Essential Practices

A clinical decision-making resource for the respiratory care professional

Asthma Diagnosis, Treatment and Management

By Tim Myers BS, RRT-NPS and Tim Op't Holt EdD, RRT, FAARC

Asthma affects approximately 21 million Americans, 7 million of whom are children. Chronic inflammation and bronchoconstriction are at the basis of asthma and therapy is focused on preventing, alleviating, and treating these factors. Diagnosis involves several components, including an assessment of the patient's medical history, a physical exam, and spirometry. Treatment should be chosen based on an assessment of asthma severity and control, which are divided into domains of impairment and risk. Pharmacological therapy is aimed at both prevention and treatment of symptoms, and should occur in a stepwise fashion. Controller medications (e.g. inhaled corticosteroids, leukotriene modifiers, non-steroidal anti-inflammatory drugs) are intended to suppress inflammation whereas quick relief medications (e.g. short-acting beta-agonists) are intended to alleviate bronchoconstriction. The precise cause of asthma is unknown, but as with so many other chronic diseases, it involves a combination of genetic susceptibility and environmental exposure. Thus, environmental control plays a large role in treatment. Factors which aggravate asthma include pollen, animal dander, dust and dust mites, insect parts, tobacco smoke, and several others. Patients with comorbid conditions, such as sleep apnea, rhinitus/sinitus or chronic stress, need special attention to control these factors which are known to exacerbate asthma. Once treated, patients should be monitored closely with questionnaires, spirometry, exhaled nitric oxide, and other tools. Patient education is a key component in asthma control and should not be neglected. Education should include instruction in how to use medication delivery devices and how to write and follow an asthma action plan.

Roundtable Discussion: How do you manage your asthma patients?

Moderator: *Tim Myers, BS, RRT-NPS*

Panelists: *Robert Cohn, MD*

Stephens Peters, MD, PhD

Karen Gregory, MS, ASPRN-BC, RRT, AE-C

The 2007 National Asthma Education and Prevention Program asthma guidelines (Expert Panel Report-3 or EPR 3) update the 1997 and 2002 Expert Panel Reports. The EPR 3 describes four essential components of asthma care: assessment and monitoring, patient education, control of factors contributing to asthma severity, and pharmacologic treatment. Subtopics were developed for each of these four broad categories. In the 2007 edition, the critical role of inflammation in asthma has been further substantiated, gene-environmental influences have been given more weight, and the relevance of early risk factors is stressed. Although the guidelines are the most comprehensive and evidence-based to date, they allow the healthcare provider to select the best treatment options for individual patients, depending on the nature of their asthma. In this roundtable, we have invited three experts to discuss the particulars of how they manage their patients.

Asthma Diagnosis, Treatment and Management

By Tim Myers BS, RRT-NPS and Tim Op't Holt EdD, RRT, FAARC

Asthma is a chronic inflammatory disease of the airways characterized by airway hyperreactivity and acute episodes of airflow obstruction caused by smooth muscle constriction. The US Centers for Disease Control and Prevention estimates that there are approximately 21 million people in the United States with the diagnosis of asthma, of which 7 million are under the age of 18.[1]

Chronic inflammation plays a key role in airway hyperresponsiveness, airflow obstruction, daily symptoms and disease chronicity. Inflammatory mediators secreted by airway cells (e.g. eosinophils, neutrophils, lymphocytes, mast cells, macrophages, dendritic cells and injured epithelial cells) play an important role in maintaining this inflammation. The exact mechanism of the pathogenesis of asthma inflammation is not clearly understood, but is currently under active investigation.

While the mechanism of inflammation remains a mystery, the origin of bronchoconstriction and airway hyperreactivity is much more clearly understood. During acute exacerbations of asthma, the smooth muscles surrounding the airways constrict, resulting in a narrowing of the airways and varying degrees of airflow obstruction. This produces the classic signs of asthma – coughing, wheezing, chest tightness and shortness of breath. Airway hyperreactivity can be simply defined as an exaggerated bronchoconstrictive response to a variety of external and internal stimuli.

Establishing a Diagnosis

According to the current National Asthma Education and Prevention Program asthma guidelines (Expert Panel Report-3 or EPR 3) [2], in diagnosing asthma, the clinician should determine (1) that the patient has episodic symptoms of airflow obstruction or airway hyperreactivity, (2) the airflow obstruction is at least partially reversible following administration of a short-acting beta adrenergic bronchodilator, and that (3) alternative diagnoses have been excluded or ruled out. The recommended methodology for establishing a diagnosis of asthma has not undergone major changes since 1997. The 4 main methods of assessment and determination are found in Table 1. We will take a closer look at each of these key recommendations separately.

Table 1. **Recommended methods to establish the diagnosis are (EPR-2 1997)3:**

- Detailed medical history.
- Physical exam focusing on the upper respiratory tract, chest, and skin.
- Spirometry to demonstrate obstruction and assess reversibility, including in children > 5 years-of-age. Reversibility is determined either by an increase in FEV_1 of ≥12 percent from baseline or by an increase ≥10 percent of predicted FEV_1 after inhalation of a short-acting bronchodilator.
- Additional studies as necessary to exclude alternate diagnoses.

Medical History

When a patient that appears to have asthma presents for the first time, one should obtain a detailed medical history. This may provide some insight to the primary symptoms that may be due to asthma. Other information gleaned from this verbal history may be supportive of the probability of asthma, such as familial history, the presence of atopy, or the pattern or context in which the asthma-like symptoms occur (e.g. allergies, viral, exercise-induced, seasonal).

Table 2. **Additional recommendations from the Expert Panel Report-32 regarding spirometry in the general or primary care practice.**

- The Expert Panel recommends that office-based physicians who care for asthma patients should have access to spirometry, which is useful in both diagnosis and periodic monitoring. Spirometry should be performed using equipment and techniques that meet standards developed by the ATS
- The Expert Panel recommends that when office spirometry shows severe abnormalities, or if questions arise regarding test accuracy or interpretation, further assessment should be performed in a specialized pulmonary function laboratory

Physical Examination

The physical exam for asthma typically focuses on three main areas: the upper respiratory tract, the chest and the skin. The upper respiratory tract is auscultated for the presence of wheezing or a prolonged expiratory phase. A secondary examination of the upper airway investigates the presence of increased nasal secretions, mucosal swelling, or nasal polyps. An examination of the chest may reveal hyperexpansion, accessory muscle use or hunched shoulders, indicating chest deformities. The patient may be asymptomatic between flares. Finally, an inspection of the skin may reveal evidence of atopic dermatitis, eczema or another manifestation of an allergic skin condition. The physical examination may be normal when the patient is asymptomatic.

