Family Medicine and Community Health
REVIEW

A review of adult asthma and the effectiveness of education programs in reducing symptoms

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Abstract

Asthma is a chronic inflammatory disease that occurs in children and adults. The National Heart, Lung, and Blood Institute (NHLBI) recommends asthma self-management education to be essential in providing patients with the skills necessary to control asthma and improve outcomes. A number of studies have been conducted to assess the effectiveness of these educational programs in children; however, such studies have not demonstrated efficacy in adult populations. This review explores the epidemiology of asthma, the different categories of asthma based on demographic differences, and environmental triggers of asthma. We also discuss common medical options that are available to treat asthma. We then describe the components of an asthma education program and the effectiveness in improving patient outcomes. The literature review was conducted using the National Library of Medicine Pub Med search engine. Comprehensive reviews were focused on the English literature involving human subjects in the last 5 years. Randomized controlled trials were selected for a citation on each subject when available. The Expert Panel Report 3 (EPR-3; Guidelines for the Diagnosis and Management of Asthma – Report 2007) was used as the primary reference source for standard of care treatment guidelines. Search terms included asthma, motivational interviewing, irritant-induced asthma, asthma education, home intervention, telemedicine, nitric oxide, asthma action plan, occupational asthma, IgE-mediated asthma, asthma guidelines, asthma prevalence, and asthma treatment.

Keywords: Asthma; asthma education; home intervention; occupational asthma; irritant-induced asthma

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Introduction

Asthma is a common chronic inflammatory disorder of the airways that is characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper-responsiveness, and underlying inflammation. The interactions between these factors determines the range of symptoms, severity, and the response to treatment [1]. Asthma is a complex disease with both genetic and environmental contributing factors. The National Heart, Lung, and Blood Institute (NHLBI) recommends asthma self-management education to be essential in providing patients with the skills necessary to control asthma and improve outcomes. The epidemiology of asthma, the categories of asthma based on demographic differences, the environmental triggers of the disease, and common treatment options are reviewed. The

components of an asthma education program and effectiveness in improving patient outcomes are also discussed.

Epidemiology

In 2012, approximately 8% or 18.7 million US adults were diagnosed with asthma [2]. The prevalence of intermittent asthma ranged from 23.6% in Alabama to 43.5% in Utah between 2006 and 2010; no specific geographic pattern was identified [3]. The prevalence of asthma is higher among younger adults (18–24 years of age). The prevalence of asthma was 10.3% in the 18–24 year age group, 8.7% in the 25–34 year age group, 8.1% in the 35–44 year age group, 8.5% in the 45–54 year age group, 9.4% in the 55–64 year age group, and 8.1% in the 65 and older age group in 2010 [4]. Currently, the prevalence of asthma is higher among females than males (10.7% vs. 6.5%). The prevalence of asthma varies among races as follows: 8.7% among white adults; 10.8% among African Americans; and 15.1% for the multi-race category [4]. Currently, the prevalence of asthma in adults varies with the level of education, and is estimated to be 10% among adults who did not graduate from high school, 8.8% among high school graduates, and 7.5% among college graduates [4]. Nine people die each day from asthma in the US [5]. Asthma costs the US economy $56 billion dollars annually, and is the cause of an estimated 14.2 million missed days of work per year [6].

In China, the prevalence of asthma in adults (18–45 years of age) was estimated to be approximately 1.73% based on the World Health Survey (WHS), which was developed and implemented by the World Health Organization in 2002–2003 in 70 countries [7]. Others estimate a total of 30 million cases [8]. The prevalence of asthma in Chinese children (0–14 years of age) has been increasing during the previous 10 years. The prevalence of asthma was estimated to be 1.97% in 2000 based on a survey of 43 cities in 31 provinces. There was major variation among the different cities; specifically, the highest rate was in Chongqing (4.63%) and the lowest rate was in Xining (0.25%) [9]. A cross-sectional survey by Zhao et al. [10] demonstrated that the prevalence of childhood asthma in the cities of Beijing, Chongqing, and Guangzhou was 3.15%, 7.45%, and 2.09%, pointing toward rising prevalence [10].

