

Asthma

Introduction

Definition & overview

A disease that affects your lungs. It's chronic it doesn't go away and needs ongoing medical management. It is brought on by inflammation and constriction of the muscles around the airways, making breathing difficult.

Asthma history

It was recorded in China in 2600 BC, then in 100AD its symptoms were described, and after that, in 129 AD it was linked to muscles. In 1500 tobacco was used to clear mucus, then 1700 AD it was linked to dust too. In the late 1800s bronchial swelling and nervous stimulation were described, then in the early 1900s treatments included β_2 were discovered, and finally by the 1980s, targeted therapies like anti-leukotrienes emerged

Epidemiology

Asthma incidence varies greatly around the globe due to unique genetic, environmental, and occupational risk factors. The prevalence in high-income nations is plateauing, but it is still rising in low- and middle-income countries, therefore there seems to be a shrinking gap in this regard. An estimated 334 million individuals worldwide are thought to be affected by asthma, and the illness is thought to be the cause of 250,000 annual fatalities. The overall prevalence of the disease is predicted to rise by 100 million by 2025 due to the ongoing growth in prevalence.

Etiology

Causes & risk factors

You have a 3:6 higher risk if you have a family background in asthma. You are more likely to suffer from atopic dermatitis (eczema) or allergic rhinitis (hay fever). Wheezing can be brought on by respiratory issues in early childhood. Certain aspects of the workplace might trigger asthma symptoms if you have the condition. The

airways get irritated by cigarette smoke. Patients who are obese frequently require more medicine, have greater symptoms, and have difficulty controlling their asthma.

Genetics & Environmental influences

Genetics: If your parents or siblings have asthma, you're more likely to have it too. It makes your immune system more sensitive, increasing the risk of asthma.

Environmental: Allergens (like dust) can trigger asthma. Pollution can make asthma worse. Respiratory infections can increase asthma risk. Weather(cold) can trigger asthma symptoms.

Clinical Features

Signs & Symptoms

Signs: headache, runny nose, sore throat, coughing after exercise, difficulty sleeping, feeling moody, and Weakness during physical activity

Symptoms: Shortness of breath, Cough, Chest tightness or pain, Wheeze (a whistling sound when you breathe), Waking at night due to asthma symptoms, and A drop in your peak flow meter reading (if you use one)

Stages & progress

First of all Stage 1 is Mild Intermittent Asthma that includes (Symptoms less than twice a week, No issues between flare-ups, Flare-ups are short, lasting a few hours to a few days, and Nighttime symptoms of less than twice a month), secondly Mild Persistent Asthma that includes (Symptoms occur more than 2 days a week but do not occur daily, Attacks interfere with daily activities, Nighttime symptoms occur 3 to 4 times a month, and Lung function tests are normal when the person is not having an asthma attack.), then Moderate Persistent Asthma causes (Daily Symptoms, Uses rescue medication daily, Flare-ups twice a week or more, Activity levels affected by flare-ups, Nighttime symptoms more than once a week) at the end Severe Persistent Asthma that leads to (Constant symptoms, Reduced physical activity, Frequent flare-ups, and Frequent nighttime symptoms)

Complications

Badly controlled asthma can badly affect the patient's quality of life such as Fatigue and exhaustion, Poor sleep quality, Reduced productivity at work or school, Inability to engage in physical exercise and activities, Decreased lung function, and Adverse effects on mental health

Diagnosis

Diagnostic Criteria

How Do Doctors Diagnose Asthma?

1. Symptoms (shortness of breath, and chest tightness),
2. Medical History: (Personal and family history of asthma or allergies),
3. Physical Exam: (Listening to your breathing with a stethoscope),
4. Lung Function Tests: (Spirometry, Peak Flow),
5. Allergy Testing: (Identifies specific allergens that may trigger symptoms),
6. Response to Asthma Medication: (Improvement in symptoms after using asthma medication can support the diagnosis)

Diagnostic Tests & Procedures

1. FeNO test: you breathe into a machine that measures the level of nitric oxide in your breath, which is a sign of inflammation in your lungs
2. spirometry: you blow into a machine that measures how fast you can breathe out and how much air you can hold in your lungs
3. peak flow test: you blow into a handheld device that measures how fast you can breathe out, and this may be done several times over a few weeks to see if it changes over time
4. after you're diagnosed with asthma, you may also have a chest X-ray or allergy tests to see if your symptoms might be triggered by an allergy.

Differential Diagnosis

The first step in dealing with an asthma patient is to make sure it is asthma. Other conditions are often misdiagnosed as asthma.

