Psychological Considerations of the Child with Asthma

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KEYWORDS

• Children • Asthma • Anxiety • Depression • Review

Asthma is a chronic lung disease defined by paroxysmal cough, wheezing, and dyspnea. Physiologically, asthma is defined as reversible obstruction of airflow caused by inflammation and hyperresponsiveness of the airways.[1] This obstruction is shown by the presence of inflammatory cells, such as neutrophils, mast cells, and eosinophils, targeting the alveolar tissue of the lungs. These cells excrete multiple cytokines and other mediators of inflammation that can be detected by lavage of alveolar secretions.[2] In addition, airways of asthmatic patients are more prone to constrict in response to stimuli such as cold air, histamine, or environmental allergens. These changes lead to decreased expiratory airflow, as shown by lower forced expiratory volume after 1 second (FEV_1). Obstruction in asthma is defined as an FEV_1 less than 80% of predicted for a child's age and size along with an FEV_1 to forced vital capacity (FVC) ratio of less than 0.8. Asthma can be misdiagnosed because of a similar triad of symptoms seen in other disease processes, such as congestive heart failure, pneumonia, foreign-body aspiration, pertussis, or cystic fibrosis.[3,4] In addition, mental health professionals need to be aware of vocal cord dysfunction (VCD), a syndrome that presents as intractable asthma symptoms but does not involve the lungs. Accurate diagnosis is critical because VCD responds to speech therapy, relaxation training, and supportive psychotherapy, and not to asthma medications.[5]

Asthma is the most common chronic illness diagnosed in children and adolescents in the United States and Europe,[1] with variance in the prevalence seen worldwide.[6] In reviewing data from 2001 to 2003, the United States Centers for Disease Control and Prevention (CDC) reported an annual rate of 6.2 million children with asthma in the United States, with a higher prevalence in children than in adults (8.5% vs 6.5%).

A version of this article was previously published in the *Child and Adolescent Psychiatric Clinics of North America, 19:2*.

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Pediatr Clin N Am 58 (2011) 921–935
doi:10.1016/j.pcl.2011.06.006 **pediatric.theclinics.com**
0031-3955/11/$ – see front matter

The CDC's 2006 National Health Interview Study shows a lifetime prevalence of asthma in children of 13.5%.[7] Studies have documented a progressive increase in asthma prevalence from 1980 to 1996 along with an increased rate of asthma-related deaths during this time.[8] However, asthma prevalence rates have not changed to a discernable degree during the last 10 years, with the rate of deaths decreasing each year since 2000.[1] In addition, there are prominent disparities in the prevalence of childhood asthma in racial and socioeconomic subgroups. In the United States, there is a higher average annual prevalence of asthma in black (12.5%) and Puerto Rican (18.7%) children compared with white children (7.7%).[1,9] Based on recent data, these disparities remain throughout life.[7]

Because of high prevalence rates and prolonged natural course, asthma has a sizeable economic and societal effect. A recent systematic review of the economic burden of asthma[10] detailed the effect of asthma on populations throughout the world. Asthma-related costs are direct and indirect. Direct costs, such as hospitalizations and medications, are strongly related to asthma severity. Most children have significant disability, leading to increased indirect costs as described by an overall decrease in productivity. This decreased productivity is a result of many missed school days by children and associated parental absenteeism from work. This gross financial effect is often in excess of $1000 per year for children, a rate that increases substantially with age and asthma severity.[10] In addition, a correlation was found between comorbid conditions and higher costs and resource use. Therefore, it is vital for treatment professionals to discuss asthma severity with those affected along with potential comorbid illnesses, such as stress and psychiatric illness.

HISTORICAL PERSPECTIVE OF ASTHMA AND PSYCHIATRIC ILLNESS

Before the advent of modern immunology and the development of the concept of atopy, asthma was considered primarily a nervous disease. In some early medical textbooks, this disease process was called asthma nervosa. In the 1940s to 1950s, psychoanalytic theorists (most notably Franz Alexander) described asthma as 1 of the 7 classic psychosomatic diseases caused by specific emotional conflicts. The conflict of asthma was between strong dependency wishes and a concomitant fear of separation; the wheeze was seen as a "suppressed cry for the mother."[11] Although this concept was intriguing, particularly from the perspective of an analyst envisioning a long-term treatment course, empiric investigations over the years failed to support this etiologic theory.

