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A Comparison: Symptomatic Improvement of Childhood Asthma versus Occupational Asthma after Removal of Causative Agents

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By

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Introduction

Asthma is a chronic respiratory condition that causes airway inflammation and narrowing which leads to symptoms such as coughing, wheezing, shortness of breath, and dyspnea.[1] In 2017 it was estimated that 25.1 million Americans had asthma, including 6.1 million children and 19 million adults.[2] From 2008-2013 the average cost of asthma in the United States (US) was $81.9 billion a year, this includes medical costs, lost days of work, and lost days of school.[1] Asthma is often a result of environmental triggers both children and adults experience throughout their day. The consequences of asthma have been studied at great lengths in both children and adults, specifically adults experiencing occupational asthma (OA). However, there have been no comparisons between these two groups with regards to reduction of symptoms after removal of environmental factors. With the economic burden of asthma in the US, asthma treatment should focus on limiting environmental triggers rather than only treating asthma symptoms.

Background

Asthma is the most common chronic illness in children less than 18 years old.[3] It affects roughly 8.4% of children in the US, and causes children to miss on average 2.3 days of school each year.[1,2] For children living in poverty, the rates of asthma can increase to upwards of 18%.[3] Common environmental triggers for children are ozone, diesel exhaust, tobacco, nitrous oxide (N_2O), cockroaches, mouse allergens, dust mites, pet dander, and pollen. Treatment of childhood asthma often revolves around reversing already present airway inflammation using agents such as inhaled or nebulized albuterol, or in more severe cases oral steroids. Prevention is usually

accomplished through inhaled corticosteroids (ICS), leukotriene modifiers, or combination inhalers. However, the most effective treatment is prevention via removal of environmental triggers.

Occupational asthma is similar to that of asthma in childhood in that there is usually a triggering agent that induces the respiratory obstruction. However, for those who experience OA the airway obstruction is specific only to their work environment.[4] On average OA accounts for 1.8 missed days of work a year, further contributing to the economic burden of asthma. The average yearly cost of missed work days due to asthma was $1.9 billion between the years of 2008-2013.[1] Many cases of OA are centered around industries with high allergen or irritant exposure such as healthcare, electronic and car manufacturing, woodworking, hairdressing, and pet shops. The irritants usually evaluated in OA research are classified as high molecular weight (HMW) and low molecular weight (LMW) agents. The primary treatment for OA is removal from the offending agent or environment, or use of personal protective equipment (PPE) in the hopes of reducing airway inflammation.

The purpose of this study is to compare and evaluate the rates of asthma symptom reduction in childhood versus those with OA after the removal of the triggering agents. This information may help determine if children have an increased ability to recover from asthma symptoms compared to adult populations, and how that may factor into long term disease prognosis.

Discussion

Asthma in children after removal from exposure

With asthma being the most prevalent chronic childhood illness, there has been much research on this topic. Specifically, when looking at environmental exposures and their effect on outcomes. One study sought to determine if a decrease in air pollution would lead to a rapid improvement in symptoms in asthmatic children. In this cohort study, 37 asthmatic children were selected to be relocated from an urban environment with increased outdoor pollution to a rural environment with improved air quality for seven days. All clinical measurements were performed in the urban environment on the day before relocation, and then again seven days after relocation.[5] The clinical parameters measured included nasal eosinophils, fractional exhaled nitrous oxide (FE_{NO}), peak expiratory flow (PEF), and urinary leukotriene E_4 (LTE_4). Prior to relocation, environmental control strategies were put in place to prevent indoor allergens from affecting baseline testing.[5]

The environmental pollutants measured were found to have significantly lower concentrations in the rural environment when compared to the urban. The results showed a fourfold decrease in nasal eosinophils, the most sensitive biomarker for pollution induced airway inflammation, after one week of relocation to the rural environment. Improvement in lower airway functioning was illustrated by a highly significant improvement in mean PEF, an approximately increase of 80 L/min.[5] These results are significant to the thought that environmental factors outside of the home play a significant role in asthmatic children, specifically in an urban environment. This also illustrates that children have the capacity to rapidly recover after environmental improvement.

According to parents, the most commonly cited potential indoor triggers was mold.[6] In a study that focused on home remediation aimed at moisture sources, the children who had the remediation efforts saw a significant decrease in symptom days as well as a decrease in the

number of exacerbations compared to the control groups.[7] After a one year follow up 36.4% of controls and only 17.2% of the remediation group had one or more acute care visits.[5] This is significant in that it illustrated that efforts for limiting home exposures can significantly affect asthma morbidity. It also advances the idea that children who experience removal or reduction in triggers have the capacity to significantly reduce chronic airway inflammation. However, many of these children are already living in poverty, so the cost of home remediation is often the limiting factor.