Behavioral and environmental factors also play a role. Approximately 21% of people with asthma smoke cigarettes compared to 17% of non-asthmatics [11]. In 2010, 38.8% of adults with asthma were obese compared to only 26.8% of adults without asthma. Obesity is associated with the development of asthma, worsening of asthma symptoms, and poor asthma control [11]. It is estimated that 15% of US adult asthma cases are attributable to occupational factors [12]. A recent genome-wide association study (GWAS) showed that variation at the 17q21 asthma locus, encoding the *ORMDL3* and *GSDML* genes, was associated with risk for childhood onset asthma [13]. The genetics involved in the eventual development of asthma is complex and incompletely understood [14, 15].

Asthma subtypes

Asthma is triggered and aggravated by many different sources. Subtypes of the condition can be described demographically by age of onset, type and place of exposure, and in terms of the pathophysiology of the underlying inflammation. Asthma has been classified according to age (childhood-onset and adult-onset asthma). Childhood-onset asthma begins during childhood with a peak prevalence of 10% among children 5–9 years of age [4]. The "allergic triad" includes asthma, atopic dermatitis, and allergic rhinitis, and there seems to be some progression from atopic dermatitis and food allergy during infancy to asthma and/or allergic rhinitis during childhood [13]. Approximately 58% of all children with asthma are expected to have complete resolution of symptoms by adulthood, and 11% will continue to have infrequent episodic asthma [16]. Male gender was a significant predictor of asthma remission [17]. Adult-onset asthma refers to persons older than 20 years of age. Asthma diagnosed among young adults is associated with cold-air bronchial hyper-responsiveness at 6 years of age, late-onset and persistent wheezing by 6 years of age, and female gender [17].

Asthma may also be classified based on the location of the exposure. Work-related asthma (WRA) includes work-exacerbated asthma (pre-existing or concurrent asthma worsened by factors related to the workplace environment) and occupational asthma (new-onset asthma attributed to the workplace environment) [18–20].

The route of inflammatory response also defines asthma. Allergic asthma is mediated by immunoglobulin E (IgE)

reactions to airborne allergens. Common IgE-mediated allergens have been identified from dust mites, pet dander, cockroaches, molds, and grass pollens [21]. Symptoms usually begin before the 20th birthday and are usually not severe and do not progress; however, heavy exposure can cause acute severe or even fatal reactions [22]. Intrinsic or non-allergic asthma is defined as that which does not involve an identified IgE response [23]. This type is more common in middle-aged and older adults [22]. Compared with allergic asthma, intrinsic asthma is more persistent, and it is more likely to progress in severity and to become irreversible [22].

Irritant asthma is caused by a non-corrosive chemical that directly causes inflammation of both the upper and lower respiratory epithelium [24]. Irritants include a wide variety of chemicals that are found in the home, workplace, and outdoor environment. Examples of irritants include solvents found in paints and glues, chlorine, bleach, and ammonia in household cleaners, hydrochloric and sulfuric acid, floor sealants, formaldehyde, capsaicin found in hot peppers, and metal-working fluids [24]. Common outdoor air pollutants are byproducts of fuel combustion and include ozone, fine particulate matter, nitrogen dioxide, and sulfur dioxide [25].

Asthma can also be exacerbated by other extrinsic physical factors. Exercise-induced bronchoconstriction (EIB) is defined as the transient narrowing of the lower airways that occurs after vigorous exercise. EIB may occur in persons with or without the diagnosis of chronic asthma. The diagnosis of EIB usually requires a 10%–15% decrease in post-exercise forced expiratory volume in 1 s (FEV_1) (pulmonary function test) compared to pre-exercise value [20].

