



## University of Utah Center For Emergency Programs

### Emergency Medical Technician Continuing Medical Education

Asthma Management

March 2007

## I. Incidence, Impact and Goals of Asthma

### A. Statistics

#### 1. Prevalence, Morbidity, Mortality

a) In 2003, 20 million Americans were diagnosed with asthma with 72% of men and 86% of women continue to experience symptoms 15 years after diagnosis

b) Prevalence varies between states (5.6 and 9.9%), however in Utah the prevalence is 8% in adults (2004)

c) Rates of asthma were on the rise until the 1990's, however, morbidity and mortality rates have peaked and may have even begin to decrease

d) In 2002, 4200 deaths from asthma, 480,000 hospital discharges, 1.9 million ED visits

#### 2. Childhood statistics

a) Asthma is the leading serious chronic illness of children in the U.S. In 2003, an estimated 6.2 million children under age 18 (1.2 million under age 5) had asthma, of which 4 million had an asthma attack.

b) Asthma is the third leading cause of hospitalization among children under the age of 15. Close to 39 percent of hospitalizations due to asthma in 2002 were in those under age 15; however, only 2 percent of the U.S. population was younger than 15 years of age.

c) It is also the number one cause of school absences attributed to chronic conditions, leading to an estimated 12.8 million school days lost annually.

#### 3. Human Impact of the disease

a) One in five adults have seen a doctor regularly and only one-third use medication to control their disease

b) One-half say the disease limits their ability to participate in physical activity or recreation

c) One-third report it limits their normal activity

d) One-half report it interferes with social activities

e) In 2003, 24.5 million work days were lost due to asthma with \$11.5 billion in direct health costs such as medical expenses and \$4.6 billion in indirect costs such as lost work, increased day care, etc..

### B. Organizations Working to Improve Asthma Management

#### 1. American Lung Association and the American Lung Association of Utah.

a) The mission of the American Lung Association® is to prevent lung disease and promote lung health. The American Lung Association® is the oldest voluntary health organization in the United States, with a National Office and constituent and affiliate associations around the country. Founded in 1904 to fight tuberculosis, the American Lung Association®

today fights lung disease in all its forms, with special emphasis on asthma, tobacco control and environmental health.

b) The mission of the American Lung Association of Utah is similar to the American Lung association but its efforts are directed to the people of Utah.

2. National Asthma Education and Prevention Program (NAEPP) was initiated in March 1989 to address the growing problem of asthma in the United States. The NAEPP is administered and coordinated by the National Heart, Lung, and Blood Institute (NHLBI). The NAEPP works with intermediaries including major medical associations, voluntary health organizations, and community programs to educate patients, health professionals, and the public. The ultimate goal of the NAEPP is to enhance the quality of life for patients with asthma and decrease asthma-related morbidity and mortality. The NAEPP Goals in Long Term Management are:

a) Assessment and Monitoring

**(1) Achieve normal or near normal lung function**

**(2) Maintain normal activities, including physical activity**

b) Pharmacologic Therapy

**(1) Quick relief medications**

**(2) Long term control medications**

**(3) Experience no or minimal side effects**

c) Control Factors Contributing to Severity

**(1) Preventing chronic symptoms during daytime and nighttime**

d) Patient Education

**(1) Be satisfied with asthma care**

3. Utah Department of Health Asthma Program is located at the Utah Department of Health in the Bureau of Health Promotion. It began in December 2001 with the intent to develop a state capacity to address asthma, including an occupational component. The program is funded through the Centers for Disease Control and Prevention (CDC). Its program goals includes

a) Create an infrastructure to address asthma from a public health perspective

b) Create a public health assessment and monitoring system for asthma;

c) Build partnerships and improve partner capacity; and

d) Develop population-based strategies to improve asthma care and management.

**C. Goals For This Continuing Medical Education Activity**

1. Review basic anatomy and physiology of the respiratory system
2. Review the pathophysiology and classification of asthma
3. Discuss the medical assessment of patients experiencing asthma
4. Discuss both acute and chronic management of asthma

## **II. Anatomy Review**

### **A. Thoracic Cavity**

#### **1. Lungs**

a) The thoracic cavity includes two lungs one on each side of the mediastinum (the space between the lungs). The right lung is comprised of three lobes. The left lung has two lobes to allow room for the heart which sits predominantly on the left.