Table 3. **Alternate diagnosis possibilities for asthma.**

Infants and Children

Upper airway diseases

- Allergic rhinitis and sinusitis

Obstructions involving large airways

- Foreign body in trachea or bronchus
- Vocal cord dysfunction
- Vascular rings or laryngeal webs
- Laryngotracheomalacia, tracheal stenosis, or bronchostenosis
- Enlarged lymph nodes or tumor

Obstructions involving small airways

- Viral bronchiolitis or obliterative bronchiolitis
- Cystic fibrosis
- Bronchopulmonary dysplasia
- Heart disease

Other causes

- Recurrent cough not due to asthma
- Aspiration from swallowing mechanism dysfunction or gastroesophageal reflux

Adults

- COPD (e.g., chronic bronchitis or emphysema)
- Congestive heart failure
- Pulmonary embolism
- Mechanical obstruction of the airways (benign and malignant tumors)
- Pulmonary infiltration with eosinophilia
- Cough secondary to drugs (e.g., angiotensin-converting enzyme (ACE) inhibitors)
- Vocal cord dysfunction

Spirometry (Pulmonary Function Testing)

The use of spirometry to determine the diagnosis of asthma is currently considered the "gold standard" for a definitive diagnosis. One of the key updates from the 1997 and 2002 guidelines regards the use of spirometry, especially in children, and in the criteria of reversibility. The 2007 Expert Panel recommends that spirometry measurements be taken before and after inhaling a short-acting bronchodilator. These include forced expiratory volume in one second [FEV_1], forced expiratory volume in 6 seconds [FEV_6], forced vital capacity [FVC] and FEV_1/FVC ratio. Table 2 provides additional recommendations from the Expert Panel in regards to spirometry in the general or primary care setting.

Differential or Alternate Diagnoses of Asthma

The Expert Panel recommends consideration of alternative diagnoses, as appropriate. Table 3 provides a general list of potential alternate diagnoses that may be considered for both children and adults during the clinical evaluation. While typically not necessary, the clinician may want to consider additional tests to facilitate or rule out the diagnosis of asthma. These include chest radiographs, allergy testing, lung volume and diffusion or challenge testing, and biomarkers of inflammation.

Asthma Severity

The EPR 3 stresses the importance of determining asthma severity upon initial assessment, as it becomes the basis for establishing a medication regimen. Asthma severity and control fall into two domains: *impairment* and *risk*. The main impairment components with regard to severity are: daytime symptoms, nocturnal symptoms, activity limitation, utilization of short-acting beta-agonists and lung function assessment in asthmatics ≥5 years of age. The areas of *risk* – which are new in the EPR 3 – include components of asthma exacerbations. Table 4 provides an example of a severity table and its components of impairment and risk. The four levels of asthma severity are: intermittent, mild persistent, moderate persistent, and severe persistent.

Treatment

The goals of pharmacologic therapy in asthma are to prevent or control symptoms, reduce functional morbidity, decrease the frequency and severity of acute exacerbations, reverse airflow obstruction and improve overall quality of life (QOL). The chronic treatment of asthma utilizes long-term control medications to achieve and maintain control of persistent asthma symptoms, and quick relief medications for treating acute symptoms and exacerbations. Patients that have persistent asthma severity require both classes of medications, while those with intermittent asthma usually require only quick relief medications. The EPR 3 guidelines still recommend a stepwise approach to the pharmacologic management of asthma (Table 5). The main difference from the EPR 2 is that the number of treatment steps has increased from 4 to 6.

Controller Medications

In EPR 3, evidence for the daily use of controller medications for persistent asthma is of the highest level (Evidence Grade A). The most effective medications in the controller class are those which suppress the primary inflammatory characteristics of asthma and potentially decrease airway hy-

Table 4. **Classifying Asthma Severity in Youths > 12 Years of Age and Adults** *(adapted from reference 2).*

Components of Severity		Classification of Asthma Severity (Youths ≥12 years of age and adults)			
		Intermittent	Persistent		
			Mild	Moderate	Severe
Impairment **Normal FEV1/FVC:** **8-19 yr 85%** **0-9 yr 80%** **40-59 yr 75%** **60-80 yr 70%**	Symptoms	≤2 days/week	>2 days/week but not daily	Daily	Throughout the day
	Nighttime awakenings	≤2x/month	3-4x/month	>1x/week but not nightly	Often 7x/week
	Short-acting beta2-agonist use for symptom control (not prevention of EIB*)	≤2 days/week	>2 days/week but not >1x/day	Daily	Several times per day
	Interference with normal activity	None	Minor limitation	Some limitation	Extremely limited
	Lung function	• Normal FEV_1 between exacerbations • FEV_1 >80% predicted • FEV1/FVC normal	• FEV_1 ≥80% predicted • FEV_1/FVC normal	• FEV_1 >60% but <80% predicted • FEV_1/FVC reduced 5%	• FEV_1 <60% predicted • FEV_1/FVC reduced >5%
Risk	Exacerbations requiring oral systemic corticosteroids	0-1/year	≥2/year →		
		Consider severity and interval since last exacerbation. Frequency and severity may fluctuate over time for patients in any severity category.			
		Relative annual risk of exacerbations may be related to FEV_1			

**EIB = Exercise Induced Bronchospasm*

perresponsiveness.

Because the asthma inflammatory response is multifactorial, the list of controller medications is diverse and includes medications from several classes, such as inhaled corticosteroids (ICS), leukotriene modifiers, non-steroidal anti-inflammatories, long-acting beta-agonists, methylxanthines and immunomodulators. Of these medications, the ICS are the most potent and consistently effective for all patients with persistent disease. (Evidence Grade A)

Quick Relief Medications

Quick relief medications are prescribed to provide prompt relief of acute asthma symptoms and to induce the resolution of bronchoconstriction by airway smooth muscle relaxation. The primary medications in this class are short-acting beta-agonists (SABAs), systemic corticosteroids and anticholinergics.

