ASTHMA

Abstract

A high number of the population in the United States visit emergency rooms and are admitted to hospitals every year due to having an asthma condition. Individuals who have asthma have to live with the knowledge that at any time, they may suddenly, and often without warning, be barely able to breathe. An asthma attack occurs when there is a sudden obstruction of the bronchial tubes, and generally is due to an exposure or triggering factor. Three complex pathologic processes found in asthma, involving hypersensitivity of the bronchial passages, airway inflammation, and airway obstruction are discussed. Asthma can be a temporary disease but for many people it is chronic and without a cure. There are effective treatments and methods of prevention available for people who live with asthma.

Learning Objectives:

1. Identify the basic causes of asthma attacks.
2. Identify common signs and symptoms of an asthma attack.
3. Identify the treatment options for asthmatic patients.

Introduction

An asthma attack occurs when there is a sudden obstruction of the bronchial tubes. This happens because the person with asthma has been exposed to some kind of "trigger." Asthma is characterized by three, complex pathologic processes in the lungs, which include hypersensitivity of the bronchial passages, airway inflammation, and airway obstruction. For some people asthma will be a temporary disease however many asthma sufferers live with a chronic disease for which there is no cure. The medical management of asthma can be very effective to treat symptoms and to provide people diagnosed with asthma have a good quality of life.

What Is Asthma?

Asthma is a sudden obstruction of the bronchial tubes that causes difficulty with breathing. The word asthma comes from an ancient Greek word that means “noisy breathing.” This description of this disease is accurate since an asthmatic attack is often characterized by audible wheezing. Unlike other lung diseases such as emphysema, people with asthma do not have difficulty breathing all the time. They have asthma attacks - sudden episodes of wheezing, coughing, difficulty breathing and other signs and symptoms. Asthma attacks happen suddenly, they are sporadic in nature, and between asthma attacks the person diagnosed with asthma feels fine.

In the great majority of people who have asthma, the disease is not dangerous. It does not have a high mortality rate. Nevertheless, asthma can be a serious disease for some people.

There are millions of emergency room visits and hundreds of thousands of hospital admissions every year that are directly related to asthma. People with asthma miss work and children with asthma miss school. Everyone with asthma has to live with the knowledge that at any time, they may suddenly, and often without warning, be barely able to breathe.

There is quite a lot that is known about why asthmatic attacks happen, what goes on in the lungs during an asthma attack, and how to treat and prevent the disease. For some people asthma will be a temporary disease but for most asthma sufferers it is a chronic disease and there is no cure. However, asthma can be managed and there are very effective treatments and methods of prevention that can help people with asthma lead normal lives.

Respiratory System Anatomy and Physiology

The respiratory system, also called the pulmonary system, begins with the nose and the mouth. Attached to the back of the mouth is a stiff but somewhat flexible tube that is called the trachea, often referred to as the windpipe. The trachea ends at about the level of the shoulders and is attached to two other stiff but flexible tubes, which are called the left and right main stem bronchi. At the end of the bronchi are the left and right lungs.

The lungs are large flexible organs that contain many small hollow passages that branch off from the two main stem bronchi, and are called the bronchial tubes. Collectively these are often referred to as the bronchial tree. The bronchial tubes extend to the outer parts of the lungs

and they end in the alveoli. The alveoli are small clusters of air sacs that look very much like clusters of grapes.

The anatomy of the pulmonary system is fairly complex but the structures that comprise this organ system can be divided into two categories: gas-transporting and gas-exchanging. The nose, mouth, main stem bronchi and the bronchial tree are gas transporting structures, and the alveoli are the gas exchanging structures.

The body uses food to produce the energy a person needs to survive. However, the nutrients in food, carbohydrates, proteins and fats, cannot be utilized for energy unless oxygen is present. One of the primary jobs of the respiratory system is to deliver oxygen to the body so it can process nutrients for energy. Oxygen is delivered to the body when a person inhales.

The body also produces waste products when nutrients are used for energy and from the normal metabolic processes. Carbon dioxide is one of the by-products of metabolism and nutrient utilization, and it is eliminated by both the kidneys and the lungs. These waste products are much like the exhaust gases of a car that result from burning gasoline and the body cannot survive if it accumulates carbon dioxide or other waste products.

Oxygen is delivered to the body when a person inhales, and carbon dioxide is eliminated from the body when a person exhales. The process of breathing, of inhaling and exhaling, and moving air through the lungs is called ventilation. The process of moving oxygen from the air to the blood and carbon dioxide from the blood to the air is called respiration.