In adults, the differential diagnosis can be Chronic obstructive pulmonary disease (COPD), Congestive heart failure, Gastroesophageal reflux disease, Mechanical obstruction of the airways (e.g., tumors, foreign bodies), Vocal cord dysfunction, Pulmonary embolism, or Pulmonary infiltrates with eosinophilia

In children, it may be that foreign body aspiration causes airway obstruction, Pneumonia/bronchiolitis, Cystic fibrosis, Bronchopulmonary dysplasia (in premature infants), Primary ciliary dyskinesia syndrome

Pathophysiology

Mechanism

At First the muscles in the airway walls can contract, making the airways tighter and narrower. In asthma, this muscle is more sensitive and contracts more easily. Reliever inhalers relax these muscles to ease symptoms temporarily, Then the inner walls of the airways become swollen and inflamed, leaving less space for air to pass through. Preventing medicines reduce this inflammation, After this Excess mucus can block the airways. Preventing medicines also helps reduce mucus production, Lastly Ongoing inflammation can cause scar tissue and thickening of the airway walls, worsening asthma.

Cellular & Molecular changes

Asthma involves various immune responses and structural changes in the airways. Inflammatory cells, such as eosinophils, mast cells, and T cells, increase in the airways, causing inflammation. Cytokines and chemokines are signaling molecules released by these immune cells that promote inflammation and attract more immune cells to the airways. IgE antibodies bind to allergens and trigger the release of histamine from mast cells, leading to allergic reactions and asthma symptoms. Chronic inflammation causes airway remodeling, resulting in structural changes like thickening of the airway walls and increased mucus production. Smooth muscle contraction around the airways becomes more pronounced, making the airways narrower and causing breathing difficulties. These combined effects lead to the typical symptoms of asthma: wheezing, shortness of breath, chest tightness, and coughing.

Impacts on Body Systems

Asthma influences many parts of the body. It makes the airways in the lungs swell up and get tight, which makes it hard to breathe. This means less oxygen gets into the blood, and people have to work harder to breathe. The heart feels the strain when there's not enough oxygen in the blood. Also swollen blood vessels can lead to high blood pressure. When someone struggles to breathe, it can make them feel scared and panicky. This happens because breathing problems set off the body's stress alarm. Not having enough oxygen can also mess with how the brain works, leading to feeling tired, confused, or dizzy. The muscles that help with breathing get worn out from working so

hard all the time. People might also start to have bad posture and tense muscles because of how they have to breathe.

Management & Treatment

Medical & surgical treatment

We have many medical treatments such as Bronchodilators: These medicines relax the muscles around your airways, making it easier for air and mucus to move, Anti-inflammatory: medicines reduce swelling and mucus production in your airways, helping air move in and out of your lungs, and Biologic therapies: These are used for severe asthma when other treatments don't work well.

We can do surgery in severe asthma cases which is (Bronchial thermoplasty) a flexible tube is passed down your throat into your lungs. Heat is applied to the muscles around the airways to help stop them from narrowing and causing asthma symptoms

Pharmacological therapies

Doctors treat asthma with inhalers and oral meds. Patients use metered-dose inhalers and nebulizers to get medicine straight to their lungs. They also take pills or liquids by mouth to control their symptoms.

Lifestyle & Dietary modification

Lifestyle: First, prioritize good sleep, relaxation, and a healthy weight. Consume whole foods with a mix of fresh fruits, vegetables, and lean meats, and try exercising every day. Never skip doctors' appointments and be regular with prescribed medications. Also, keep the prescription refills on time. Stay updated with vaccinations, close windows during bad air and high pollen days, and remain informed to be knowledgeable and responsible about your lungs.

Diet: Maintain an ideal weight through proper diet and long-term habits. Make sure to eat plenty of fruits and vegetables that are rich in antioxidants to help lower lung

inflammation. Avoid foods that cause allergies. Also, ensure that you have enough vitamin D and avoid sulfites that trigger symptoms.

Rehabilitation & supportive care

Rehabilitation: Pulmonary rehabilitation (PR) is a program for people with long-term lung conditions, offering exercise classes, lung care information, and breathlessness management techniques. A PR team of physiotherapists, nurses, and occupational therapists provides personalized care.

Supportive care: Supportive care for asthma might include education about the condition, symptom recognition, and practical and emotional support. Ensure the workplace is safe by having clear policies around asthma and first aid for asthma.

Prevention & control

Primary, secondary, and tertiary prevention

Primary prevention includes avoiding allergens, reducing pollution exposure, maintaining a healthy lifestyle, managing respiratory infections, controlling the indoor environment, and minimizing stress to reduce the risk of developing asthma. Secondary prevention focuses on regular check-ups, proper medication use, symptom monitoring, trigger avoidance, having an asthma action plan, and self-education to manage asthma and prevent severe attacks. Tertiary prevention involves ongoing medical care, medication management, rehabilitation programs, lifestyle changes, support and education, and emergency preparedness to effectively manage asthma, prevent complications, and maintain a good quality of life.

Public health Interventions

Public health interventions for asthma include improving air quality, promoting smoking cessation, and increasing access to healthcare and medications. Education programs raise awareness about asthma management, while policies support cleaner environments to reduce triggers.