#### **2. Heart**

a) The heart, a muscular organ that circulates blood around the body is also located in the thoracic cavity. It is comprised of two pumping systems, one of which circulates blood and fluids throughout the body while the other circulates blood and body fluids through the lungs. Both systems carry oxygenated and deoxygenated blood.

#### **3. Other Thoracic Structures**

a) The thoracic cavity contains other structures such as large blood vessels and the esophagus. The lining of the thoracic cavity, the parietal

pleura, makes constant contact with the lining that covers the lungs, the visceral pleura. These two linings slide between each other during ventilation with the help of a pleural fluid.

## B. Upper Respiratory Anatomy

### 1. Nose and Mouth

a) The mucus membranes that cover turbinates and concha of the nose and mouth aid in warming, humidifying and filtering the air that is breathed into the respiratory system.

### 2. Pharynx

a) The pharynx is that portion of the throat located between the mouth (oropharynx), the nose (nasopharynx) and the larynx (laryngopharynx).

### 3. Epiglottis

a) The epiglottis is a leaf-shaped structure that prevents food and liquid from entering the larynx during swallowing of food and fluids.

## C. Lower Respiratory Anatomy

### 1. Larynx

a) The larynx is comprised of several cartilaginous structures, including the thyroid cartilage, and the cricoid cartilage that connect to the trachea. The larynx provides support for the vocal cords and is also referred to as the voice box.

### 2. Trachea

a) The trachea is a tube that connects the larynx with the smaller tubes of the airways. It is comprised of "C" shaped cartilaginous rings held together by fibrous connective tissue. Small hair like projections that line the trachea, called cilia, help to trap particles breathed into the lungs not previously caught by the mucus membranes of the nose and pharynx.

### 3. Bronchi

a) The trachea divides into two major branches of called bronchi. Each bronchus divides into smaller air passages called bronchioles. The bronchioles are lined with cells that produce mucus. They also have circular layers of smooth muscles that contract and relax to decrease or increase the size of the lumen of the bronchiole. These bronchioles continue to branch smaller and smaller eventually ending at the alveoli.

### 4. Alveoli

a) The alveoli are the functional unit of the lung. The wall of the alveoli is only one cell thick and covered with capillaries from the pulmonary vascular system. Exchange of oxygen and carbon dioxide occur in the alveoli.

## D. Muscles of Respiration

### 1. Primary Muscles of Respiration

a) The primary muscles of respiration are the diaphragm, external intercostal and scalene muscles.

### 2. Accessory Muscle of Respiration

a) Additional muscles that may also be used to assist in the movement of air into and out of the lungs include sternocleidomastoid, internal intercostal, and the rectus abdominus muscles. These muscles help during inhalation and exhalation.

## III. Physiology Review

### A. Respiration

1. Respiration is a complex process of moving oxygen and carbon dioxide into and out of the cell. In air-breathing vertebrates such as humans, respiration of oxygen includes four stages:

a) Ventilation from the ambient air into the alveoli of the lung.

b) Pulmonary gas exchange from the alveoli into the pulmonary capillaries.

c) Gas transport from the pulmonary capillaries through the circulation to the peripheral capillaries in the organs.

d) Peripheral gas exchange from the tissue capillaries into the cells and mitochondria.

2. Quite breathing describes respirations at rest under normal conditions

**B. Ventilation** is a two step process of inhalation and exhalation. It is regulated by various processes within the body producing changes in ventilations that can be measured.

1. Inhalation

a) Inhalation is an active process. It requires the expenditure of energy (ATP used by the muscles to contract) during normal ventilations. During ventilation, the diaphragm and intercostal muscles contract, increasing the size and volume of the thoracic cavity. During this process the diaphragm flattens and moves downward flaring the lower portion of rib cage and the ribs move upward and outward.

b) These changes to the shape of the thorax cause an increase in the volume or space of the thorax and creates a negative pressure drawing air into the lungs.