When a person inhales, air moves through the nose and mouth, down the trachea to the bronchi and then to the alveoli. Immediately next to the alveoli are an enormous number of tiny blood vessels called the pulmonary capillaries. The walls of the alveoli have extremely small pores and the inhaled air with oxygen moves through these pores and combines with the blood that is passing by in the pulmonary capillaries. Oxygen combines with a special protein in the blood called hemoglobin and it is carried by hemoglobin to the tissues and organs where it can be used to process nutrients for energy. When a person exhales, carbon dioxide leaves the pulmonary capillaries, passes into the alveoli, and is eliminated through the lungs.

Incidence and Prevalence of Asthma

Asthma is one of the most common lung diseases, and more than 22 million Americans have asthma. Asthma is also the most common chronic disease among children, and it is the number one reason for hospitalization in the pediatric population. This has led to the perception that asthma is a childhood disease. Despite this perception, asthma is almost as prevalent in adults as it is in the pediatric population. Each year in the United States there are approximately 2 million patient visits to emergency rooms because of asthma attacks, and over 500,000 patients are admitted to hospitals for the treatment of asthma.

Asthma develops in most children by the age of 3 and in this age group, many more boys are affected than girls but by adulthood this difference has disappeared and men and women are equally affected. Adult onset asthma affects more women than men and in adults asthma is more severe in women than in men.

In many patients, asthma resolves once adolescence or early adulthood is reached but if the disease is carried over to the later years, it is rare that people with asthma will ever be completely asymptomatic in the future. The pattern of asthma and the character of a patient's disease appear to be fixed; people who have mild asthma will always have mild asthma and those with a severe form of the disease will always have severe asthma.

The number of cases of asthma and the death rate from the disease have been rising in the past several decades, but there is evidence that these increases have started to decline or at least stabilize. Asthma is the number one diagnosis in children admitted to hospitals, and asthma is responsible for more school absences and hospitalizations than any other childhood disease. The prevalence and seriousness of asthma is particularly high in African American and Hispanic children; approximately 15% of all Hispanic children have asthma and African American children are twice as likely to die from asthma as are White children.

In recent decades the prevalence of asthma, especially in children, has been rising. This increase has been explained by changes in living patterns that have led to greater exposure to air pollution, indoor air pollution, and allergic material such as mold, house dust, and plant pollens. However, there is evidence that in the past few years this increase in the number of childhood asthmatic cases has levelled.

Disease Causative Factors

There are many different causes of asthma. In most cases, the disease is caused by exposure to a causative factor in a susceptible person. The

causes of asthma can be confusing because many people mistake the underlying causes of asthma with asthmatic triggers, *i.e.*, environmental factors, and the two are not the same.

The causes of asthma are typically atopy, genetics, environmental, occupational exposure, genetics, prenatal, obesity and gender.

Atopy

Atopy is defined as a "predisposition to developing allergic reactions" and asthma is in many important ways an allergic reaction. An allergic reaction, which is also called a hypersensitivity reaction, is an abnormal response by the body's immune system to a foreign substance that normally would not cause a problem. In asthma these foreign substances are called allergens (explained in a later section) and common allergens associated with asthma are air pollutants, dust, cigarette smoke, or pet dander.

When someone who has asthma is exposed to these allergens the exaggerated and intense immune response - the allergic reaction - produces many of the signs and symptoms of an asthmatic. The hypersensitivity to allergens is also the basis for several of the pathologic changes that occur in the lungs of people who have asthma. Almost everyone who has asthma has atopy and people who do not have atopy have a low risk for developing asthma.

Genetics

It is clear that the tendency to develop asthma is inherited and the level of severity of the disease may be partially inherited, as well. The genetic predisposition toward asthma may explain why some people who have

atopy do not suffer from asthma. The atopic person may have a predisposition to developing allergic reactions but this predisposition cannot be fully expressed if the genetic susceptibility to the disease is absent.

Prenatal

The term prenatal refers to the period before birth. Maternal cigarette smoking, increased age of the mother at birth, and a mother who smokes have all been implicated as causes of asthma.

Researchers have looked into the possible relationship between viral infections, air pollution, and allergens as possible causes or triggers for asthma attacks. As discussed here, the evidence is inconclusive with respect to causation.