Asthma Vaccination and Screening Programs

Vaccination is also an important part of asthma management. This would include the flu vaccine, which is recommended yearly to prevent respiratory infections that may exacerbate asthma, and pneumonia vaccines to protect against infections that may trigger symptoms. Screening programs are equally important, including regular follow-ups with the doctor to check on your asthma, spirometry testing to assess lung function and pick up on any changes early, and allergy testing for identification of triggers and avoidance measures. Asthma education programs can help patients acquire different and efficient management methodologies to ensure complete care and control over the diseases.

Prognosis

Asthma Outcomes & Survival Rates:

Outcomes: Asthma outcomes can vary widely. Effective management often leads to fewer symptoms, reduced hospitalizations, and improved quality of life. Poorly controlled asthma may result in frequent exacerbations, emergency room visits, and decreased lung function over time. Long-term outcomes depend on factors like adherence to treatment, environmental triggers, and overall health. Early intervention and consistent medical care are key to positive outcomes. **Survival rates:** Asthma deaths decreased from 15 to 10 per million between 2001 and 2016. 65 years and older people, children, and males have the highest death rate

Factors influence prognosis

Gender, genetics and environmental factors are known to influence asthma risk. In childhood, boys have a higher prevalence of asthma than girls, probably due to the smaller size of the airways. A strong genetic factor is reflected in having a family history. Environmental exposures, like pollution and tobacco smoke, are also associated with a raised risk of asthma, particularly in children and adolescents. Obesity enhances severity, therefore increasing the severity of diseases and medication requirements. Moreover, smoking moms or premature birth during pregnancy may become a risk factor for asthma in children.

Quality of life

Repeated asthma attacks may produce anxiety and physical distress, limit the potential for physical activity, and cause sleeping and daytime fatigue problems. Emotional and social functioning may also become impaired as patients avoid the triggers or are absent from work and school. Treatment of asthma needs frequent medication and visits to the doctor, which can be expensive, but with proper medication, alterations in lifestyle habits, and avoiding the triggers properly, asthma can be well-managed

Current research and future direction

Recent Advances and Discoveries

Researchers at USC have discovered a new way to potentially treat allergic asthma. They found that a protein called Piezo1 can prevent immune cells in the lungs, known as ILC2s, from becoming overly active in response to allergens like dust mites and pollen. When ILC2s are hyperactivated, they produce inflammation in the lungs, making breathing difficult for asthma patients. By using a drug called Yoda1 to activate Piezo1, the researchers reduced inflammation in mice exposed to allergens. This discovery suggests that Yoda1 could be developed into a treatment to help alleviate asthma symptoms caused by allergic reactions in humans as well.

Ongoing Clinical Trials

Several clinical trials are underway with new asthma treatments and mechanisms. These involve biologics: omalizumab, mepolizumab, and reslizumab, which target specific immune pathways that lower inflammation and result in better control of severe disease, as well as new drugs including those that activate the Piezo1 channels in immune cells, thus may reduce lung inflammation and airways hyperresponsiveness and hence symptoms of asthma. Research is underway in bronchial thermoplasty—a procedure using thermal energy to reduce the smooth muscle mass in the airways. It is theorized that these procedures will someday reduce asthma symptoms over time. Such trials are trying to improve the treatment options and thereby enhance the management of the condition.

Future research needed

Asthma research in the future must focus on genetic factors contributing to the condition, which may then lead to targeted treatments. Structuring new drugs and biologics that affect specific asthma pathways is the mainstay for the advancement of better therapies with reduced side effects. The study of the immune system itself, including certain immune cells and proteins, may also yield potential targets for therapies. Such studies of the long-term effects of asthma and its treatments are critical to enhance our understanding of disease progression and management. Further research should address how the condition affects different demographic groups, reducing disparities in treatment and improving outcomes.

Case study

Ben, 16, had an asthma attack before a soccer game, likely triggered by pollen and lacking his rescue inhaler. Allergens often cause asthma in kids and teens by tightening bronchial muscles and forming mucus. Symptoms include chest tightness, wheezing, difficulty breathing, and a fast heart rate due to low oxygen. Asthma severity is measured using oxygen saturation and peak flow meters. Ben received oxygen, three albuterol nebulizer treatments, and Medrol, an oral corticosteroid, to reduce lung inflammation. Common asthma meds are rescue inhalers, inhaled corticosteroids, long-acting beta-agonists, and sometimes IgE blockers. In the US, 8% of adults and 9.3% of children have asthma, with pollution contributing to rising rates. Prognosis varies; mild to moderate asthma can improve, while severe cases may lead to permanent lung issues. Risk factors include maternal smoking, secondhand smoke, and severe RSV illness in childhood. Following an asthma action plan helps manage the condition. ER staff treated Ben, who will follow up with his primary doctor to adjust his asthma action plan and medications.