler

Elaboration – Asthma

Asthma is a disease that affects the bronchi and bronchioles that carry air in and out of the lungs. In persons with asthma, the inside walls of the airways are swollen. They are very sensitive to things such as dust, pollen, drugs, air pollutants, and physical stimuli. The airways become narrow and less air flows into the lungs. This causes symptoms like wheezing, coughing, chest tightness, and breathing difficulty.

In an asthma attack, muscles around the airways tighten, making the airway openings narrower so less air can flow through. Inflammation increases and the airways become more swollen and narrow. Cells in the airways also produce more mucus than normal. This extra mucus also narrows the airways.

COPD

Chronic obstructive pulmonary disease (COPD) is a category of diseases that includes asthma, emphysema, and chronic bronchitis. COPD causes a slow process of dilation and disruption of the airways and alveoli and includes several related, irreversible conditions that limit the ability to exhale.

Persons with COPD can present with shortness of breath, fever, and increased sputum production. Their medical history can include upper-respiratory infection, chronic bronchitis, emphysema, or a history of smoking or working in a hazardous environment (e.g., coal smoke or asbestos). Common medications for COPD include:

- Prednisone
- Albuterol (Proventil or Ventolin)
- Theophylline (Theo-Dur)
- Ipratropium (Atrovent)
- Azmacort

BLS treatment for a COPD patient with respiratory distress should include high flow oxygen.

Elaboration – Emphysema

In emphysema, the very small airways that join the alveoli are damaged and the walls lose elasticity. Chronic irritation of small airways causes inflammation and swelling,

reducing the diameter of these air passages. Irritation causes bronchospasms and further decreases the lumen.

On inspiration, the expansion of the lungs holds airways open. On exhalation, the lungs relax and the airways narrow, trapping air.

Elaboration – Chronic Bronchitis

Chronic bronchitis is characterized by structural changes in airways of the lungs and enlargement of the mucous glands that cause coughing and production of sputum. Chronic bronchitis also causes shortness of breath and is often accompanied by infection, mucus production, and coughing.

Congestive Heart Failure

Congestive heart failure (CHF) is a result of too much fluid in the lungs making it difficult to get air in—as opposed to a COPD patient who has trouble getting air out.

CHF is usually chronic with acute exacerbations. During an acute exacerbation the patient will present sitting up, short of breath, diaphoretic, and pale or cyanotic in color. Breath sounds can include rales or wheezes. The medical history can include increased salt ingestion, respiratory infection, non-compliance with medications, angina, or symptoms of acute coronary syndrome. Common medications include:

- ACE inhibitors
- Furosemide (Lasix)
- HCTZ (hydrochlorthiazide)
- Beta-blockers
- Angiotensin II receptor blockers
- Digoxin (Lanoxin)

Medications can help differentiate this patient's symptoms from those of someone with COPD. When treating CHF, seat the patient upright and administer high flow oxygen; consider positive pressure ventilation with a BVM if the patient is experiencing severe respiratory difficulty.

Elaboration – CHF

Congestive heart failure occurs when the ventricles are weakened by myocardial infarction, underlying coronary artery disease, hypertension, or valve disease.

This impairs the heart’s ability to contract and empty during systole and blood backs up in the lungs and tissues of the body. Increased pressure in the left ventricle is transmitted to the lung capillaries and fluid is forced into the alveoli. This interrupts gas exchange and results in shortness of breath.

Increased pressure in the right ventricle causes fluid to back up into the body’s tissues, leading primarily to swelling in the lower extremities.

CHF patients commonly do not suffer from a purely left- or purely right-ventricle heart failure, but rather they present with a combination of symptoms (e.g., fluid in the lungs and swelling in the lower extremities).

If a patient is producing copious amounts of frothy pink sputum, do not spend a lot of time suctioning, but instead provide aggressive, positive-pressure ventilation. When done correctly, positive-pressure ventilation can relieve symptoms dramatically.

Inhalation Injuries

Inhalation injuries are due to breathing of chemicals, smoke, or other substances. Common chief complaints include: shortness of breath, coughing, hoarseness, chest pain due to bronchial irritation, and nausea. Individuals with decreased respiratory reserve (e.g., history of COPD or CHF) are likely to experience an exacerbation of the disease.

If a patient is in respiratory distress, treat immediately with high flow oxygen. Assist breathing with a BVM if the respiratory effort is insufficient as indicated by a slow rate and poor air exchange.