There has been extensive research investigating the connection between viral infections and asthma, especially the rhinovirus that causes the common cold but at this time there is no evidence that viral infections cause asthma. These infections may trigger an asthma episode or worsen the disease but it does not appear that they cause asthma.

Air pollution has been considered to be a possible cause of asthma. It makes intuitive sense that high levels of air pollution might cause asthma but asthma is as common in rural areas as it is in large urban areas with lots of traffic, and there is no evidence that proves air pollution causes asthma.

Exposure to allergens can definitely trigger an asthmatic episode, but exposure to common allergens such as air pollutants, dust, cigarette

smoke, or pet dander has not been proven to cause asthma. There is no evidence that a specific diet or exposure to common food allergens can cause asthma.

Occupational Exposure

Asthma can definitely be caused by occupational exposure to a wide variety of allergens such as chemicals and fumes.

Obesity and Gender

Asthma is more common in people who are overweight. As mentioned previously, depending on age asthma is more common in one gender as compared to the other.

Pathophysiology of Asthma

This section discusses what happens in the lungs during an asthmatic episode. Asthma is characterized by three, complex pathologic processes in the lungs: 1) Hypersensitivity of the bronchial passages, 2) Airway inflammation, and 3) Airway obstruction. These processes combine to produce *reversible airway obstruction*. Airway obstruction is the primary cause of the signs and symptoms of an asthmatic attack. To understand hypersensitivity of the bronchial passages, airway inflammation, and airway obstruction is to understand asthma.

The term asthmatic episode is more formal and is typically used in the medical literature but the term asthma attack is more commonly used. In the following sections the two terms will be used interchangeably.

Hypersensitivity of the Bronchial Passages

As mentioned earlier, asthma is an allergic reaction. An allergic reaction is an abnormal reaction by the body's immune system to a foreign substance; that is, a person without asthma would not have this reaction. These foreign substances are called allergens and people are exposed to them every day. However, when someone with asthma is exposed to these allergens, there is an exaggerated and intense immune response that is driven by substances such as histamine and cytokines.

Histamine and cytokines are released and/or produced during the hypersensitivity reaction and they have many harmful effects on the lungs. They constrict the bronchial passages, dilate blood vessels, which in turn narrow the bronchial passages, cause excess mucus production, which causes bronchial obstruction, and, they initiate the process of inflammation in the lungs.

Airway Inflammation

Inflammation is one of the defense mechanisms the body uses to respond to infection, injury, or trauma. When there is harm or damage to tissues or organs, the body initiates inflammation and the process of inflammation increases blood flow, causes the blood vessels to "leak" fluid into the affected area, and increases the local production of mucous. The last two inflammatory responses help brings antibodies and other healing components to where they are needed and help to remove injured cells, bacteria, and viruses (if there is an infection) from the inflamed area. Increased blood flow and the leaky blood vessels are an invaluable part of inflammation and the healing process. They also cause the inflamed area to become hot, painful, red, and swollen, the classic signs and symptoms of inflammation.

Inflammation is a natural process and an essential way by which the body protects itself and repairs itself. However in asthma the inflammation is not caused by tissue damage or infection. It is not temporary but it is chronic, can be very intense, and it occurs in a vulnerable area of the body. The result is bronchial passages that are always swollen, leaking fluid, and producing excess mucus. Inflammation in asthma, instead of being a healing process, interferes with normal ventilation.

Airway Obstruction

Airway obstruction is one of the basic pathologic processes in the asthmatic lung, but it primarily results from inflammation and hypersensitivity of the bronchial passage. Inflammation causes the bronchial passages to become swollen and it causes excess mucus production, and bronchial hypersensitivity causes the airway to narrow. However, over time asthma does cause the respiratory passages to become narrow and stiff, an effect that happens apart from inflammation and bronchial passage hypersensitivity.

As mentioned, an asthma attack occurs when there is a sudden obstruction of the bronchial tubes because the person with asthma has been exposed to some kind of "trigger." The asthma trigger starts the process of a hypersensitivity response, which include airway inflammation and airway obstruction. These three processes induce various changes in the bronchial tubes and are closely linked; the changes cause them to become very constricted, narrowed and at times, completely obstructed.

Triggering Factors of Asthma Attacks

There are many causes that trigger an asthma attack; these are the triggers that were mentioned previously. However, everyone is exposed to some level of these asthma triggers but obviously not everyone has asthma. There is a lot of evidence that people with asthma inherit hypersensitivity to the asthma triggers and there is a large amount of evidence that environmental exposure is an important part of why people develop asthma. Someone may be sensitive to an asthma trigger, but if that trigger is not a persistent part of the environment then asthma will not happen.