Anticholinergics, combined with SABAs, are recommended for patients who have moderate-to-severe obstructive airflow exacerbations. While systemic corticosteroids have a much slower onset of action, their use in moderate-to-severe exacerbations is recommended as they prevent the progression of the exacerbation, facilitate a quicker recovery and minimize the potential for relapse.

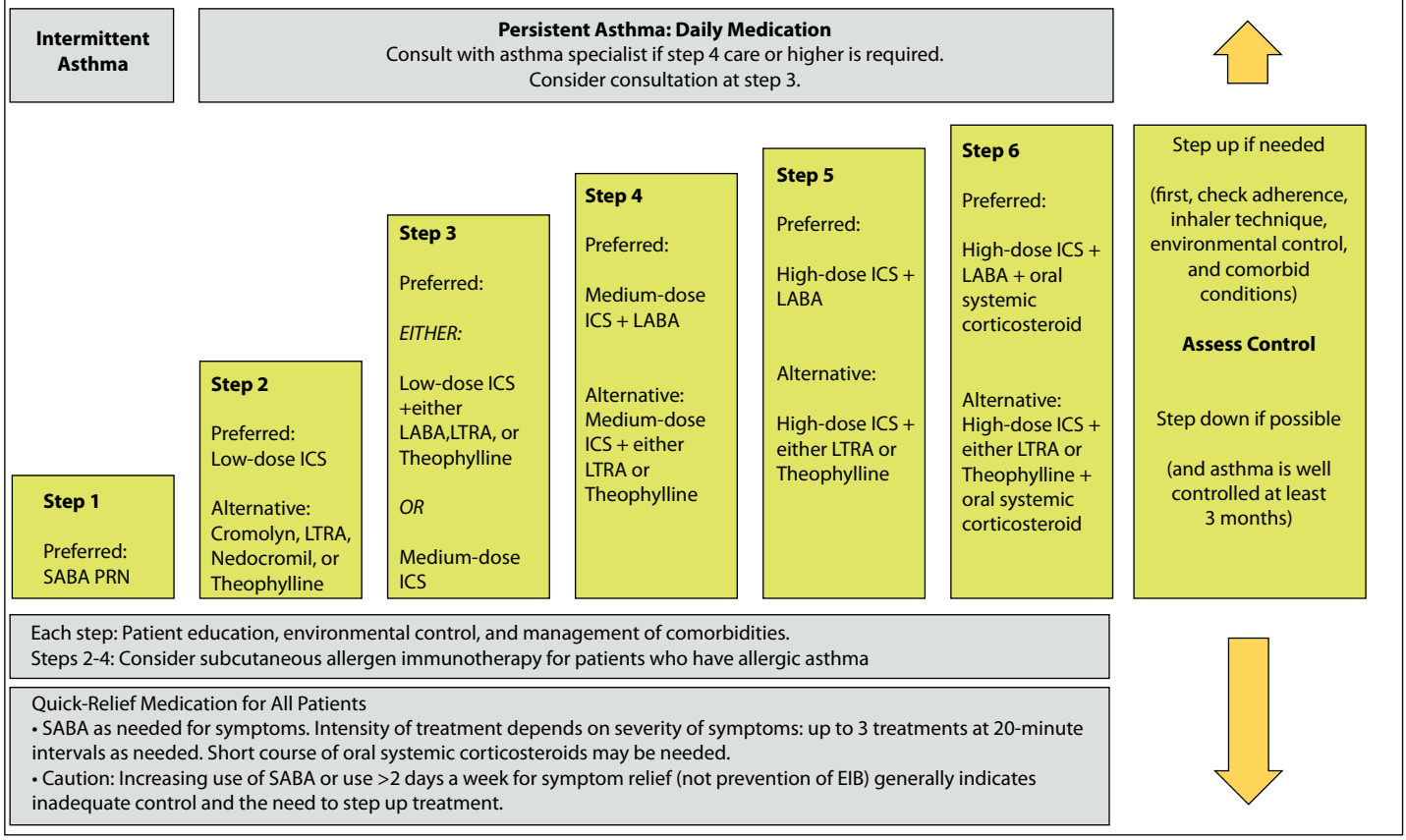
Asthma Assessment and Monitoring

Assessment and monitoring are linked to severity, control and responsiveness to treatment. As defined in EPR 3, severity is the intrinsic intensity of the disease process and is most easily measured in a patient not receiving long-term control therapy. So, when we ask the patient about the nature and frequency of their symptoms and evaluate pulmonary function, we are evaluating severity. This step is usually performed when the patient first presents with symptoms. Severity is based upon the frequency of symptoms, the number of night-time awakenings, frequency of short-acting beta agonist use for symptom control, interference with normal activity, and lung function. Severity increases with the frequency of symptoms and with decrements in pulmonary function. As in the EPR 2, asthma is classified in 4 categories as previously discussed. However, the first category is now called "intermittent," as opposed to "mild intermittent," since there are reports of patients with previously reported "mild" intermittent asthma experiencing a severe exacerbation requiring ventilation, or even dying, so the term "mild" was a misnomer.

Asthma Control

Control is the degree to which symptoms of asthma are minimized and the goals of therapy are met. When we evaluate control, we are again assessing impairment and risk for future exacerbations as we did when the patient first presented (Table 6). A variety of age-appropriate questionnaires are used to assess control, which are listed in EPR 3. In addition to *impairment*, the patient is evaluated for the *risk* of future exacerbation. This is based on the number of exacerbations per year requiring oral systemic corticosteroids, reduction in lung growth, and intensity of treatment-related side effects. Asthma control is classified as: well-controlled, not well-controlled, or very poorly controlled. A reduction in therapy may be considered if the patient is well-controlled for 3 months on the present therapy. An increase in therapy is considered after determining that environmental control is

Table 5. **Stepwise Approach for Managing Asthma in Children 5-11 Years of Age** *(adapted from reference 2).*



EIB= exercise induced bronchospasm

adequate, and the patient has adhered to drug management as prescribed, but is still not controlled. Responsiveness is the ease with which control is achieved by therapy.