Medical treatment

There are a number of options available to treat asthma. For patients with intermittent symptoms, initial treatment of acute symptoms is with short-acting bronchodilators, including albuterol and levalbuterol. When these medications reach the bronchi via inhalation, they act as agonists on the beta-adrenergic receptors of the bronchi to reverse airway constriction and typically have therapeutic effects for 4 h [26]. The short-acting anticholinergic, ipratropium, is also used as an alternative in patients who cannot tolerate bronchodilator use because of side effects [26]. When an inhaler is used during active inhalation, medication is forcefully propelled from the inhaler by the use of chemical propellants in suspension to the bronchi. If the patient has difficulty with the timing needed, it can be inserted into a small tube (spacer) that allows the patient to inhale the aerosolized medication into the bronchioles more easily [1].

The proper treatment of asthma is based on the severity of presenting symptoms, which are classified as follows: mild intermittent; mild persistent; moderate persistent; and severe persistent [1]. Symptoms are rated in terms of nighttime awakenings, frequency of use of short acting beta-2 agonists, interference with normal daily activity, and the severity of airway constriction [1]. Beta-2 agonists bind to receptors on the smooth muscle of the bronchioles and cause temporary dilation, thus allowing for relief of asthma symptoms [1]. Treatment for each of these categories is divided into a stepwise treatment of escalating medications. Mild intermittent asthma is treated with short-acting bronchodilators, which are used as needed. Inhaled corticosteroids and long-acting bronchodilators are added at increasing doses, with options to include other immune pathway inhibitors, such as mast cell inhibitors (cromolyn and nedocromil), leukotriene receptor antagonists (monteleukast), or smooth muscle relaxants (theophylline) [1]. Oral steroids are included in the more severe forms of asthma and anti-IgE medications are also added for those individuals with elevated IgE titers [1, 26, 27].

Control of environmental triggers

Patients with asthma symptoms should be assessed for triggers that affect their condition. Skin testing or serum analysis of the IgE response to panels of common allergens can help to identify specific causes [1]. If a single source of allergen reactivity is identified from testing, then one should consider allergen immunotherapy [1]. Potential environmental triggers to asthma are identified with the use of questionnaires [21, 28]. A review of the literature has not identified any specific environmental questionnaires available that have been validated in controlled studies. Home intervention programs are focused on instructing patients how to reduce exposure to indoor allergens and respiratory irritants [1, 21]. Home investigators can also be trained to identify sources of triggers and implement low cost ways to decrease exposure [1]. Approaches to

reducing home allergen content from house dust mites, cockroaches, animal dander, and mold have been developed [21]. Other common home irritants include exposure to paint, glue solvents, household cleaners, pesticides, and tobacco smoke. Use of a gas stove with poor ventilation and wood burning stoves can also be a large contributor of particulate irritants in the home [21].

Asthma education

Asthma education programs commonly focus on the following areas:

- Patient understanding of the pathophysiology of asthma;
- Recognition and treatment of the early symptoms of asthma exacerbations
- Understanding asthma triggers and how to avoid them
- The role of medications in asthma and how to most effectively administer the medications [1].

These basic tenets of asthma education are all important aspects of achieving maximal control of an individual's symptoms. There is a wide range of options for how to best deliver this information to the patient. The location, method of delivery, and the use of ancillary tools are a few of the choices that an asthma chronic disease management program team needs to make in delivering care.

In a randomized controlled study of both adults and children, an asthma educator contacted patients leaving an emergency center after being treated for an acute asthma exacerbation (acute attack) within 5 days of discharge to arrange a follow-up visit with a primary care provider (PCP). During the follow up with the PCP, the educator was present and complemented the advice given by the provider to ensure all points of the asthma education program were covered. Six weeks later, a nurse made a home visit to the patients reinforcing the points made in the initial visit and conducting a home environmental visit to identify known triggers. Despite the comprehensive nature of this follow-up intervention, the study showed no significant changes at the 6-month follow-up visit with respect to health care use, reported change in symptoms, or survivability [29]. Another randomized controlled trial showed no significant difference in pulmonary function or symptom improvement in asthma patients in primary care practices [30]. However, there have been some examples of how asthma self-management programs have led to improved outcomes in a variety of settings [31, 32]. Different studies have shown mixed results on health outcomes, yet have very similar basic curricular components. The authors have conducted a further analysis of the literature to point out agreements of what components need to be in place to achieve improvements in health outcomes.