Over the past several decades, transformations in the field have emphasized a complex bidirectional integration of biologic and psychological factors, which are related to the course and functional outcomes of asthma. The onset and severity of asthma is currently believed to be predicted by a combination of genetics, environmental variables including exposure to infections, allergens, or irritants, and psychosocial influences such as maternal distress, psychological illness, and stress.[2,12,13] Recent evidence shows that maternal anxiety during pregnancy has been linked to significantly increased rates of asthma at approximately 7 years of age (odds ratio 1.64).[14] Maternal depression has also been consistently linked to asthma in childhood, resulting in higher morbidity as shown by more severe asthma symptoms,[15] higher number of unscheduled visits to physicians, and more frequent emergency room visits,[16] all resulting in a higher number of inpatient medical hospitalizations.[17–19] Furthermore, parental/caregiver stress has been linked to higher likelihood of wheezing[20] and associated respiratory infections[21] in early childhood; caregiver stress often results in family relationship issues and parenting difficulties, which can lead to more prevalent asthma symptoms and diagnosis in early childhood.[19,22]

In children suffering from asthma, it is apparent that dyspnea, paroxysmal cough, and wheezing induce prominent distress in those affected and can lead to emergency room visits and subsequent hospitalizations. Conversely, dyspnea and shortness of breath are central symptoms of panic attacks, which can lead to hyperventilation and ultimately worsen bronchoconstriction. However, there has been considerable debate as to whether or not children with asthma have more behavioral problems or psychiatric disturbance than healthy peers, with results of individual studies supporting both positions.

ASTHMA AS A PREDISPOSING FACTOR TO PSYCHIATRIC ILLNESS IN YOUNG PEOPLE

Recent studies have demonstrated an increased diagnosis of psychiatric illness in children with asthma compared with healthy controls. A rigorous meta-analysis of all such studies concluded that children with asthma have a small but consistent increased risk for behavioral difficulties relative to healthy children.[23] This study found a direct link between asthma severity and worse behavioral issues and reported a prevalence of internalizing symptoms (anxiety and depression) compared with externalizing symptoms (hyperactivity or oppositionality). These findings are consistent with a previous study by Wamboldt and colleagues,[24] which found that parental ratings of internalizing symptoms were correlated with asthma severity. In addition, Kashani and colleagues[25] in 1988 performed a small study (n = 112) of asthmatic young people and found a statistically significant increase of anxiety symptoms reported by parents of children with asthma compared with normal controls.

Asthma and its Association with Anxiety Disorders

Despite the increase in symptoms, it remained to be determined whether there was an association between asthma and increased diagnosis of internalizing disorders in children. Most research in this field has explored a link between asthma and anxiety disorders, which also demonstrated a higher level of anxiety disorders in the asthmatic population in children, as reviewed recently by Katon and colleagues[26] One of the first studies examining the prevalence of anxiety disorders in the pediatric population with asthma was reported by Bussing and colleagues[27] in 1996. This study demonstrated an increased prevalence of anxiety disorders in children with asthma (43.2%) compared with healthy controls (19.4%) in a study of 62 children. Two subsequent studies by Vila and colleagues[28,29] compared children with asthma with a similar number of children with insulin-dependent diabetes and healthy controls. These studies found that 32% to 35% of children with asthma met criteria for an anxiety disorder, with clinically increased mean scores on the State-Trait Anxiety Inventory for Children and Child Behavior Checklist in the asthmatic group compared with the diabetic group. The latter study[29] found a high prevalence of generalized anxiety disorder of 24% in the studied asthmatic population. These findings were followed by a large (n >1000) longitudinal study of children from age 3 to 21 years that determined that a diagnosis of asthma before age 18 years resulted in an increased risk for agoraphobia or panic disorder in early adulthood.[30] This research paved the way for research on a large community sample of 1285 young people called the Methods of the Epidemiology of Child and Adolescent Mental Disorders Survey. Through analysis of this population, Ortega and colleagues[31] determined a prevalence of anxiety disorders in 49.2% of those suffering from asthma compared with 37.7% of healthy controls along with clinically increased diagnosis of simple phobia, separation anxiety disorder, and overanxious disorder. Goodwin and colleagues[32] also performed a secondary analysis of this population, finding a statistically significant risk of panic