Identifying Precipitating Factors

The precise mechanism of asthma is unknown. However, it is known that the interaction of genetic and environmental factors during the development of the immune system is responsible for making one vulnerable to allergies and asthma. The inflammation in asthma is related to an imbalance between Th1 and Th2 lymphocytes, favoring the Th2 lymphocytes which generate the cytokines present in asthma. At birth, there is a trend toward Th2 generation. Stimuli, such as infections, exposure to other children, and less frequent use of antibiotics, activate Th1 responses, bringing the Th1/Th2 relationship into balance. This is known as the "hygiene hypothesis." However, absence of exposure to other children, frequent antibiotic use, and exposure to infection favor the persistence of a lymphocyte pattern dominated by Th2. In children who have this persistence of Th2 lymphocytes, IgE antibodies to environmental antigens are produced.

Genetics may also play a role, as it is known that a parent with asthma often has one or more children with asthma. Genetic polymorphisms of the $beta_2$ adrenergic receptor can alter the response to bronchodilators. Gender also plays a role in asthma. Asthma is more prevalent in boys, but following puberty, the incidence is greater in females.

Environmental factors play a significant role in the persistence and severity of asthma; most importantly, airborne allergens and viral respiratory infections. Sensitivity to house dust mites and *Alternaria* are important factors in the development of asthma in children. Other allergens affecting children in particular are cat and cockroach.

Interestingly, exposure to cats and dogs early in life may protect against asthma. The respiratory syncytial virus (RSV) and parainfluenza virus cause bronchiolitis and there is a strong correlation between bronchiolitis in infancy and development of asthma later in life. Surprisingly, exposure to RSV may be protective against asthma, according to the hygiene hypothesis. Therefore, it's not always a bad thing for a child to be exposed to what would normally be considered hazardous, but this is not the case with cockroach and *Alternaria.* There are other numerous environmental factors which may act as triggers of an asthma exacerbation: tobacco smoke, air pollution, change of weather, aerosols and sprays, strong emotion, and exercise. Exercise is a significant trigger in 80% of those with asthma.

Environmental control is, then, a major part of the teamwork necessary for control of asthma. Feathered or furred animals should not be allowed in the house. If this is impossible, at least the bedroom of the allergic person should be kept animal-free. Surfaces that may attract dust should be minimized. For example, carpets and drapery should substituted with wood and hard surface blinds. Stuffed animals should be removed if possible. If not, they may be kept in a plastic bag in the freezer when not in use. Mattresses and pillows should be zipped into mite-proof sacks, available at most department stores. The air in the bedroom should be filtered. However, there is no evidence to recommend electrostatic filters to control all indoor allergens. Care should be taken to control roaches with traps, bombs, or boric acid. Food containers should be sealed and unused food disposed of quickly. Room humidity of about 50% discourages both roaches and dust mites. Any trace of mold should be removed.

There is no more toxic substance to the asthmatic lung than tobacco smoke. There must be no smoking in the house of a person with asthma, nor should the person with asthma smoke. Patients with asthma who are aware that exercise is a trigger should be encouraged to use their short-acting $beta_2$ adrenergic bronchodilator 15-20 minutes before exercise. They should also warm up slowly and wear a scarf if exercising in cold weather. For patients who are susceptible to cold weather, or changes in weather, the environment should be kept as constant as possible, avoiding extremes. Emotional stress should be minimized. Patients may find meditation helpful, although there is no conclusive evidence that this is helpful in all cases. When cleaning, the patient with asthma should wear a dust mask and avoid aerosol cleaners. Likewise, a mask should be worn when working outside during pollen season.

Comorbid conditions

Patients with asthma should be evaluated for the presence of allergic bronchopulmonary aspergillosis (ABPA), gastroesophageal reflux (GERD), obesity, obstructive sleep apnea (OSA), rhinitis/sinusitis, and chronic stress or depression.

ABPA, a fungal infection, should be

Table 6. **Assessing Asthma Control in Children 0-4 Years of Age** *(adapted from reference 2).*

Components of Control		Classification of Asthma Control (Children 0-4 years of age)		
		Well Controlled	**Not Well Controlled**	**Very Poorly Controlled**
Impairment	Symptoms	≤2 days/week	>2 days/week	Throughout the day
	Nighttime awakenings	<1x/month	>1x/month	>1x/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting $beta_2$-agonist use for symptom control of EIB) (not prevention	≤2 days/week	>2 days/week	Several times per day
Risk	Exacerbations requiring oral systemic corticosteroids	0-1/year	2-3/year	>3/year
	Treatment-related adverse effects	Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk.		

EIB= exercise induced bronchospasm

suspected in patients who have asthma and a history of pulmonary infiltrates and evidence of IgE sensitization to *Aspergillus*, and in corticosteroid-dependent patients who have asthma. Diagnostic criteria for ABPA are unclear, but generally include a positive immediate skin test to *Aspergillus*, a total serum IgE >417 IU (1,000 mg/mL), elevated serum IgE and/or immunoglobulin G (IgG) to *Aspergillus*, and central bronchiectasis. ABPA is treated with prednisone and antifungal agents.

GERD should be medically managed in patients with asthma by avoiding heavy meals, fried food, caffeine, and alcohol, avoiding all food within 3 hours of retiring, elevating the head of the bed on 6-8 inch blocks, and by using appropriate pharmacologic therapy, such as omeprazole. Reflux during sleep can contribute to nocturnal asthma symptoms.

In obesity, weight loss may improve asthma control, but studies are limited. Increased risk of exacerbation is greatest in postpubertal women and is associated with more severe symptoms, airway inflammation, and new-onset or persistent disease (EPR 3, p 179). Weight loss in adults results in improved pulmonary mechanics, improved FEV_1, reductions in exacerbations and courses of oral steroids, and improved QOL.