Asthma is an issue of genetics and the environment. The triggers of asthma do not cause asthma; they simply set the disease in motion. The most common triggers that can cause an asthma attack include:

- Emotional stress
- Temperature, especially cold
- Dust
- Air pollution
- Exercise
- Weather changes
- Humidity
- Respiratory infections
- Pollen
- Mold
- Gastroesophageal reflux disease (GERD)
- Sinus infections
- Cigarette smoke
- Animal dander
- Exposure to cockroaches, rodents, and dust mites

Asthma Attack Signs and Symptoms

Common signs and symptoms of an asthma attack are dyspnea, wheezing, cough, chest tightness, and a rapid respiratory rate. Each one may be more or less prominent.

From the patient's point of view, an asthma attack is very sudden, and at times without much warning, and the patient cannot breathe. The chest feels tight, there is audible wheezing, and no matter how hard the patient tries to inhale, not enough air can be obtained.

An asthma attack can be very frightening for the person with asthma and for anyone witnessing it. For the person who is having an asthma attack, trying to breathe is like trying to inhale through respiratory passages that are restricted, or figuratively speaking, the size of a tiny straw.

Asthma attacks are typically classified as mild, moderate, severe, and imminent respiratory arrest. When a patient is having a mild asthmatic episode, wheezing usually happens during expiration but not inhalation. The pulse rate is less than 100 and the respiratory rate is increased. The patient can speak in complete sentences and can tolerate lying flat. The oxygen saturation is usually normal.

In a moderate asthmatic episode the heart rate is typically greater than 100 and the respiratory rate is increased. The nasal passages are flared and the patient is obviously using all chest muscles to inhale. The wheezing can be clearly heard but it is still usually on expiration only. The patient does not tolerate lying down and although is able to speak, and the patient appears “breathless” while talking. The oxygen saturation is typically at the low end of the normal range.

A severe asthmatic episode is characterized by difficulty breathing while at rest. The patient can only speak in short sentences or perhaps only in words. The patient wheezes during inhalation and exhalation, and the heart rate is greater than 120. The patient is not comfortable lying down, and will usually sit leaning forward, which allows the patient's chest to expand with less effort. The oxygen saturation is abnormally low.

Imminent respiratory arrest is very dramatic. This type of asthmatic attack occurs when the bronchial passages are almost completely closed and the flow of oxygen and carbon dioxide through the lungs is severely restricted. In this type of asthmatic episode the patient may be drowsy and confused, which is more common with children. The patient will be diaphoretic, and the airways become constricted and obstructed to the point that wheezes are very slight or even absent.

Death from asthma is very unusual. Millions of children have asthma but far less than 1% each year will die from the disease, and only 5,000 people in the United States will die each year from asthma. However, at times, the bronchial tubes become obstructed to the point that almost no oxygen can pass through. Despite aggressive treatment, there are times when the condition cannot be reversed and a patient expires.

Oxygen saturation measures how much oxygen is in the blood and it is a way of determining how obstructed the bronchial passages are during an asthma attack. Oxygen saturation can be measured at the bedside with a pulse oximeter. A pulse oximeter uses a sensor that is placed on the finger and the pulse oximeter detects how well the blood is saturated

with oxygen. The pulse oximeter is a useful tool but it has limitations and using it correctly requires training.

Asthma can also be classified according to how often the attacks occur and when and what medications are needed to control them. Asthma may be *intermittent* or *persistent*. Intermittent asthma is characterized by asthma attacks that happen two or fewer days a week; the patient is woken up by an attack two or fewer nights a month and asthma does not interfere with normal activities of daily living between the asthma attacks. Persistent asthma occurs more than twice a week and may be characterized as mild, moderate or severe. For example, a patient who has severe, persistent asthma needs to use bronchodilators several times a day. The patient wakes up with an asthma attack every night and the asthma interferes considerably with the patient's normal activities of daily living.

Other Characteristics of Asthma

Someone who has asthma and is experiencing an asthmatic episode will typically have dyspnea, accompanied by wheezing and coughing, and an increased respiratory rate. These signs and symptoms are common to many respiratory and cardiac conditions such as chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF), so a clinician must look for characteristics that clearly distinguish asthma from other respiratory and cardiac conditions. These include onset, warning signs, wheezing, reversible, asymptomatic periods and frequency.