attacks in the asthmatic population (odds ratio = 1.5). Similar correlations were shown in studies of a community sample of Puerto Rican children, which determined a greater risk of internalizing disorders in children affected by asthma compared with nonasthmatic Puerto Rican young people at baseline and 1-year follow-up while controlling for socioeconomic factors.[33,34] In a recent study of 200 adolescents, those who suffered life-threatening asthma symptoms had higher levels of posttraumatic stress symptoms and associated diagnosis of posttraumatic stress disorder (PTSD). In addition, a diagnosis of PTSD was found to be directly linked to asthma morbidity.[35] Within the last 5 years, 2 studies have attempted to investigate the link between social anxiety and history of asthma symptoms. These studies by Ortega and colleagues[36] and Bruzzese and colleagues[37] found no significant correlation between a lifetime diagnosis of asthma and social phobia; however, the latter study[37] demonstrated a significant link between active asthma symptoms with higher levels of social anxiety, as seen on the Social Anxiety Scale of Adolescents.

Following these initial studies, Katon and colleagues[38] conducted the largest study to date (n = 1379) of psychiatric illness in young people with asthma. This study was completed after interviewing children (aged 11–17 years) with the telephone version of the National Institute of Mental Health Diagnostic Interview Schedule for Children (NIMH DISC-4.0) and subsequent parent interview, reviewing sociodemographic factors and completing the Child Behavior Checklist (CBCL) for all participants. This study demonstrated an almost twofold increased prevalence of at least 1 anxiety or depressive disorder diagnosis in asthmatic children (16.3%) when compared with normal controls (8.6%). It was also found that several independent factors significantly increased the risk of meeting criteria for 1 or more internalizing disorders, including female gender, living with a single parent, increased report of externalizing behaviors by parents, a more recent diagnosis of asthma, and more impairment from asthma symptoms.

Asthma and its Link to Depression and Increased Risk Behaviors

Other studies have reported an increased link between negative affect, depression, and other psychiatric disorders in asthmatic children and adolescents. Blackman and Gurka[39] reviewed data taken from the National Survey of Children's Health 2003, which was designed to investigate the health of the general child population in a random selection of 102,353 children aged 0 to 17 years, including the national prevalence of emotional and behavioral issues.[40] This research found clinically increased rates of depression, attention-deficit/hyperactivity disorder (ADHD), behavioral disorders, and learning disabilities in asthmatic young people. Furthermore, a diagnosis of asthma was associated with an increased likelihood of being bullied, along with higher rates of missed school. The severity of asthma symptoms was also found to be directly linked to the likelihood of depression, learning disabilities, ADHD, and other behavioral disorders.[39] Asthma is also correlated with increased risk-taking behaviors in children, including increased substance abuse, driving without a seat belt, and dangerous sexual practices.[39,41] In 2007, Bender reviewed data on depression and substance use in asthmatic young people who participated in the CDC's 2005 Youth Risk Behavior Survey,[42] which monitors 13,917 high-school students for high-risk behaviors that can result in unintentional injuries and violence. In the 720 young people surveyed who were diagnosed with asthma (5.2% of total population), depression and rates of cigarette and cocaine use were more common than in those without asthma.[43] These findings are augmented by a recent research study on asthmatic young people that found an increased risk of cigarette use in those affected by comorbid anxiety and depressive disorders.[44]

PSYCHIATRIC ILLNESS AND ITS CORRELATION WITH ASTHMA SEVERITY IN YOUNG PEOPLE

Conversely, sadness and the diagnosis of depression and anxiety may be associated with more severe asthma symptoms. Waxmonsky and colleagues[45] monitored a group of asthmatic, inner-city children (n = 129) and found clinically increased depressive symptoms in 26% of subjects. In this depressed subgroup, children's self-reported neurovegetative symptoms strongly correlated with asthma activity, more so than either parental depression or parent/clinician ratings of the child's depression. Anxiety and depression are strongly correlated with asthma symptom burden in children and adolescents. Asthmatic children with 1 or more internalizing disorders have a higher number of days with asthma symptoms compared with asthmatic young people without an internalizing disorder.[46] Recent research demonstrates that higher negative affect scores predict increased asthma symptom severity as rated by children and their parents.[47]