OSA and asthma may be mistaken for each other, due to similar nocturnal symptoms: nocturnal arousals, changes in oronasal airflow, ventilatory effort, and decreases in oxygen saturation. Also, OSA and asthma may coexist in many patients, leading to the Expert Panel recommendation to evaluate sleep-disordered breathing in asthmatic patients. Patients with both OSA and asthma who are treated with continuous positive airway pressure demonstrate improvement in peak expiratory flow (PEF).

It is important to evaluate patients with asthma for rhinitis, sinusitis and vice-versa. The upper and lower airways share a mucosa, and therefore show similar changes when inflamed: congestion, edema, and increased secretions. Treatment of patients with rhinitis/sinusitis and asthma with intranasal corticosteroids has resulted in decreased markers of lower airway inflammation (NO and H_2O_2). It appears that treatment of asthma improves rhinitis/sinusitis and treatment of rhinitis/sinusitis improves asthma.

The relationship between stress and asthma is not well defined. Stress has been implicated both as a trigger for asthma, and for encouraging behaviors that trigger asthma, such as smoking. Stress and depression in the patient with asthma should be treated with counseling and pharmacologic treatments, as required.

Monitoring Tools

The QOL and control of asthma may be monitored with paper and pencil screening tools, such as the Asthma Control Test and others. According to EPR 3, key areas of QOL should be periodically evaluated, including work or school time missed because of asthma, reduction in usual activities, sleep disturbances due to asthma, and change in caregivers' activities due to a child's asthma. These factors are also listed on the tables for evaluating the patient's severity and control. EPR 3 lists some QOL questions the asthma educator may ask the patient (EPR 3, figure 3-7; p. 79).

Spirometry is used at initial assessment for determining severity and during follow-up visits to determine effectiveness of therapy and to monitor ongoing changes in lung function in patients 5 years-of-age and older. (Table 4) Peak flow or FEV_1 are used as part of the assessment of control (Table 6). Peak flow may be used by the patient at home to monitor effectiveness of therapy and to assess which zone they are in during an exacerbation to determine the need for additional therapy (Figure 1). Peak flow is also used by those who are "poor perceivers" of lung function, again to determine the need for additional therapy, or the need to seek medical attention.

The use of exhaled nitric oxide (FE_{NO}) in asthma is a recent development. Nitric oxide is a marker of inflammation in the airways, and concentration of $N0_2$ in exhaled air correlates with inflammation and eosinophilia in induced sputum, bronchoalveolar lavage and tissue. While there is no consistent normal value, values in non-atopic men range from 2.6 to 28.8 parts per billion (ppb) and in women from 1.6 to 21.5 ppb. FE_{NO} is measured noninvasively. The patient inhales from an NO-free gas source, then exhales at 50 mL/sec into the device. Since nasal FE_{NO} is greater than pulmonary $FE_{NO,}$ nasal exhaled air must be excluded. FE_{NO} monitoring may be used for asthma screening in epidemiological studies, diagnosis of eosinophilic airway inflammation, predicting response to steroids, evaluation of response to asthma medications, selection of alternative treatments, predicting asthma exacerbations, predicting asthma relapse, adherence check, and dose titration of ICS. An FE_{NO} of > 35 ppb is considered high. Eosinophilic airway inflammation is significant and asthma is very likely, as is a positive response to ICS. The monitor for FE_{NO} is around $30,000 which may limit its widespread use.[3,4]

Figure 1.Pocket peak Flow Meter (Teleflex Medical)

Asthma Self Management

Asthma self management education is important for teaching patients skills to control asthma and improve their QOL. This self management education should be accessible and available to patients and their families across the entire continuum of care. Two key components that should be discussed and evaluated at each visit are how to use medication delivery devices and how to write asthma action plans.

Delivery Device Education

As part of effective self-management, appropriate use of the medication delivery device is of vital importance. Review of delivery device technique should take place at each and every asthma interaction, and is absolutely necessary when switching medications or delivery systems. Device education should also address the use of spacers or valved holding chambers when the patient is prescribed metered dose inhalers. Also important is the proper method of maintaining and cleaning the delivery devices or accessory components.

Metered Dose Inhaler (MDI) Use and Cleaning

The proper technique for the use of an MDI, as recommended by the American Association for Respiratory Care (AARC), is detailed in Table 7*.[5] The MDI should be cleaned once a week or as needed, because

the medication may clump at the nozzle of the actuator, which reduces the dose of medication. It is vitally important for the patient to keep track of the doses expelled from the MDI, so it may be replaced when near empty. The previous method of floating the MDI canister is no longer recommended. Now, the patient must keep track of the number of actuations on a daily basis until the use of dose-counters becomes a standard. The educator should instruct the patient to keep a "tick sheet" and record daily, the number of actuations used. A better alternative is to use the dose counter on the MDI, which counts down from a full canister (usually 160-200 doses). When the counter indicates that the MDI is nearly empty, it should be replaced. Even though spray comes out of the MDI, when the dose counter registers "0", it is just propellant.

Spacers and Holding Chambers

The purpose of spacers and holding chambers is to improve medication dose delivery and actuation timing (Figure 2). A spacer is a tube with a mouthpiece or mask on one end and a boot to receive the MDI mouthpiece on the other. A valved holding chamber is a tube with a boot to receive the MDI mouthpiece on one end and a 1-way valve and mouthpiece or mask on the opposite end. The 1-way valve prevents the patient from exhaling into the tube, which may displace medication and decrease the medication dose available. A spacer or holding chamber should always be used with an inhaled corticosteroid to reduce the possibility of oral infection risks. It is optional with a short-acting beta$_2$ adrenergic or anticholinergic medication. The technique for using the MDI with a valved holding chamber is described in Table 9*. The device should be cleaned every two weeks or as needed (Table 10*).

Figure 2. Anti-static pocket chamber (Teleflex Medical)

Dry Powder Inhalers (DPI)

There are two types of DPI: single-use and multiple-use. The single-use DPI is loaded with a capsule before each inhalation (e.g. Foradil® Aerolizer® and Spiriva® Handihaler®). The multiple-dose MDI typically contains 30-60 doses, so it is used for a month before needing to be replaced (e.g. Serevent® and Advair® Diskus®, Asmanex® Twisthaler®). Instructions for each of these devices come with each device and are also found in the AARC guide to aerosol delivery devices.[5] An important difference between the MDI and the DPI is that the inspiratory flow with a DPI must be much faster than with the MDI, because there is no propellant in the DPI. It may be useful for the educator to teach the patient how to use a DPI with an inspiratory flow meter, such as the InCheck Dial™. The DPI and medication should be kept in a dry place so the medication does not clump due to dampness or excessive humidity. The patient should be instructed only to inhale from the DPI, never to exhale into it. The DPI must not be cleaned or rinsed, rather just kept in a clean location.