Onset:

When compared to other conditions, such as chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF), an asthmatic episode usually has a rapid onset. Asthmatic episodes also usually have a definite beginning and an end, and are episodic.

Warnings Signs:

Many patients who have asthma will have what are called prodromal signs and symptoms before an asthma episode begins. Prodromal signs and symptoms are “warning signs” that an asthma episode is going to occur. These prodromal signs and symptoms vary for each patient.

Wheezing:

Wheezing is a prominent part of asthmatic episodes, less so for COPD and CHF.

Reversible:

Dyspnea and wheezing from COPD, CHF, or other cardio-pulmonary diseases will respond to treatment but an asthmatic episode will usually respond more quickly and dramatically.

Asymptomatic Periods:

Many people who have COPD, CHF or other cardio-respiratory diseases that interfere with breathing have some level of signs and symptoms during the day; however, people with asthma are asymptomatic in the periods between asthmatic episodes.

Frequency:

Asthma attacks are intermittent and sporadic. Other types of cardio-pulmonary diseases produce signs and symptoms that are more chronic and continuous.

Exercise-induced Asthma

Exercise-induced asthma is a form of asthma that occurs during exercise. Exercise-induced asthma can occur by itself or in people who have asthma, and it is a relatively common condition.

Approximately 10% of the general population has exercise-induced asthma and 90% of people who have asthma have exercise-induced form of the disease as well. Exercise-induced asthma happens most often when people exercise in cold weather. It also occurs more often if there is a high pollen count or a high level of pollution in the air, if someone has poorly controlled asthma, or if an upper respiratory tract infection is present.

The cause or causes of exercise-induced asthma is not known but there are two theories as to how it happens. It may be that air movement through the bronchial passages dries out the airway, and this acts as an asthma trigger. Air movement in the bronchial passages can also cool the airway and the change in temperature can be an asthma trigger.

Exercise-induced asthma is a relatively benign form of the disease. Most attacks last for only a few minutes and respond well to exercise cessation and drug therapy. Exercise-induced asthma can be prevented by warming up before exercising, using bronchodilators before beginning to exercise, and avoiding exercise in cold, dry air. If proper preventive techniques and medications are used, exercise- induced

asthma can be prevented and there should be no limits for how often and how strenuously someone exercises.

Treatment and Prevention

There are two ways to treat asthma attacks. The first step is to understand why they happen and to take preventive steps to make sure the attacks do not happen and to decrease the frequency of the attacks. The second step is to treat the asthmatic episodes as they happen.

Asthma Prevention

Asthma is a chronic disease and it cannot be cured but as with many chronic diseases it can be managed, and asthmatic episodes can be prevented. The following are methods that people with asthma can use to manage their disease.

Identify and Manage Asthma Triggers:
Asthma triggers differ for each person, and asthma triggers will need to be identified by every individual. In general, people who have asthma should avoid going outside during days and during the times of day when air pollution and pollen counts are high. The home should be kept as clean as possible; dust, mold, mildew, and insect allergens can all trigger an asthma attack. Bedding should be washed on a regular basis. If possible, an air conditioner and a dehumidifier should be used.

Attention should be paid to changes in weather that have in the past precipitated asthma attacks and the day should be planned accordingly. Before starting an exercise program a physician should be consulted to determine which exercises and how much exercise is appropriate.

Use a Peak Flow Meter:

A peak flow meter is a simple, hand-held device that can help someone with asthma determine how well air is moving out of the lungs during exhalation. Using a peak flow meter can be a valuable way for someone to confirm that an asthma attack may be starting, and it can help the person identify the triggers that may be present at that time. By using a peak flow meter regularly, a person with asthma can determine normal peak flow in his/her individual case and what the peak flow is during an asthmatic attack, and this information can be used to determine how bad an attack is going to be. The peak flow meter can also let someone know when his or her breathing is compromised.

Make an Asthma Action Plan:

An asthma action plan is an organized plan designed to help an asthmatic prevent and manage asthmatic episodes. There are many examples of asthma action plans that are freely available on the internet but an asthma action plan should be formulated with the help of a healthcare professional.