2. Exhalation

a) Exhalation is a passive process that does not require energy under normal ventilations. When the diaphragm and intercostal muscles relax, the size and volume of the thoracic cavity decreases. During this process the diaphragm moves upward and arches to a normal position while the ribs move downward and inward returning to a normal position.

b) With a decrease in the space within the thoracic cavity a positive pressure is created and air is forced out of the lungs.

c) When exhalation becomes an active process, using accessory muscles of ventilation to expel air from the lungs, an individuals work of breathing is considered increased.

3. Neuroregulation of Ventilation

a) The Central Pattern Generator is a group of neurons located in the brain stem that automatically create the rhythmic cycle of inspiration and expiration. Part of this group of neurons (dorsal respiratory group) stimulate contraction of primary muscles of respiration initiating inspiration for 2 seconds. As neurons found in this group fire and recruit more neurons to fire until the rib cage expands smoothly. Another group of neurons (ventral respiratory group), located within the central pattern generator, control active expiration, for example, during exercise. The central pattern generator is quite sensitive to levels of various chemicals within the body.

4. Chemoregulation of Ventilations

a) Ventilations are regulated by chemical receptors that measure the pH of the blood, oxygen and carbon dioxide levels. The primary drive to breath in normal healthy people is the level of  $\text{CO}_2$  in the blood.

b) However, in some people with Chronic Obstructive Pulmonary Diseases (COPD), increased  $\text{CO}_2$  levels, from years of hypoxia, weaken the influence of this chemical drive for respirations. These individuals may become more dependent on the levels of oxygen in the blood to drive respirations rather than the levels of carbon dioxide.

c) Chemoreceptors measure the pH (a measure of hydrogen ion concentration) of the blood and make acute adjustments to acidosis or alkalosis by changing the ventilatory rate.

5. Air Flow Measurements

a) Respiratory rate is the number of ventilations per minute. Remember that one ventilation or respiration includes both inspiration and expiration. The normal rate of respirations for an adult during quiet breathing is between 12 and 20 breaths per minute. For children during quiet breathing the normal respiratory rate is a bit faster, between 15 and 30 breaths per minute depending on the age of the child.

b) Tidal Volume is the amount of air moved in one ventilation. For the average male adult, this is about 500 ml per each ventilation during quiet breathing.

c) Total Ventilation or Minute Volume is calculated by multiplying the ventilation rate with the tidal volume. This represents the amount of air moved in and out of the lungs during ventilation.

d) Forced Vital Capacity (FVC) This is the total amount of air that you can forcibly blow out after full inspiration, measured in liters.

e) Forced Expiratory Volume in 1 Second (FEV<sub>1</sub>) This is the amount of air that you can forcibly blow out in one second, measured in liters. Along with FVC it is considered one of the primary indicators of lung function.

f) Peak Expiratory Flow (PEF) This is the speed of the air moving out of your lungs at the beginning of the expiration, measured in liters per second.

C. Perfusion is the process of transporting nutrients, including oxygen to the tissues of the body. In human physiology this is done using the cardiovascular system.

1. Pulmonary Gas Exchange

a) Gasses, oxygen and carbon dioxide, are exchanged in the alveoli of the lungs based on concentration gradients. Ambient air contains about 21% oxygen, 78% nitrogen (an inert gas), and 1% of various other gasses. During ventilation, as the air passes over the mucus membranes of the nasal passages, the air is humidified. The addition of water to the inhaled gasses assists in the exchange of gasses in the alveoli.

b) Capillaries from the pulmonary vascular system contain low quantities of oxygen higher concentrations of carbon dioxide it received from the tissues of the body.

c) The high concentrations of oxygen in the alveoli cross through alveolar wall membrane into the pulmonary capillary system which has a low concentration of oxygen. The high concentrations of carbon dioxide in the pulmonary capillary bed diffuse across the pulmonary capillary membrane into the alveoli. The movement of gasses is done through simple diffusion in an effort to equalize the concentrations of gasses on both sides of the alveolar and pulmonary capillary membranes.