Stress and emotional responses are also related to inflammation and airway resistance. Some of the early conceptualizations of asthma as psychosomatic may derive from case reports of emotions as a trigger for asthma exacerbations. Although asthma is not seen as largely caused by emotions, research does demonstrate that emotions can trigger asthma symptoms in 15% to 30% of people with asthma.[48,49] In a laboratory setting in which children with asthma were monitored while watching affectively evocative film scenes, marked emotional and autonomic responses were observed. These responses were associated with increased airway reactivity and decreased pulmonary function.[50] Experimental studies in which pulmonary function is measured before and after a patient is exposed to a stressful experience, such as performing mental arithmetic, watching emotionally charged films, or public speaking, consistently show significant bronchoconstriction in about 22% of studied asthmatic patients.[51] In addition, evidence suggests that stressful, negative life events significantly increase the risk of a new asthma attack within 2 days of the event, along with a higher potential for a delayed attack 5 to 7 weeks later.[52]

The mechanism that links emotional processes to asthma exacerbations is unclear, but autonomic mediation is likely. In addition to the direct effects of the autonomic system on bronchial smooth muscle, there are bidirectional relationships between the neuroendocrine system (including the hypothalamic-pituitary-adrenal axis) and the immune system that influence lung inflammation.[49,53–55] On a molecular level, T-cell lymphocytes have 2 different responses to microbial or allergen exposures: Th1 or proallergenic Th2 responses. In asthma and atopy, the Th1/Th2 dynamic equilibrium has been shown to be unbalanced, demonstrating increased Th2 activity and associated cytokine response, such as interleukin (IL)-4, IL-5, and IL-13.[56–62] Emotional stress produced in the laboratory setting has been associated with a greater increase in the ratio of Th2 cytokines versus Th1 in asthmatic children compared with controls, which reflects proinflammatory activity.[63] On a biochemical level, evidence suggests that the biologic link intertwining anxiety symptoms and asthma may be the brainstem respiratory sensor system as it responds to real or perceived increases in Pa_{CO_2} to stave off impending asphyxiation.

MANAGEMENT OF ASTHMA

Classification and Assessment of Asthma Severity

It is essential that mental health professionals working with asthmatic children be familiar with the medical management of the illness. Asthma is classified into 2 major classes based on symptom prevalence: intermittent versus persistent. Intermittent

symptoms occur 2 or less days per week, cause no significant interference with normal activity, and do not cause nighttime awakenings. Persistent symptoms are classified into mild, moderate, and severe subcategories, based on lung function, the prevalence of symptoms during the daytime, nighttime awakenings, frequency of rescue-inhaler use, and frequency of severe exacerbations requiring oral glucocorticoids, as detailed in the National Asthma Education Prevention Program (NAEPP) Expert Panel Report for 2007.[64] The goals of treatment are to reduce impairment through adherence to an individualized asthma treatment plan. This plan entails providing patient/family education, monitoring lung function, controlling environmental factors and triggers, treating comorbid conditions that can exacerbate asthma, and providing proper pharmacologic therapy with quick relief and long-term, controller medications.[65]

Monitoring of asthma and pulmonary function is generally performed at home and in the medical office. Pulmonary function is most commonly assessed at home by measurement of peak expiratory flow rate (PEFR), which is decreased with obstruction seen during asthma exacerbations. A normal PEFR range is individualized for each patient and is defined as 80% to 100% of the child's best PEFR reading or 80% to 100% of an expected PEFR for a child of that age and size. PEFR can be checked as often as tolerated on inexpensive, widely available, peak flow meters and can be vital in asthma monitoring and control. However, the PEFR index is highly effort dependent and peak flow meters have their limitations. Spirometry is preferred by the NAEPP in children aged 5 years and older for studying PEFR, FEV_1, and FVC in the medical office setting; home spirometry is expensive but increasingly available. In an effort to control asthma, individual asthma triggers should be identified. Screening should focus on seasonal components versus year-round symptoms, exposure to smoke (tobacco and workplace), indoor and outdoor pollutants, and sulfites in the diet. Illnesses that may exacerbate asthma, such as upper respiratory infections, influenza, gastroesophageal reflux disease, and rhinitis, should be assessed and treated. Medications, such as β-blockers and antiinflammatory agents (such as aspirin or nonsteroidal antiinflammatory drugs), can also cause or worsen asthma symptoms.