The asthma action plan should have a section that identifies the allergens; thereafter, the plan should be divided into three sections: asymptomatic, symptomatic, and severe symptoms. Each section will have information about the signs and symptoms that characterize that particular stage of asthma, and what to do when asymptomatic, symptomatic, or severely symptomatic; for example, what medications to use and when, and when to call a physician or go to the hospital. For example, a patient is sensitive to pet dander and cold weather, however is symptomatic when peak flow is 80% of normal peak flow, when wheezing during exhalation, and there is a cough. The plan for this stage

is to rest, use a bronchodilator and wait one hour. If after an hour the peak flow has become worse, and/or the symptoms have not improved, the patient should use another medication and call the physician. Obviously each person will have a different plan.

Know When to Seek Help:

Asthma action plans are tailored for each individual and should include specific signs and symptoms that would indicate when a patient needs to seek help from the patient's physician, or go to an emergency room. However, anyone who has asthma and has any of the following signs and symptoms should not try and manage the asthmatic episode at home: cyanosis, inability to speak, drowsiness, absence of wheeze during inhalation and exhalation, serious decreases in the peak flow measurement, chest pain, or any signs or symptoms that are not typical for that person's asthma attacks. These all may be signs of imminent respiratory arrest.

Asthma Medications

Asthma medications are divided into several categories: medications that are used for immediate relief, for long-term control of asthma, to treat inflammation, and medications that are used to dilate the bronchial passages. The two primary categories of medications used to treat asthma and asthma attacks are bronchodilators and anti-inflammatories.

Immediate Relief Medications:

Some of the more common medications used to relieve the symptoms of an asthma attack in use are Xopenex®, Proventil®, and Ventolin®, all

of which contain *albuterol.* Many of these come in the form of a small, pressurized canister. The nozzle of the canister is placed in the mouth and as the patient inhales, a trigger is pressed and a puff of the medication is released. Some of these medications can also be placed into hand-held nebulizers or nebulizer masks.

These drugs work by dilating the bronchial passages. Some of the anti-inflammatory medications such as methylprednisolone and prednisone can be used for acute asthma attacks and for short-term use (3-10 days) to control asthma.

Long-acting Medications:

There are many long-acting medications that can be used to treat asthma. There are long-acting bronchodilators such as Serevent®, Foradil®, and Brovana® that have a similar mechanism of action to the short-acting bronchodilators, long-acting anti-inflammatory medications such as Pulmicort®, and Singulair®, long-acting bronchodilators such as Atrovent® that have a unique mechanism of action, and cromolyn sodium, a medication that prevents the release of histamine.

It is important to stress to patients that the medications that are used to treat asthma must be used as prescribed. It is counterproductive to use more of the medication than the amount prescribed. Drugs that are used to prevent and treat asthmatic episodes are designed to work within a certain period of time (the onset of action) and they are designed to be effective for a specific amount of time (the duration of action). Taking extra doses, larger doses, or doses too close together will not change how quickly a medication will work or its effectiveness.

Case Study: Pediatric Asthma

The following case study was located through a PubMed search and the authors reported on a 12-year-old boy with acute onset of asthma symptoms.

The authors stated that the patient presented to the emergency department with an acute flare of asthma. He had labored breathing on arrival at the hospital. He was initially evaluated with a respiratory rate of 35 breaths/min, heart rate of 96 beats/min, pulse oximetry of 90% in ambient air, temperature of 37.3 °C, nasal flaring, and diffuse wheezing in all lung fields.

A patient history was done that showed the patient had an upper respiratory tract infection for two days and a 10-year history of asthma. The authors reported that the patient had poor drug compliance and for the past four years there had been no medical follow up. The patient reportedly experienced cough and shortness of breath during the day and at night, but only used a salbutamol inhaler to relieve his symptoms. There was a history of allergic rhinitis and the patient had been placed on a corticosteroid nasal spray.

The patient's family history revealed that the patient's mother and sister suffered from allergic rhinitis.

Laboratory testing showed that the patient had an arterial blood gas (ABG) with a low blood oxygen. A chest X-ray was done that revealed hyperinflated lungs, but no evidence of fluid or blood around the lungs. The electrocardiogram (ECG) showed a rapid heart rate. The pulse

oximetry probe showed the patient had a low oxygen saturation, and this corresponded with symptoms of air hunger and chest pain after bronchodilator therapy. Since the patient had experienced chest pain, the medical team also obtained a blood test of his heart enzyme levels that increase with a heart attack episode, however these enzymes were normal.