Pneumonia

Symptoms of pneumonia include fever, chills, cough (often with yellowish sputum), shortness of breath, general discomfort, fatigue, loss of appetite, and headache. There can be chest pain associated with breathing (usually sharp and stabbing in nature) and worsened by coughing or deep inspirations. Other signs that sometimes present are rales, clammy skin, upper abdominal pain, and blood-tinged sputum.

Emergency care for pneumonia depends on the severity of breathing difficulty but may include oxygen therapy.

Pneumothorax

A pneumothorax is the presence of air in the pleural space. It is caused when an internal or external wound allows air to enter the space between pleural tissues. This causes collapse of the lung.

A pneumothorax can cause sharp chest pain and shortness of breath. You may be able to feel subcutaneous air and breath sounds will be diminished.

Treatment of a pneumothorax includes high flow oxygen. Be judicious with use of positive-pressure ventilation; it can turn a spontaneous pneumothorax into a life-threatening, tension pneumothorax.

Elaboration — Pneumothorax

A pneumothorax is the presence of air between the two layers of the pleura — also called the pleural space. Under normal conditions there is no air between these layers because they are sealed together. However, air or blood can enter the space, for example, when a hole is punctured in the chest wall by a gunshot or stab wound.

A pneumothorax can occur spontaneously (e.g., a rupture due to disease or localized weakness of the lung lining) or as a result of trauma. Forceful coughing can cause a pneumothorax as well. Chest injury and prior history of pneumothorax are possible medical histories. COPD is a risk factor.

A pneumothorax can cause collapse of the entire lung. The only symptom may be sudden chest pain.

Elaboration — Tension Pneumothorax

A tension pneumothorax is a progressively worsening pneumothorax that begins to impinge on the function of the lungs and the circulatory system. It is caused when a lung injury acts like a one-way valve that allows free air to move into the pleural space, but prevents the free exit of that air. Pressure builds inside the pleural space and compresses the lungs and other organs. The early signs of a tension pneumothorax include:

- Increased dyspnea
- Cyanosis
- Signs of shock
- Distended neck veins
- Tracheal displacement
- Tracheal deviation

Pulmonary Embolism

A pulmonary embolism (PE) occurs when a particle (such as a blood clot, fat embolus, amniotic fluid embolus, or air bubble) gets loose in the blood stream and travels to the lungs. The embolus lodges in a major branch of the pulmonary artery and circulation through a large portion of the lung is interrupted. Blood is not able to reach the alveoli and it cannot be oxygenated.

This condition can be caused by immobility of the lower extremities, prolonged bed rest or recent surgery. Signs of PE are a sudden-onset of shortness of breath, tachypnea, chest pain worsened by breathing and coughing up blood.

Pulmonary embolism is a life-threatening condition and should be treated with high flow oxygen and rapid transport. Move the patient gently to avoid dislodging additional emboli.

Assessment of Respiratory Status

Start your evaluation of respiratory status by assessing the rate and depth of respirations. A normal rate is between 12 and 20 respirations per minute for an adult. The depth of respirations is more subjective and varies from shallow, normal, labored, or gasping. Together the rate and depth will tell you whether tidal volume is adequate.

In addition to rate and depth, your assessment of respiratory status should take into consideration other signs that indicate an adequate oxygen supply to the body’s tissues such as:

- Level of consciousness
- Breathing effort
- Ability to speak in complete sentences
- Use of accessory muscles
- Skin color
- Breath sounds
- Body position

Elaboration – Irregular Breathing Patterns

Irregular breathing patterns are generally caused by specific conditions. For example, *Cheyne-Stokes respirations*, which may be seen in head injuries and stroke, are characterized by periods of breathing with gradually increasing and decreasing of tidal volume interspersed with periods of no breathing.

Irregular, ineffective respirations with no clear pattern are called *ataxic respirations*.

Agonal respirations are an abnormal pattern of breathing characterized by ineffective, slow inspirations followed by long pauses. They are often sound like gasps. Agonal respirations are associated with cardiac arrest or severe end-stage shock.

Auscultation of Breath Sounds

The proper technique for auscultating the chest using a stethoscope includes:

- Listen at six locations on the back
- Listen at four locations on the front
- Instruct the patient to take a deep breath through the mouth then exhale
- Listen to one or two inspiration/expiration cycles per location
- Avoid listening through clothing

Changing airflow patterns inside the lungs produce normal breath sounds. They make a "swishing" sound as one breathes in or out. Absent breath sounds can indicate apnea, pneumothorax, hemothorax, or lung removal.

Breath Sounds

EMTs must be able to distinguish normal breath sounds from abnormal breath sounds.