Small Volume Nebulizers

The small volume medication nebulizer (SVN) is often used when the patient is incapable of using the MDI or DPI. There are a number of advantages to using a SVN. Many drug solutions may be aerosolized that are not available by MDI or DPI and if drugs are compatible, they may be mixed in the same treatment (e.g. albuterol and budesonide). No special breathing pattern or breath holding is required. The SVN may be used by the very young, very old or debilitated patient with adequate lung deposition. Most patients inhale from the SVN through a mouthpiece or mask (Figure 3). The "blow-by" technique must not be used for children, as virtually no medication is delivered to the airways. Likewise, medicated aerosol therapy should not be delivered to a crying child due to prolonged exhalation phases with short inspiratory times. SVNs are either pneumatically or electrically powered.

Figure 3. Small Volume Nebulizer (Teleflex Medical)

Written Asthma Action Plans

Written asthma action plans offer a mechanism for the patient or caregiver to directly participate in patient self management. This written plan should be reviewed and revised as necessary at each asthma visit. The action plan should be made up of two components; (1) a management plan that indicates what medications should be taken on a daily basis and how to control environmental factors and, (2) a component on how to recognize and manage worsening asthma. There should also be an assessment component based on symptoms or peak flow, or both. The plan should clearly delineate what medications are taken for long-term control and which should be taken for quick relief. Finally, the written asthma action plan should contain information on when the patient or caregiver should call for emergency medical help.

Conclusion

Asthma is a chronic inflammatory disorder of the airways with periodic episodes of hyperreactivity and airflow obstruction. Although there is no cure for this chronic disease, it is quite manageable with medications and self management education. Accurate diagnosis and appropriate management can lead to improved patient outcomes and improved QOL for both the patient and their families or caregivers.

Tables 7-10 can be accessed at www.clinicalfoundations.org

References

1 Moorman JE, Rudd RA, Johnson CA, et al. National surveillance for asthma—United States, 1980-2004. *MMWR Surveill Summ* 2007; 56 (8):1-54. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5608a1.htm. Accessed: May 16, 2008.

2 National Institutes of Health, National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR 3): Guidelines for the diagnosis and management of asthma. Pub. No. 07-4051, 2007. Available at: http://www.nhlbi.nih.gov/guidelines/asthma/ Accessed: May 16, 2008.

3 Pijnenburg MWH, DeJongste JC. Exhaled nitric oxide in childhood asthma: a review. *Clinical and experimental Allergy* 2007;38:246-259.

4 Stewart L, Katial R. Exhaled nitric oxide. *Immunology and Allergy Clinics of North America* 2007;27: 571-586.

5 Hess DR, Myers TR, Rau JL. A guide to aerosol delivery devices. American Association for Respiratory Care. http://www.aarc.org/education/aerosol_devices/index.asp.Accessed May 14, 2008.

How do you Manage Your Asthma Patients?
Roundtable Discussion

Moderator:
Tim Myers, *BS, RRT-NPS*

Panelists
Robert Cohn, *MD*
Stephens Peters, *MD, PhD*
Karen Gregory, *MS, ASPRN-BC, RRT, AE-C*

The 2007 National Asthma Education and Prevention Program asthma guidelines (Expert Panel Report-3 or EPR 3) update the 1997 and 2002 Expert Panel Reports. The EPR 3 describes four essential components of asthma care: assessment and monitoring, patient education, control of factors contributing to asthma severity, and pharmacologic treatment. Subtopics were developed for each of these four broad categories. In the 2007 edition, the critical role of inflammation in asthma has been further substantiated, gene-environmental influences have been given more weight, and the relevance of early risk factors is stressed. Although the guidelines are the most comprehensive and evidence-based to date, they allow the healthcare provider to select the best treatment options for individual patients, depending on the nature of their asthma. In this roundtable, we have invited three experts to discuss the particulars of how they manage their patients.

Once an initial diagnosis of asthma has been established, how should current information and guidelines be used to determine the most appropriate treatment?

Peters: The new Expert Panel Report 3 (EPR 3) guidelines suggest that medical professionals estimate asthma severity before initiating treatment. This is done by evaluating *risk* and *impairment* in patients not on controller therapy, or by adhering to the lowest treatment step needed to maintain asthma control in patients on controller therapy. (The meanings of *Risk* and *impairment* are discussed in the article). This information should be applied using the EPR 3 algorithm of asthma severity. A more complete evaluation would include identification of asthma triggers, comorbid conditions, gastroesophageal reflux disease, efforts to minimize exposures to asthma triggers, and response to asthma medications.

Cohn: In order to assess asthma severity, it is important to define symptoms, functional limitations and baseline pulmonary function on initial presentation. It is also important to assess the need for a short-acting beta-agonist for quick relief of daytime or nighttime symptoms, frequency of night time awakenings, monthly work or school days missed, quality of life, and spirometric lung function. On the initial visit, the clinician should determine history of exacerbations, drug therapy used in the past, and the patient's goals for achieving asthma control.

Gregory: Asthma presents in many different ways. In order to implement evidence-ased practice, assessment of physical limitations, adherence, cognitive skills, and finances should be identified to appropriately guide therapy. Appraisal of cognitive skill is a critical factor in designing the individualized asthma management plan. Health care providers must also be attentive to patient accessibility and coverage of specific medications.

In order to assess asthma severity, it is important to define symptoms, functional limitations and baseline pulmonary function on initial presentation.

Can you discuss the key components of control, impairment and risk and some practical applications on how they can be assessed in a clinic setting?