2. Hemoglobin

a) Red blood cells contain a protein, hemoglobin, which has an affinity for oxygen that helps transport oxygen in the body. The lack of oxygen attached to the red blood cells (hemoglobin) of the pulmonary capillary system facilitate the movement of oxygen across the alveolar and pulmonary capillary membranes. When the red blood cells (specifically the hemoglobin) bind with the newly arriving oxygen the color of the red

blood cell changes. This contributes to the “brighter” color of oxygenated blood.

#### D. Transport of Gasses

1. Gasses diffused during ventilation and perfusion are transported to the various tissues and cells of the body through the systemic vascular system. The arterial side of the cardiovascular system transports blood away from the heart and for the most part carries oxygenated blood. The exception to this rule is the pulmonary arteries which carry deoxygenated blood from the heart to the lungs.
2. After peripheral gas exchange, the venous side of the cardiovascular system returns the blood back to the heart and for the most part veins carry deoxygenated blood. The exception to this rule is the pulmonary veins which carry oxygenated blood from the lungs to the heart.

#### E. Peripheral Gas Exchange

1. Gasses transported to the tissues and cells of the body by the systemic cardiovascular system contain high concentrations of oxygen and low concentrations of carbon dioxide. At the cellular level of tissues within the body and exchange of oxygen for carbon dioxide occurs, again in part through the concentration gradients of diffusion.
2. The result is higher concentrations of carbon dioxide and lower concentrations of oxygen after peripheral gas exchange.

#### F. Assessment Tools of Ventilation, Perfusion and Oxygenation

1. Respiratory Rate and Effort (place chart of values)
  - a) Normal respiratory rates vary depending on the individuals age, oxygen needs, and baseline pulmonary function. Change in respiratory rate help to determine poor oxygenation and or perfusion.
  - b) Normal respiratory effort should be without increased work and effort to move air into and out of the lungs. Changes in respiratory effort may indicate poor oxygenation and or perfusion.
2. Skin Assessment
  - a) Normal skin color, or the normal color of a persons mucus membranes, should be pink indicating the presence of blood within the capillaries. Normal skin temperature should be warm indicating the movement of blood from the warm core of the body to the surface capillaries in the skin. Changes in the skins color or temperature may indicate poor oxygenation and/or perfusion.
3. Pulse Oximetry
  - a) Pulse oximeters use an LED and sensor to measure the diffusion of light in a capillary bed, the most common is in a finger, however, the toe, the nose or an ear lobe may also be used. Depending on the size of an infant, a foot may be used.
  - b) The change in the LED light from one side of the capillary bed to the sensor on the other side measures the amount of hemoglobin that is bound to oxygen, also known as oxygen saturation.
  - c) Under normal conditions, a pulse oximeter is presumed to indicate levels of oxygen in the capillary bed specifically and the blood stream generally. However, because the oximeter only measures the saturation of hemoglobin, a person could be exposed to a chemical (e.g. carbon monoxide which also is bound to hemoglobin) and indicate a normal oximetry value despite hypoxia in the patient.
  - d) Since the pulse oximeter is dependent on adequate blood flow through the capillary bed to read accurately. Hypoperfusion for any reason (severe anemia, cold digits, significant hypotension), may return an inaccurate oxygen saturation reading.
  - e) Coloring of nail beds may also affect the accuracy of the pulse oximeter reading

f) At this altitude, in the intermountain area, an oxygen saturation above 93% is considered normal. When a saturation is between 90 and 93%, the provider should consider potential causes for the low values. It is not unusual for chronic smokers or those with significant lung disease to have values in the low 90s. For individuals with a pulse oximeter reading of under 90%, the provider should immediately determine causes and initiate appropriate treatment to correct the hypoxia based on the patients history and physical exam.

#### 4. Pulmonary Function Tests

a) Pulmonary function tests are used to measure volumes of air patients move in and out of their lungs during breathing. Conditions can be varied to assess how well and how much air moves in and out of the lungs.

b) Spirometry (meaning the measuring of breath) is the most common of the Pulmonary Function Tests (PFTs), measuring lung function, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. Spirometry is used to measure airway resistance and air flow for assessing conditions such as asthma, cystic fibrosis, and COPD.

c) Typically, initial pulmonary measurements (TV, FVC, FEV<sub>1</sub>) are taken in a patient and then again after treatment with a bronchodilator. The pre and post values are compared to each other to determine if increased airflow resistance and/or decreased air flow is present.