Airway Management

Airway management is one of the most important skills for an EMS provider. You should be well versed in the following airway management techniques:

- Head tilt/chin lift
- Jaw thrust
- Patient positioning
- Airway adjuncts
- Suction
- Oxygen therapy

- Assisted ventilation
- Relief of foreign body airway obstruction

Suction

The purpose of suction is to remove vomit, blood, excretions, and other matter from the airway. Here are some guidelines to use for suctioning:

- Measure the tip from corner of mouth to earlobe
- Oxygenate the patient well (if the situation permits)
- Insert the tip into the oral cavity without applying suction
- Move the suction tip side–to-side
- Oxygenate well after suctioning

Elaboration - Tips for Effective Suctioning

Measure the tip the same as for an oropharyngeal airway—from the corner of the mouth to the ear lobe or from the center of the mouth to the angle of the jaw. Insert the tip only to the base of the tongue.

If the situation permits (e.g., there is no significant airway threat), give at least 30 seconds of oxygen before suctioning. Administer oxygen after suctioning and consider assisting ventilations with a bag-valve mask to help provide extra oxygen.

Do not apply suction while inserting the tip. This can rob the airway of oxygen.

Apply suction for no more than 15 seconds at a time. In rare cases, copious vomiting that threatens the airway may require more suctioning. In infants and children, suction for shorter periods of time (e.g., no more than 5 seconds).

If there are secretions or emesis that you cannot easily remove with suction, position the patient so that gravity and a finger sweep can quickly clear the airway.

Assisted Ventilation

For patients who lack oxygen (e.g., someone with a decreased respiratory drive from a narcotic overdose) you must take quick action to improve the depth and rate of respirations. A bag-valve mask (BVM) is a useful tool for improving ventilation and acid-base (pH) balance. The proper technique for assisting ventilation with a BVM is as follows.

Unconscious breathing patient:

- Consider the need for an oropharyngeal airway
- Do not over-ventilate
- Keep the airway open
- Maintain a good seal
- Apply the Sellick maneuver which can help reduce airflow into the stomach

Non-breathing patient:

- Deliver a ventilation of 1-second duration
- Deliver enough volume to make the chest rise
- 12 ventilations/min
- 8-10 ventilations/min if an advanced airway is in place

Oxygen Delivery

The amount of oxygen you administer to a patient and the method of administration depend on several factors including medical history and the cause of respiratory problem. Here are delivery rate guidelines for various devices:

Rate	Volume (liters/min)	Device
Low flow	2 – 6	Nasal cannula or blow by
High flow	10 – 15	Non-rebreathing mask
High flow with ventilation	15+	Bag-valve mask with reservoir

Summary

The main structures of the respiratory system are:

- Pharynx
- Trachea
- Epiglottis
- Alveoli
- Bronchi
- Bronchioles
- Larynx
- Pleura
- Diaphragm

The respiratory system is an important mechanism for regulating pH in the body. If respiration is impaired, carbon dioxide builds up in the blood (causing hypercarbia) and producing an acid. BLS providers can help treat this condition by improving ventilation.

Signs of severe airway obstruction include poor air exchange and increased breathing difficulty.

Persons with a COPD-related emergency may present with shortness of breath, fever, and increased sputum production. Signs of congestive heart failure can include an acute onset of breathing difficulty, diaphoresis, and cyanosis.

A pneumothorax can cause sharp chest pain and shortness of breath. Signs of pulmonary embolism include a sudden onset of shortness of breath, tachypnea, chest pain worsened by breathing, and coughing up blood.

Treatment for a respiratory emergency can include high flow oxygen and, in the case of decreased respiratory drive, assisted ventilations. CHF patients may require positive-pressure ventilations.

The proper technique for auscultating the chest includes:

- Listen at six locations on the back

- Listen at four locations on the front
- Move from bottom to top in a medical patient
- Instruct the patient to take a deep breath through the mouth then exhale
- Listen to one or two inspiration/expiration cycles per location
- Avoid listening through clothing

Guidelines for use of suction include:

- Measure the tip from corner of mouth to earlobe
- Oxygenate the patient well (if the situation permits)
- Insert the tip into the oral cavity without applying suction
- Move the suction tip side to side
- Oxygenate well after suctioning

The key points for ventilating an unconscious breathing patient are:

- Consider oropharyngeal airway
- Do not over ventilate
- Keep the airway open
- Maintain a good seal

Apply the Sellick maneuver which can help reduce airflow into stomach