Search methodology

A literature review was conducted using Pub Med. Comprehensive reviews were focused on the English literature involving human subjects during the last 5 years. Randomized controlled trials and literature reviews were cited for each subject topic. The 2007 NHLBI guidelines were used as the primary reference source for standard of care treatment guidelines. Search terms included asthma, motivational interviewing, irritant-induced asthma, asthma education, home intervention, telemedicine, nitric oxide, asthma action plan, occupational asthma, IgE-mediated asthma, asthma guidelines, asthma prevalence, and asthma treatment.

Key components of a successful educational program

- Engage the target population in the planning phase: When planning an asthma education program, develop an advisory board of the various types of providers who deliver care, leaders in the local community, and patients who have asthma. Specific populations often have very different concerns about how asthma affects their daily life than what educators envision [33, 34]. Including representatives of the target population as part of the advisory committee can often assist planners in providing a more relevant program for their patients, and as a result, make a greater impact on improving their health. Qualitative studies with specific target groups have shown that patients often have goals in asthma treatment that are much different than what providers expect [33]. Successful programs also integrate a variety of specialties to jointly plan asthma education. Once implemented, program providers continue the dialog in terms of how to provide ongoing care for individual patients. Participants

include pulmonary specialists, primary care physicians, mid-level providers, respiratory therapists, case managers, and nursing staff [35].

- Implement a comprehensive education program: The asthma care program must be a comprehensive treatment plan that integrates a dynamic education program about the pathophysiology of asthma, a comprehensive assessment of environmental triggers, and a high-quality active asthma action plan [31, 35]. This plan must be expressed with an education level and cultural style that is appropriate for the intended patient population [31, 36]. This plan should be able to succinctly provide a decision tree for the patient to have a strategy for the different stages of an asthma exacerbation. The program should also be part of a multidisciplinary effort that involves pulmonologists, family physicians, respiratory therapists, and case managers who are communicating with each other regularly [35]. The program should be designed to allow the patient to provide feedback to the health care providers and educators on what aspects of the disease most affects them. The program should be adjusted individually to meet these needs [36]. Asthma providers often underestimate the severity of the patient's disease [31]. Listening to patient concerns will help engage them in the program and assist the provider treating their disease [31, 36].
- Objective measurements: Spirometry measurements at baseline and periodically during the course of an education program help the provider and the patient have a better understanding of the current level of severity of the disease. Jain et al. [35] enrolled 104 adult patients with asthma and chronic obstructive pulmonary disease (COPD) in a study which provided a comprehensive chronic lung disease program to participants and followed their degree of asthma control over the course of 1 year. All participants had an initial spirometry measurement and subsequent measurements on an as-needed basis. Spirometry utilization was an independent factor for significantly reducing the number of respiratory related ER visits in the intervention population (odds ratio =2.94).
- Treatment of comorbid conditions: The most successful education programs are integrated into the clinical evaluation of the patient. Congestive heart failure, obstructive sleep apnea, gastroesophageal reflux disease, and chronic sinusitis are a few common diseases that can exacerbate asthma. The mental health of the patient must also be assessed [36]. Untreated anxiety and depression can affect patient compliance with medication [1]. Appropriate treatment of these symptoms can greatly reduce the severity of asthma [35].
- A comprehensive home intervention/follow-up program: Home interventions should be designed to not only mitigate environmental exposures, but also reinforce the educational and behavioral aspects of reducing the severity of asthma. Home visit investigators should review information discussed in an asthma action plan, and the mechanics of proper inhaler use [28]. The social aspects of asthma management should also be addressed, including assistance with housing management, and health insurance coverage [28]. Positive encouragement should be provided to the patient at every opportunity, along with constructive feedback [36]. In a randomized clinical trial, Krieger et al. [28] provided 177 patients with an average of 4.9 home visits over a 1-year study period. The program used motivational interviewing techniques to provide a tailored program for the patient that educated patients about the disease of asthma, discussed medication use, advocated for patients on access to health care, and reduced patient exposure to asthmagens in the home by remediation efforts. Interventions have showed statistically significant improvements in reduction of asthma symptoms, improved quality of life assessments, and reduction in urgent health care visits [28].