For those children living in poverty, the Reducing Ethnic/Racial Asthma Disparities in Youth (READY) study illustrated low-cost interventions could significantly improve asthma outcomes. This study consisted of five home visits by a community health worker (CHW) over the course of six months. The CHW provided asthma self-management education, environmental trigger remediation education, and low-cost trigger remediation supplies (HEPA vacuum cleaners, dust mite covers)[8]. The READY study found that the average number of asthma related emergency department (ED) visits per year decreased by 46%. Children who had at least two ED visits during the control period experienced a 63% decrease after CHW intervention.[8] These results are meaningful to this population where costly home improvements are not an option. It also strengthens the idea that asthma education should be at the forefront of asthma treatment and prevention.

Occupational Asthma after removal from triggering agents

For those who experience occupational asthma, the recommendation is to remove the patient from their exposure either through relocation or through PPE.[9] Reasonable thinking

would suggest that removal from the workplace would lead to a rapid decrease in symptoms for workers with OA. However, a systematic review of the literature by Rachiotis et al. found a pooled estimate of the rate of symptomatic recovery at 32% of patients experiencing OA. There was also a finding that the rate of recovery decreased with increasing age, however this relationship was not found to be linear.[4]

A cross-sectional study was conducted by Munoz et al. to determine if cessation of exposure truly improves prognosis of OA. What they found is that 47% of patients who terminated their exposure and 22% of patients who remained exposed showed clinical improvement. However, although clinical improvement was seen in a higher percentage of the removed patients, there was no statistical significance to this improvement.[9] This is significant because after being removed from their aggravating work environment 53% of people did not show clinical improvement in their symptoms. This phenomenon of lingering disease was further evaluated by a small study looking at latex as a possible cause of OA. The researchers looked at seven nurses who were exposed to latex gloves and found that asthma symptoms continued even years after removal from the latex exposure.[10] It has been also shown that in OA forced expiratory volume in one second (FEV_1) declines at about 100 ml/year while exposed, and improves by only 12 ml in the first year after the removal of the exposure.[11]

Comparison of childhood asthma and occupational asthma

One study specifically evaluated children with asthma and followed them until 26 years old. The researchers found that 26.9% of participants had continued symptoms of asthma by their final evaluation at 26 years of age. Of this subset, 14.5% had persistent symptoms, while 12.4%

relapsed after a period of remission. Only 15% of the study population reached and stayed in remission from wheezing.[12] The researchers found that the evidence suggests outcomes in asthma may be determined in early childhood.

When comparing the recovery of children and adults experiencing asthma symptoms, the evidence suggests that children have a higher ability to correct airway inflammation causing their symptoms. In the outlined studies there is evidence that adults often times having lingering disease even years after removal from their offending occupation trigger. Furthermore, the determinants of adult asthma may be tied to asthma control in early childhood.

Limitations

There are a few limitations that exist with this study. The first of which is the heterogeneity of the studies used. There is no set standard in the evaluation of airway inflammation, and many of these studies evaluated various clinical parameters as well as non-standardized questionnaires. Further, childhood asthma is often a combination of various triggers, whereas OA is often caused by a single offending agent. Many of the studies looking at OA focused on LMW and HMW agents, while childhood asthma studies focused on allergens and global environmental pollutants. This makes it difficult to directly compare the results of these studies.

Another limitation faced by many of the added studies is that many of the participants in these studies were recruited from specialty clinics. This can cause a bias to some of the results in that those evaluated may have more severe disease and may not be truly representative of the actual population. A further limitation is that many of these studies had small sample sizes which can influence some of the results, and create bias. However, most of the results did show statistical significance.

Conclusions

In this review of the literature there is evidence to suggest that children have an increased ability to recover from airway inflammation after removal of exposures compared to adults experiencing occupational asthma. This points to the idea that children have an increased capacity to reverse chronic airway inflammation, whereas adults, may suffer from lingering disease even after removal of offending agents, specifically those who experience occupational asthma.

Going forward it is imperative that education on environmental triggers of asthma be at the forefront of asthma management. Often times treatment of symptoms supersedes education. There are exposure factors in the home such as moisture, dust, and mold which have been proven to decrease asthma symptoms and are reasonably modifiable.

This evaluation of the literature raises the question that if asthma triggers are limited in childhood, can it prevent or decrease adult asthma morbidity? This is a worthwhile topic for further research considering the economic burden asthma has annually in the United States. It would be beneficial in a prospective longitudinal study to see if aggressive remediation of homes of asthmatic children leads to decreased rates of asthma or asthma exacerbations in adulthood.

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