Treatment involved the delivery of oxygen with a reservoir mask. The patient was given multiple nebulizer treatments with ventolin every 20 min for one hour, and he was also given oral anti-inflammatory medications. During the patient's hospital stay, he reported that he felt slightly better, and the health record noted that his respiratory rate lowered to 25 breaths/min, and heart rate to 90 beats/min.

There was wheezing that could still be heard, so ventolin nebulization every hour was continued. Oxygen therapy continued, and, after two hours, the patient developed chest discomfort. This pain happened about 10 min after receiving the last dose of nebulized ventolin. The patient became developed rapid breathing, was screaming in pain and highly agitated. The heart rate increased to 110 beats/min, and blood pressure was 130/90. Although he had no signs of cyanosis, the pulse oximetry revealed an oxygen saturation of 89% while receiving supplemental oxygen with a reservoir mask. There were expiratory wheezes audible all over the patient's chest.

The authors reported that transient ischemia (lack of oxygen to the heart) had caused the patient's symptoms but it resolved without serious outcomes. The patient's condition eventually improved, and he no longer had any signs of chest discomfort. The patient was admitted

to hospital and monitored closely. The patient's asthma attack was controlled, and he was discharged two days later in good condition. The angina-like chest pain did not recur.

Discussion

The authors stated that asthma is an "inflammatory disease that affects the small airways related to reversible airflow obstruction, hyper reactivity in airways, and variable pulmonary symptoms, from dyspnea to respiratory failure." During an asthma attack, patients will experience narrowing of the airway due to mucosal edema, bronchospasm, and increased secretions.

In the management of a severe asthma attack, nebulized or inhaled medications with the delivery of oxygen help to reduce symptoms until anti-inflammatory medications, including corticosteroids take effect. The authors stated that almost all patients with asthma attacks have some level of low oxygen. Nebulizer treatments might aggravate the patient's condition by pulmonary vasodilation in areas of the lung that in not ventilated properly. The authors described a teenage boy, a known case of asthma, admitted and treated as an asthma attack, during which time he developed chest discomfort and low blood oxygen. The health team discovered that continuous salbutamol nebulization and supplementary oxygen had been disconnected accidentally.

Pneumothorax and rib fracture was excluded by chest X-ray, and the patient's ECG (electrocardiogram) and the patient had no sign of ischemic changes. The patient had no prior history of chest wall trauma or sickle cell anemia. Blood tests and electrolytes also were normal. The patient's heart enzymes were checked, which were normal.

The patient was not receiving oxygen while ventolin was being administered, and shortly after receiving supplemental oxygen, the patient's chest discomfort improved. It was determined that nebulization of salbutamol (during an asthma attack episode) without supplemental oxygen could result in pulmonary vasodilatation, increasing perfusion to lung areas that were not properly ventilated, and thus aggravate low blood oxygen, which clinically presented with chest pain in this case.

The authors noted that it is recommended that ventolin be administered along with oxygen, but the incidence of chest pain hasn't been mentioned before. Although pediatricians may be familiar with the chest pain described by some asthmatic patients during severe attacks, heart pain is not a common symptom in asthma attacks. Supplementary oxygen should be provided in order to keep an oxygen saturation of ≥ 92%. All nebulized medications also should be delivered with oxygen in order to avoid causing or worsening the patient's condition and symptoms.

Summary

Asthma is a very common chronic respiratory disease that causes intermittent episodes of reversible airway obstruction, typically called asthma attacks. Asthma affects millions of people and despite being often perceived as a childhood disease there are many adults who have asthma. In most people asthma is caused by a combination of

hypersensitivity to common allergens and a genetic susceptibility to the disease.

Asthma attacks are caused by exposure to triggers such as cold, animal dander, and dust. These triggers initiate several pathologic processes that are the cause of the signs and symptoms of an asthma attack, hypersensitivity of the bronchial passages, airway inflammation, and airway obstruction, all of which combine to narrow and block the respiratory passages. The common signs and symptoms of an asthma attack are cough, dyspnea, chest tightness, wheezing, and an increased respiratory rate.

There is no cure for asthma. Some people develop asthma when they are children and the disease will stop by itself in early adulthood, but if asthma becomes chronic the patient will always have the disease. Some people have asthma that is intermittent and mild and some patients have asthma that is severe and constant; the presentation of the disease is on a continuum. Asthma rarely causes death, but it can have a very negative effect on a person's life. Treatment is focused on avoiding asthma triggers and acute asthma attacks with the use of bronchodilators and anti-inflammatories.