**(1) FEV<sub>1</sub>/FVC is the percentage of maximum inspiration that is expired in 1 second, usually 80% of FVC.**

d) This type of test is used to evaluate for obstructive lung diseases like asthma, emphysema, and chronic bronchitis.

5. Peak Expiratory Flow Meter or a peak flow meter is a small, hand-held device used to manage asthma by monitoring airflow through the bronchi and thus the degree of restriction in the airways. The peak flow meter measures the patient's maximum ability to expel air from the lungs, or PEF. Peak flow readings are higher when patients are well, and lower when the airways are constricted. From changes in recorded values, patients and doctors may determine lung functionality, severity of asthma symptoms, and treatment options.

## IV. Asthma Pathophysiology

### A. Description

1. Asthma is defined as a chronic inflammatory disorder of the airways. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness and coughing, particularly at night or early in the morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment.

2. Asthma is characterized by excessive sensitivity of the lungs to various stimuli. There is increasing evidence to suggest genetics play an important role in the etiology of the disease. Apparently, environmental factors interact with inherited factors to increase the risk of asthma. Environmental triggers range from viral infections and allergies, to irritating gases and particles in the air. Each person reacts differently to the factors that may trigger asthma. Triggers include:

#### a) Indoor Air Pollutants

**(1) *Secondhand smoke* triggers asthma attacks and causes lower respiratory tract infections, pneumonia and many other harmful conditions. Studies have estimated that secondhand smoke may significantly aggravate symptoms of asthma for 200,000 to 1,000,000 children each year.**

1. *Combustion Products* (aside from tobacco smoke) include carbon monoxide, nitrogen dioxide, and sulfur dioxide. Sources of combustion products include stoves, furnaces, dryers, fireplaces and heaters.

(2) *Biologicals* include substances such as waste matter and dander from living organisms (both pets and pests), pollen, molds, mildew, dust mites, bacteria and viruses.

(3) *Volatile Organic Compounds* are emitted as gases from solids or liquids. Sources include formaldehyde-containing building materials, as well as an array of home and office products ranging from cosmetics, paints, and cleaners to pesticides, copiers and printers, glues and adhesives, and craft supplies.

#### b) Outdoor Pollutants

(1) *Ozone (O<sub>3</sub>)* is a highly reactive form of oxygen that results from sunlight mixing with hydrocarbons (also called volatile organic compounds) and nitrogen oxides released in fuel combustion. Ozone is the main component of smog. Levels in the United States tend to be highest during the summer months. Wind can carry ozone hundreds of miles, so people who don't live in areas with lots of industry or automobiles aren't necessarily safe from high ozone levels.

(2) *Particulate Matter* air pollution (pm) is a complex mixture of substances, including carbon-based particles, dust, and acid aerosols formed in the atmosphere from gaseous combustion by-products such as volatile organic compounds, sulfur dioxide and nitrogen oxides. Sources are vast and varied, including diesel bus and truck emissions as well as ordinary automobile exhaust, industrial and utility smokestacks, coal-fired power plants, mining, and construction. Particle pollution is especially high in urban industrial and heavily trafficked areas, as well as in some rural locales with unpaved roads and extensive wood burning.

(a) Nitrogen Dioxide (NO<sub>2</sub>) forms when fossil fuels are burned at high temperatures and is principally derived from motor vehicle exhaust, coal-fired electric utilities and industrial boilers. Nitrogen oxides are also a key ingredient in the formation of ozone and some particle pollution. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza.

(b) Sulfur Dioxide (SO<sub>2</sub>) is formed when fuel containing sulfur (mainly coal and oil) is burned, and during metal smelting and other industrial processes. Sulfur dioxide is a key ingredient in the formation of some particle pollution as well.

#### c) Other Triggers

(1) **Vigorous Exercise**

(2) **Exposure to cold air or sudden temperature change**

(3) **Excitement**

(4) **Over-The-Counter Drugs** may also trigger asthma. One study found that one adult asthmatic in five can suffer a potentially life-threatening reaction to aspirin.