Pharmacologic Interventions for Asthma

Pharmacologic treatment focuses on a stepwise approach based on asthma severity.[64,65] For quick relief in all classes of severity, inhaled, short-acting β_2-agonists (SABA), such as albuterol, levalbuterol, or pirbuterol, should be used as needed. Intermittent asthma, by definition, should be adequately managed by use of these agents alone (step 1). Inadequate control is usually shown by use of short-acting agents more than 2 times per week, which often necessitates a step-up in treatment. Persistent asthma requires daily medication use, starting first with low-dose inhaled corticosteroid (ICS) use (step 2), using agents such as budesonide, fluticasone, beclomethasone, triamcinolone, or mometasone. Other agents, such as cromolyn, leukotriene-receptor agonists, nedocromil, or theophylline, can be used instead of inhaled steroids if there are adverse effects or sensitivities. If insufficient, subsequent titration of the ICS or addition of long-acting β_2-agonist bronchodilators (LABA), such as formoterol or salmeterol, is recommended (step 3). If these changes are inadequate, the dosing of each agent is titrated (steps 4 and 5) until the addition of oral corticosteroids is warranted (step 6). If asthma is well controlled for more than 3 months on a certain step, a step-down is considered if clinically possible.

Treatment of asthma is often complicated, laden with potential risks, side effects, and adverse effects. One of the biggest complicating factors with treatment is poor

patient adherence. Research has demonstrated limited adherence to controller medications in children with asthma, with a likely adherence rate across studies of approximately 50% to 60%.[66–70] Adolescents with asthma have increased knowledge about the disease process and treatment and usually have assumed greater responsibility for treatment; however, they also seem to have lower treatment compliance than younger children.[70] Although strategies of prevention of exacerbations focus on psychoeducation,[64–71] prior research has found little association between knowledge and reasoning about asthma with adherence.[70]

MANAGEMENT OF PSYCHOLOGICAL COMPONENTS OF ASTHMA

Assessment of Complicating Factors

As discussed earlier, asthma symptoms include anxiety-inducing dyspnea, which often necessitates medical interventions and hospitalizations, which in turn further provoke anxiety in a child. If repeated over time, these experiences may contribute to the development of an anxiety disorder. Conversely, dyspnea and shortness of breath are central symptoms of panic attacks, which can lead to hyperventilation. This hyperventilation, with its associated colder air moved more deeply into the lungs, has the potential to precipitate or aggravate asthmatic bronchoconstriction. In addition, evidence shows comorbid behavior problems and psychiatric disorders have been associated with limited asthma control, marked by poor adherence to the treatment regimen.[43] Psychiatric disorders in asthmatic patients are underdiagnosed, which results in increased treatment costs. The rate of recognition of anxiety and depression for children diagnosed with asthma is low; approximately 35% of depressive disorders are diagnosed, with a slightly higher recognition (43%) of major depressive disorders.[72] These low recognition rates are complicated by low agreement rates between children and parents regarding diagnosis of an internalizing disorder.[73] In addition, few children in the asthmatic population receive optimal mental health treatment.[72] An increased health care cost of approximately 50% was found in asthmatic young people with a depressive disorder with or without an associated anxiety disorder, which was also correlated with higher health care use than asthmatic young people without an internalizing disorder.[74] Furthermore, internalizing disorders seen in asthmatic patients may be exacerbated by side effects from conventional asthma treatments. Certain asthma medications, such at β_2-agonists, can increase autonomic arousal, thereby worsening anxiety symptoms. When anxiety disorders and asthma coexist, the risk of overuse of bronchodilators is considerable. Behavioral disturbances and worsening anxiety can also occur with inhaled steroids, whereas oral steroid use can be linked to worsening anxiety and depression, with the potential to lead to mania or psychosis.