Emerging developments

New technologies have great potential for helping providers to improve the quality and accessibility of asthma education. Personal interaction with patients is critical to assisting with chronic diseases, including asthma. However, difficulties in transportation and exposure of the patient to outside environmental triggers can make a physical visit to the physician's office problematic. Telemedicine, internet-based, and mobile phone applications provide a means to make patient-provider communication more accessible and data more easily monitored. In a randomized controlled trial by Van der Meer

et al. [37], patients were first provided with a comprehensive asthma education course and taught to use a handheld spirometer. Over the course of the year-long study intervention patients used a self-monitoring computer program that instructed them on how to adjust their medication based on self-administered spirometry. Patients also received communication remotely via phone and electronic mail with remote case managers. Significant improvements were seen in the quality of life, symptom-free days, asthma control, and pulmonary function.

Helping patients make long-term behavioral changes is the foundation upon which asthma education rests. These changes include diligence on the proper use of medication, compliance with medical visits, avoiding asthma triggers, physical conditioning, and healthy nutrition. All of these require patients to adopt lifestyle changes long after the education program has ended. Employing educators and providers that are skilled in cognitive change is a key to program success [28]. Motivational interviewing is a technique used by health care providers from many different disciplines as an approach for practicing cognitive change. This approach is designed to help the patient explore reasons for making a change and look at the pros and cons of their decisions [38]. Motivational interviewing was first developed as a treatment in the field of addiction medicine and has since been used successfully in many different fields. Diabetes care, weight control, and smoking cessation programs have used this technique extensively during treatment to exchange unhealthy habits with healthy habits [38, 39]. Motivational interviewing has been used to a limited extent in studies of effective asthma treatment. Krieger et al. [28] used motivational interviewing during community health home visits to tailor educational goals for patients with asthma. More extensive application of motivational interviewing is needed in asthma education before its effectiveness is established.

Summary

Asthma is a complex disease that has been identified across many different demographic variables, including age, ethnicity, and gender. Asthma is the source of a significant amount of morbidity, medical expense, and loss of productivity. This disease is triggered by an array of different sources and stimulates a variety of different inflammatory responses in the respiratory airways.

Health care providers must have a comprehensive understanding of individual triggers of asthma to customize the treatment plan for the individual. Medical treatment revolves around suppression of the inflammatory response by a variety of different pathways of the immune response. In addition to pharmaceutical treatment, an asthma patient education and home intervention program is an effective means of reducing the patient's symptoms and improving their quality of life. Education and intervention must be dynamic interactions between the provider and the patient. The provider must able to communicate to the patient in a style and educational level that the patient can understand. Programs must be structured to allow the patient to express what aspect of their disease is the most debilitating and a treatment plan must subsequently tailored to address that.

There are a number of new approaches to help enhance the provider-patient interaction. The use of telemedicine can improve the frequency and convenience of the provider-patient relationship. Motivational interviewing may assist providers in helping the patient to overcome barriers and reduce their exposure to asthma triggers and hence improve treatment compliance. All of these areas of study have exciting treatment potential for this common and debilitating disease. Further studies will improve our ability to better design comprehensive primary, secondary, and tertiary treatment programs for asthma.

Conflict of interest

The authors declare no conflict of interest.

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