Peters: In asthma control, many of the components of *impairment* and *risk* are similar to those used to judge asthma severity. In addition to the above components, assessing *impairment* includes the use of validated questionnaires, such as the Asthma Control Questionnaire (ACQ) or Asthma Control Test (ACT).[1] The ACQ has been used primarily in research settings, while the ACT has been used more often clinically. The ACT, which has validated versions for use in both adults and children, is particularly easy to use to gain insight into

the patient's perception of asthma control. Gathering this information is rather straight forward -- it is more challenging to gather accurate information concerning activity limitation or quality of life. Asking "how are you doing?" is sure to elicit the response "fine," which is completely uninformative. Rather, questions about activity levels need to be tailored to each individual patient. For example, it is better to ask, "can you do everything everyone else does in gym class?" The *risk* domain includes not only the frequency of exacerbations requiring oral or systemic corticosteroids, but also the potential for progressive loss of lung function over time, which requires repetitive measures of pulmonary function, at least every 6 to 12 months. Evaluation for treatment-related adverse effects requires a discussion of medication side effects and issues which are important for treatment adherence.

Cohn: In 1999, we established a very specific Pediatric Asthma Compliance and Technique clinic (PACT) to improve childhood asthma outcomes in inner-city Cleveland. The clinic was designed to be a physician and respiratory therapist collaborative effort. We developed a very standardized assessment of symptom classification related to asthma control as well as spirometry use so that we could review and collect data in a very specific format based upon the National Heart Lung and Blood Institute Expert Panel Guidelines. Our goals were to (1) ensure that every child with asthma is appropriately classified for asthma severity and control; (2) develop and improve treatment adherence for both children and parents, and (3) reinforce medication delivery technique at each visit. As I point out to patients, you can have the best asthma medication in the world, but if you do not know how to take it properly, it will be of no value.

Gregory: Achieving and maintaining optimal asthma control is the primary goal of asthma management. Several instruments are currently used to specifically assess asthma control based on patient symptoms, frequency of beta-agonist use, and limitations of daily activities. The ACQ and ACT, mentioned by Dr. Peters, and the Asthma Therapy Assessment Question (ATAQ) are the most utilized instruments. I use the ACT which is a short and simple patient-based, five-item questionnaire. The ACT shows high internal consistency and is well correlated with specialist ratings of asthma control based on spirometry. [1]

> Every asthma patient should be aware that viral infections can trigger an asthma exacerbation and should be prepared to rapidly escalate therapy should such an event occur.
>
> – Peters –

How do you instruct patients on how to avoid or otherwise manage environmental factors that exacerbate asthma, such as airborne allergens and viral respiratory infections?

Peters: A careful history can reveal if environmental allergens are triggering asthma episodes. This can be supplemented with allergen skin testing or blood tests (RAST), if necessary. Having identified triggers, the patients can then be counseled on allergen avoidance techniques. Every asthma patient should be aware that viral infections can trigger an asthma exacerbation and should be prepared to rapidly escalate therapy should such an event occur. Patient information on dealing with environmental triggers is available from a number of sources including the American Lung Association and the American Academy of Allergy, Asthma and Immunology.

Cohn: I'd like to add that controlling environmental factors can be difficult. Many of the families we serve live in low income housing and are subject to environmental problems beyond their control. Despite that, we make every effort to teach them how to minimize mold, dust, and other allergen exposures. Minimizing viral respiratory infections is more difficult since many of our families live in close contact with one another and many of their children attend daycare.

Gregory: Our patients are encouraged to purchase hypoallergenic pillow cases and mattress covers and use a HEPA filter vacuum cleaner in the home for indoor allergens. We teach them about the hazards of mold which thrives in damp environments, and how to remove it. Our patients are provided with educational modules to help reduce the risk of an asthma exacerbation because of viral respiratory infections. They are also strongly encouraged to receive an annual flu vaccination and a pneumonia vaccine as appropriate.

The EPR 3 recommends that patients be repeatedly educated about asthma self management concepts. Can you describe the key components of the education process and any educational tools you employ?

Peters: Key elements of the educational process include information about asthma pathogenesis, asthma triggers, and medication use and side effects. Information about all of these aspects of the disease is available from the national organizations I mentioned above. The goal is to have a patient who actively participates in the management of the disease. Repetition of key aspects of the management plan by all elements of the health care team can help us reach this goal. The correct use of inhalers is a particularly important element which should be reinforced by all members of the health care team.

Cohn: We start by reviewing the goals of asthma therapy for each patient. Specifically, we want to prevent chronic and troublesome symptoms and maintain pulmonary function as close to normal as possible. We want to maintain normal activity levels, prevent exacerbations, and provide the best treatment regimen with the least amount of adverse effects. Although these are all important goals, families sometimes want to focus on one goal at a time, so we tend to review specific components of asthma man-

agement. It is important at times to enforce the need for spirometry and peak expiratory flow rate monitoring, and to discuss the important differences between controller and reliever medications. We underscore the importance of addressing the inflammatory process in asthma. We want to provide each patient with an up-to-date asthma action plan and, since our patient population is multi-cultural, we provide information in a culturally appropriate manner. In order to facilitate asthma self-management, it is important for us to determine what influences patient adherence to therapy. We try to keep the regimen as simple as possible.

Gregory: Asthma education must begin at the time of diagnosis. Asthma self-management must be individualized to achieve successful outcomes. A key component of the education process is to adapt the material to the patient's cognitive skills and learning style, and address any language barriers. In our clinic, written asthma plans are designed to empower patients and their families to become involved in their asthma care and be prepared for an acute asthma exacerbation. Patient education materials accommodate different learning styles and include lung models for visual and kinesthetic learners. Perceived asthma control and psychosocial factors are addressed to improve asthma outcomes and treatment adherence.

Can you discuss how you address adherence, compliance, and correct use of delivery and assessment devices in your patient population?

Peters: It is important to appreciate the difference between compliance and adherence. A patient is *compliant* if they "follow the orders" of a health care professional, regardless of what the patient thinks. A patient is *adherent* when they perceive a need based on their understanding of the disease and decide on a course of action that includes taking controller medication regularly. Adherence is really disease self-management at the highest level. This is enforced with repeated education, especially concerning the correct use of asthma inhalers. We do this at each medical visit.