Improving Symptom Perception

The corollary to these findings is that identification and effective treatment of psychiatric disorders frequently leads to better asthma management and decreased morbidity. One of the ways to improve asthma management is to focus on symptom perception in asthmatic young people.[75] An emerging literature links psychological characteristics with the ability to perceive varying degrees of respiratory compromise accurately. Recognition of early clinical symptoms prompts the early initiation of timely and appropriate self-management strategies, which in turn minimizes asthma morbidity. In the psychiatric literature on somatization, a range of characteristic individual patterns of responding to physical symptoms has been described, from extreme stoicism and denial (eg, the football player who plays an entire game with

a broken hand) to those who amplify their symptoms. Those who amplify symptoms are often seen as somatizers or hypochondriacs. Prior research on limited sensitivity to resistive respiratory loads was found to increase the likelihood of near-fatal asthma attacks when compared with other people with asthma and control subjects.[76,77] Therefore, the literature on perception of asthma symptoms is relevant to our understanding of the psychiatric phenomenon of somatization, and vice versa.

Researchers have several methods to quantify perceptual accuracy of asthma in children and adults. These approaches involve individuals rating their subjective degree of compromise before objective pulmonary function testing, either in a laboratory with a methacholine challenge test or naturalistically, using a portable spirometric device that stores corresponding subjective and objective data points.[78] The accuracy of perception can be summarized by the level of correlation between the subjective judgment and the objective reality. In general, most individuals perceive pulmonary function compromise with reasonable accuracy; however, some perceptual patterns may be problematic for disease management. In several studies involving different populations of children, greater perceptual accuracy has predicted less morbidity, at baseline and at 1-year follow-up.[79] However, some children are dangerously inaccurate, ignoring or underestimating significant impairment, whereas others tend to overestimate their compromise.[80]

These patterns are illustrated by comparing 2 children of similar age and asthma severity seen in the authors' clinic. One 11-year-old boy had subjectively predicted peak flow values that were consistently lower than his actual peak flow values. His pattern was to magnify his degree of compromise, and his clinical history over the preceding year was one of high use of health care. Despite having readily controlled moderate persistent asthma, this patient had 2 inpatient hospitalizations, 10 emergency room visits, and 12 unscheduled visits to his pediatrician. His high level of sensitivity and concern led to excessive use of asthma-related medication and health care, placing him at substantial risk for side effects from overmedication and other iatrogenic problems. In contrast, a 14-year-old boy had similar symptoms and a diagnosis of moderate persistent asthma, but was accurate at perceiving his pulmonary function at any given time. This child had no history of hospitalizations, emergency department visits, or unscheduled pediatric visits in the preceding year. Although several factors, such as disease severity, family context, and health care access, are also relevant with this comparison, these cases illustrate the importance of individual variability in detecting and assessing severity of asthma symptoms.

Relaxation and Biofeedback

Psychological treatments have also proven helpful in treating physical symptoms of asthma, especially for children with asthma symptoms that are triggered emotionally, as previously reviewed by McQuaid and Nassau.[81] Early studies by Alexander[82,83] reported positive outcomes from progressive muscle relaxation, noting modest improvements in PEFR that were later replicated by Miklich.[84] The likely benefit from this intervention is related to the potential emotional triggering of asthma exacerbations. Later research by Vasquez and Buceta[85–87] showed limited benefit from relaxation alone in providing pulmonary function test improvements; however, for those children with emotionally triggered asthma symptoms, relaxation and self-management could limit the duration of asthma exacerbations. Even although they demonstrate clinically significant pulmonary function changes in the treatment groups, these studies were hampered by a small degree of improvement (<10% change) from baseline and limited long-term follow-up of results.[81,88]