### **B. Pathophysiology**

1. With exposure to a trigger, a cascade of cellular responses that cause:

a) Increased production of thick tenacious mucus with impaired mucociliary function

b) Mucosal swelling due to increased vascular permeability and vascular congestion

c) Bronchial smooth muscle contraction

2. These changes cause bronchial hyperresponsiveness and obstruction. Airway obstruction increases resistance to air flow and decreases flow rates, including expiratory flow. Impaired expiration causes hyperinflation distal to the obstruction and increases the work of breathing. These changes are not uniform throughout the lungs but regional. Continued air trapping cause



increased intrapleural and alveolar gas pressures resulting in decreased perfusion of the alveoli the result is hypoxia.

3. Late Asthma Response occurs in cases of significant allergen exposure. The symptoms can recur 4 to 12 hours after the initial attack due to persistent cellular activation. It can be more severe than the initial attack.

4. Untreated inflammation can cause long term airway damage that is irreversible (airway remodeling).

### C. Signs and Symptoms of an Asthma Attack

1. Signs and symptoms of an asthma attack include but are not limited to:

a) Classification of Asthma The classification of asthma was previously based on the pathophysiologic differences. Current classification of asthma is based on clinical severity. This allows asthma sufferers and clinicians to better manage treatment choices and clinical outcomes.

2. Mild Intermittent asthma occurs in people with daytime symptoms that occur no more frequently than twice a week and nighttime symptoms that occur no more than twice a month. These people are usually asymptomatic with normal PEFr between exacerbations.

Exacerbations vary in intensity but are usually brief, lasting only hours to days. They do not take daily medications for long term control, only short for quick relief.

3. Mild Persistent asthma is characterized by daytime symptoms that occur more than twice a week but less than once a day with nighttime symptoms more frequent than twice a month. These people are asymptomatic but have abnormal pulmonary function tests. Exacerbations begin to limit their activity. They usually take one medication on a daily basis for long term control. Using medications for quick relief on a daily basis indicates a need for additional long term therapy.

4. Moderate Persistent asthma occurs in people who have daytime symptoms every day and nighttime symptoms more than once a week. Exacerbations limit their activity and occur at least twice a week, and may last for several days. These individuals take one or two long term control medications. Also using medications for quick relief on a daily basis indicates a need for additional long term therapy.

5. Severe Persistent asthma is characterized by continual daytime symptoms and frequent nighttime symptoms. They experience limited physical activity and exacerbations are frequent. These people often take two medications daily for long term control. Also using medications for quick relief on a daily basis indicates a need for additional long term therapy.

### D. Asthma as a Diagnosis

1. Exacerbations of asthma symptoms equates to an individuals control of their asthma. To prevent long term complications of airway remodeling, early detection with an accurate diagnosis is needed to exclude other diseases and causes for difficulty breathing. For example, COPD, CHF, pulmonary embolisms, or mechanical obstruction (from tumors).

2. Spirometry is used to facilitate both diagnosis as well as continued monitoring of pulmonary function throughout an individuals life. Peak Flow meters can be used to establish daily baselines and acute changes from those baselines.

3. Based on the severity of their condition, patients are frequently prescribed medications to control both long and short term symptoms. Taking medications as prescribed is important to maintain an anti-inflammatory effect.

### E. Special Populations with Asthma

1. Infants
2. Children
3. Teenagers
4. Pregnant Women

## V. Management of Asthma

### A. Asthma Control

1. Asthma Management Plan is a written plan to manage the long term effects and control of asthma. The plan is a joint effort of the patient and their physician specific to the individual. An asthma management plan includes things like:

a) medications for daily control including names, dosages, and frequencies

- b) management goals are used to identify the progress of management.
- How well are symptoms being monitored? What are baseline PEFs?
- c) physician contact information and frequency of physician visits
- d) individual triggers must be controlled for prevent exacerbations
- e) reminder for annual flu vaccines

2. Asthma Action Plan (asthma control plan) is a written plan used to manage acute exacerbations of asthma. This is also a joint effort between the patient and their physician and is specific to the individual. An asthma Action plan should include:

- a) Peak flow numbers measure how well the patient is breathing. If the peak flow numbers drop, it means they are having trouble breathing.
- b) Asthma Symptoms such as: coughing, wheezing, shortness of breath and chest tightness. The action plan should tell the patient what to do when they are awakened in the night with symptoms and when to increase treatments to manage asthma symptoms. The plan should be based on the severity or seriousness of these symptoms.
- c) Asthma Medications include different types that the patient should take to control and treat symptoms. You will need to develop instructions about when to take asthma medications.
- d) Emergency Telephone Numbers and Location of Emergency Care

## B. Asthma Medications

### 1. Bronchodilators - Sympathomimetics

- a) The effect of sympathomimetic bronchodilators are airway relaxation, increased ciliary beat frequency, increased force of contraction of skeletal muscles, stop uterine smooth muscle contractions, and intracellular potassium shift.
- b) The mechanism of action for sympathomimetic bronchodilators is to bind the beta2 receptors in airway smooth muscle thus causing bronchodilation and increased ciliary beat frequency. Activation of Na<sup>+</sup>/K<sup>+</sup>/ATPase leads to gluconeogenesis and increased insulin secretion.
- c) Examples of sympathomimetic bronchodilators include albuterol, salmeterol, and terbutaline.

### 2. Bronchodilators - Anticholinergics

- a) The effect of anticholinergic bronchodilators are bronchodilation through inhibition of bronchoconstriction secondary to blockade of the effects of acetylcholine.
- b) The mechanism of action for anticholinergic bronchodilators is non-selective antagonism of muscarinic receptors leads to down regulation of cGMP which results in bronchodilation. Additional acetylcholine is released in response, thus overcoming the effect in smooth muscle.
- c) Examples of anticholinergic bronchodilators include Ipratropium.

### 3. Inhaled Corticosteroids

- a) The effect of inhaled corticosteroids is reduced airway inflammation. Overall airway bronchial hyper-responsiveness decreased. Improved asthma control and increased sensitivity of beta-receptors in smooth muscle.
- b) The mechanism of action for inhaled corticosteroids is to suppress granuloma formation, reduce arachidonic acid metabolism, up regulate beta-adrenergic receptors on leukocytes, and decrease synthesis of prostaglandins and leukotrienes

- c) Examples of inhaled corticosteroids include Beclomethasone, Flunisolide, Triamcinolone.
- 4. Biologic Response Modifiers - Monoclonal Antibodies
  - a) The effect of Biologic Response Modifiers is Decreased frequency of allergen-induced asthma exacerbations. Reduced need for inhaled corticosteroids in maintenance treatment of asthma.
  - b) The mechanism of action for Biologic Response Modifiers is when the monoclonal antibody binds to IgE, thus interfering with mast cell binding. This prevents mast cell degranulation and release of inflammatory mediators. Cytokine release seen in the late phase of an allergic reaction is also prevented through blocking the receptors on dendritic cells, epithelial cells, eosinophils, monocytes, and platelets.
  - c) Examples of monoclonal antibodies include Omalizumab
- 5. Leukotriene Receptor Antagonists
  - a) The effect of leukotriene receptor antagonists is prevention of allergen induced bronchoconstriction.
  - b) The mechanism of action for leukotriene receptor antagonists is antagonism of cysteinyl-leukotriene receptors, thus preventing histamine release.
  - c) Examples of leukotriene receptor antagonists are Montelukast and Zafirlukast
- 6. Mast Cell Stabilizers
  - a) The effect of mast cell stabilizers is prevention of bronchoconstriction and inflammation.
  - b) The mechanism of action of mast cell stabilizers is to antagonize mast cell degranulation to prevent the release of histamine and other mediators of allergic reaction. Agents do not interfere with IgE. The anti-inflammatory mechanism is unknown. Examples of mast cell stabilizers include Cromolyn and Nedocromil.
- 7. Methylxanthene Derivatives
  - a) The mechanism of action for methylxanthene derivatives is bronchodilation. Secondary effects include increased strength of diaphragm, decreased fatigue, CNS stimulation, improved response to hypoxemia, decreased
  - b) The inhibition of phosphodiesterase stops the breakdown of 3',5' - cAMP at high doses. Proposed mechanisms of action include prostaglandin antagonism, stimulation of endogenous catecholamines, inhibition of calcium influx into smooth muscle (preventing muscle contraction), antagonism of adenosine receptors, and inhibition of release of mediators from leukocytes and mast cells.
  - c) Examples of methylxanthene derivatives include theophylline.