In comparison, electromyogram (EMG) biofeedback has a strong, well-supported evidence base demonstrating its benefit in children with emotionally triggered asthma. The strength of biofeedback in this population centers around the core principle that a physical symptom can be influenced by continuous reporting on the physiology of that symptom. Early research in the field used biofeedback to augment relaxation training.[89,90] However, researchers began to speculate that EMG biofeedback of stress in the frontalis muscle may be related to airflow resistance via a reflexive mechanism with the trigeminal and vagus nerve systems.[81,91,92] Studies on reducing stress reflected in the frontalis muscle by EMG biofeedback reported clinical benefit in improving PEFR, exceeding benefits seen in comparative brachioradialis biofeedback.[93,94] These results led to further investigation into the short-term and long-term effects of EMG frontalis feedback. Children who were instructed to reduce frontalis muscle tension via biofeedback and continue these strategies in the home setting showed improvement in pulmonary function testing compared with children who were instructed to maintain frontalis tension.[91] These benefits of biofeedback may also translate into decreased respiratory resistance; however, evidence for this mechanism is limited to several adult studies and 1 early study in children.[95] In this study of 4 children, Feldman examined tonal feedback from forced oscillation, which is a technique used to determine airway resistance in obstructive airway diseases. This technique is performed by measurement of the velocity of returned air produced in a pulsed fashion from a sine-wave pump placed at the patient's mouth; with increased resistance, there is an associated increase in the frequency of resonated air. In this study, this higher resonated frequency correlated to a higher tonal pitch; patients were instructed to decrease the tonal pitch, thereby decreasing airway resistance. All participants demonstrated improvement in airway resistance. These intriguing findings in children have never been replicated, but would seem to merit further controlled research in a larger population.

School-based Interventions

Interventions treating the psychological aspects of asthma are not limited to laboratory testing, however. As described earlier, indirect costs of asthma are exorbitant; children with asthma miss approximately 10 million days of school each year.[64] In an effort to address this societal cost, many educational programs have been developed for parents and children with asthma. These programs were created to occur either during the day or as part of after-school education. In a recent review of these educational programs, Guevara and colleagues[96] found improvements in lung function, school absenteeism, nighttime symptoms, and visits to emergency departments. However, these programs were limited by parental availability and difficulty in accessing children's classes.[97]

In 2000, an after-school program for asthma education was developed in Providence, Rhode Island in effort to address limitations from prior studies. This program, called the Providence School Asthma Partnership, used a school-based model in an after-school setting to provide psychoeducation for inner-city families.[97] During the 3-year study period, 972 families participated in this 1-time, 2.5-hour after-school program, which focused on asthma knowledge, management of asthma triggers, and use of appropriate treatment strategies. All parents were given the opportunity to repeat this workshop as necessary along with attending a bimonthly support group, established by the program. In this study, all measured outcomes significantly improved during the 1-year treatment period. Frequency of asthma symptoms was reduced from several times per week to less than once per week. In addition, the prevalence of those children hospitalized in a given year decreased from 11% to

2% along with the frequency of emergency room visits (35% to 4%). Those children who missed school because of asthma symptoms decreased from 48% to 20%. Most importantly, this program has been sustained by private and government insurance reimbursement, providing a model that can likely be reproduced throughout the country.

SUMMARY

Asthma is a very prevalent and costly illness, affecting society in high direct and indirect costs. The triad of asthma symptoms (dyspnea, intermittent cough, and wheezing) can cause marked and potentially life-threatening distress in children suffering from asthma. As detailed in this review, the effect of asthma is not confined to respiratory distress and airway inflammation. Asthma is associated with a higher prevalence of internalizing psychiatric disorders, which in turn can further exacerbate asthma symptoms and perceived distress. The severity of self-reported neurovegetative and anxiety symptoms is directly associated with functional status, psychologically and physiologically, and can lead to worsened morbidity.[98] These findings emphasize the need for increased awareness of the association between asthma and psychiatric illness along with improved treatment strategies for asthma-related symptoms. Treatment providers should consider screening all children with asthma for depression, anxiety, and high-risk behaviors. This screening may take the form of a clinical interview in a primary care physician's office to a full psychiatric/diagnostic interview for those at highest risk.[43,99,100] In addition, mental health professionals should consider discussion of asthma control with asthmatic patients and their families seen in psychiatric clinics and hospital settings. This intervention may serve as a conduit into further psychological management and other treatment strategies. Improving asthma education and enhancing asthma control will lead to diminished psychiatric symptoms, which will ultimately decrease morbidity of this prevalent chronic disease of childhood.

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