### C. Additional and Alternative Therapies

1. Asthma Education - Specific asthma education can help patients reduce the psychosocial complications in asthma management. The education should be provided in a formal setting, either by a certified asthma educator, an asthma camp or other means.
2. Cognitive Behavior Therapy is a psychotherapy based on modifying everyday thoughts and behaviors, with the aim of positively influencing emotions. Cognitive Behavioral Therapy (CBT) is based on the idea that how we think (cognition), how we feel (emotion) and how we act (behavior) all interact together. Specifically, our thoughts determine our feelings and our behavior. Therefore, negative - and unrealistic - thoughts can cause us distress and result in problems. CBT is widely accepted as an evidence-based, cost-effective psychotherapy for many disorders. It is sometimes used with groups of people as well as individuals, and the techniques are also commonly adapted for self-help manuals and, increasingly, for self-help software packages.

a) Relaxation Exercises - Relaxation and distraction techniques are also commonly included. There is a strong anxiety component to asthma and anxiety disorders are more common in asthmatics and have a considerable influence on asthma management because they influence symptom perception. Excessive anxiety about asthma symptoms can affect the patient's response to an asthma attack; anxiety related to asthma triggers can reduce the patient's quality of life and anxiety related to medical treatment can influence compliance. During an asthma attack every attempt should be made to reduce the anxiety that accompanies difficulty breathing. Relaxation exercises may be used to prevent acute attacks and may be useful in treating mild to moderate cases of acute exacerbations.

3. Chinese Herbal Therapy (CHT) - used for thousands of years, has been suggested to have a potential for treating allergies and asthma. However, a role for CHT in asthma therapy remains to be established because there are few well-controlled scientific studies demonstrating its efficacy, safety and mechanisms of action. During our grant period we generated an asthma herbal medicine intervention ASHMI (composed of 3 herbs) derived from the original anti asthma formula (composed of 14 herbs). This development makes herbal formula quality control less difficult. Accomplishing this study will be of fundamental importance to validate the possible pharmacological actions of Chinese herbal medicine on allergic asthma, and provide advanced understanding of the immunotherapeutic mechanisms underlying ASHMI effects on allergic asthma. Ultimately, this study along with the studies addressed in other projects of this center grant may lead to a novel approach-botanical drug for treating asthma and perhaps other allergic inflammatory disease.

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- IX. National Asthma Education Prevention Program, <http://www.nhlbi.nih.gov/about/naepp/>
- X. Asthma Management: The Pathway to IgE in Asthma Inflammation; American Academy of Physician Assistant's 34<sup>th</sup> Annual Physician Assistant Conference, San Francisco, CA, 2006. Sponsored by Genetech, Inc. And Novartis Pharmaceuticals Corporation.
- XI. Human Physiology, an Integrated Approach, 3<sup>rd</sup> edition, Silverthorne, D., Pearson Education, 2004

Write up a sample asthma action plan. Give the plan to the EMTs. Using a slide show, present the acute symptoms, based on the plan have the EMTs determine correct course of treatment.

Frequently asked questions can be used as myths or truths game, write power point jeopardy of some kind, or do who wants to be a millionaire.

## Chinese Herbal Treatment

[http://crisp.cit.nih.gov/crisp/CRISP\\_LIB.getdoc?textkey=7126542&p\\_grant\\_num=5P01AT002647-02&p\\_query=&ticket=27058158&p\\_audit\\_session\\_id=190532450&p\\_keywords=](http://crisp.cit.nih.gov/crisp/CRISP_LIB.getdoc?textkey=7126542&p_grant_num=5P01AT002647-02&p_query=&ticket=27058158&p_audit_session_id=190532450&p_keywords=)