Gregory: As an essential component of asthma control is designing a treatment regimen which the patient understands and is able to easily implement on a daily basis. Reasons for nonadherence are multifactoral and include poor perception of asthma severity, concerns about safety and efficacy of medications, and low treatment expectations. As Dr. Peters suggested, patients are better motivated to adhere to treatment when they understand their illness, the therapeutic modality, and the side effects of asthma medications. Initially, I try to develop a trusting, therapeutic partnership with my patients to promote successful asthma outcomes. Patients are asked to keep an asthma journal, including a medication calendar and action plan to promote adherence. The journal is reviewed and updated at each patient visit.

> An expanded role for the respiratory therapist cannot be overstated when striving for successful asthma outcomes.
>
> – Gregory –

Traditionally, the respiratory therapist has focused on managing acute exacerbations in the emergency room and hospital setting. Do you see an expanded role for these professionals in chronic asthma disease management, both in the clinic and at home?

Peters: The respiratory therapist is in a unique position to assist in the management of the asthmatic patient. At the time of the pulmonary function assessment, the therapist can educate the patient about the importance of objective measures, such as lung function, in determining whether asthma control is optimal or not. The therapist can also introduce or reinforce the principles of correct inhaler technique. This is particularly important for patients who have both a dry powder inhaler (DPI) and a pressurized metered dose inhaler (pMDI). The techniques for proper use differ markedly between these two devices.

Cohn: In Cleveland, we have been very successful in creating an expanded role for respiratory care practitioners in the clinic setting. In fact, we have published an article about it in Respiratory Care.[2] In our Pediatric Asthma and Compliance Technique clinic, I am the physician responsible for evaluation of all patients, both at their initial visit and at follow up. Jim Martin, our respiratory care practitioner, is instrumental in performing spirometry, developing teaching techniques, and reviewing asthma education with the patient and their families. Jim and I discuss every patient at length and come to a mutually acceptable plan of therapy, as well as follow-up. This teamwork concept is the right way to go because it allows each of us to contribute our strengths in managing asthma patients. Jim is also very good with children; he engages them in things that they are interested in while he is either performing spirometry or trying to educate them on different aspects of asthma.

Gregory: An expanded role for the respiratory therapist cannot be overstated when striving for successful asthma outcomes. The literature shows that education and interventions by respiratory therapists significantly improve asthma outcomes. With their specialized training and experience in clinical assessment and other physiological variables, pulmonary function testing and treatment, respiratory therapists are uniquely qualified to provide asthma education at the bedside, at home and in the classroom.[3]

What would you recommend for a patient requiring high levels of oxygen and medication during an acute asthma exacerbation?

Peters: It is important to administer systemic corticosteroids as early as possible in these individuals, and when it is clear that they are not responding well to standard therapies, to admit them to the hospital in a closely observed setting, usually an intensive care unit. In this setting, alternative therapies, such as continuous nebulization

...highlights the potential benefits of heliox in the treatment of asthma exacerbations especially as an alternative to intubation.

– Myers –

of a beta-agonist can be considered. In addition, patients can be intubated under carefully controlled conditions should that be necessary. Managing a patient with status asthmaticus on a ventilator requires knowledge of the specialized physiology of these patients, which is quite different from most patients who require mechanical ventilation.

Cohn: We will use continuous albuterol or levalbuterol nebulization for those chlidren who are having a severe asthma exacerbation and requiring high oxygen concentrations. We will also use IV magnesium sulfate. We try to avoid intubation and mechanical ventilation unless absolutely necessary.

What would you recommend for a patient requiring high levels of oxygen and medication during an acute asthma exacerbation?

Myers: In my presentation at the 2006 AARC Symposium, "What would you do?" I presented a case study entitled *Adolescent with Asthma Exacerbation* that highlights the potential benefits of heliox in the treatment of asthma exacerbations especially as an alternative to intubation[4]. Heliox administered to spontaneously breathing patients is most efficacious when delivered through a closed-system. Typical clinical administration consists of a facemask and reservoir bag or a non-rebreather mask. Frequently, a Y-piece attachment is placed between the mask and the reservoir bag to add a nebulizer for concurrent beta-agonist administration. Many questions remain unanswered regarding the clinical effectiveness of heliox for acute asthma. Patients with the most severe airflow obstruction may benefit from the early use of heliox. Studies suggest that early rather than late heliox administration may decrease work of breathing and dyspnea while facilitating improved gas exchange, or at least serve as a stabilizing measure to allow conventional therapies time to take effect. Heliox has a relatively safe treatment profile and direct beneficial outcomes should be observed almost instantaneously.

References

1 Nathan, RA, Sorkness, CA, Kosinski M, et al. Development of the asthma control test: A survey for assessing asthma control. *J Allerg Clin Immunol* 2004; 113:59-65.

2 Minai BA, Martin JE, Cohn RC. Results of a physician and respiratory therapist collaborative effort to improve long-term metered-dose inhaler technique in a pediatric asthma clinic. *Respir Care.* 2004;49(6):600-5.

3 Making a difference in the management of asthma: A guide for respiratory therapist. (May, 2003). *National Institute of HealthPublication* No. 02-1964. Available at: http://www.nhlbi.nih.gov/health/prof/lung/asthma

4. Myers TR. Adolescent with an Asthma Exacerbation. Proceedings from a special symposium on "What Would You Do?" An Audience Interactive Review of Four Clinical Cases. Presented at the 52nd International Respiratory Congress of the American Association for Respiratory Care December 2006, Las Vegas, Nevada. (pp. 11-16) Available at: http://www.aarc.org/education/four_clinical_cases Accessed: July 3, 2008.

Stephen Peters, MD, PhD is Professor of Medicine and Pediatrics, Director of Research in the Section on Pulmonary, Critical Care, Allergy and Immunologic Diseases, Training Program Director for Allergy and Immunology, and Associate Director, Center for Human Genomics at Wake Forest University School of Medicine, Winston-Salem, North Carolina. His current research interests include mechanisms of subepithelial fibrosis in asthma, control of immunoglobulin E-mediated pulmonary inflammation in humans, and the pharmacogenetics of asthma. Dr. Peters has authored more than 240 articles and reviews that have appeared major journals. He is an Associate Editor for the American Journal of Respiratory and Critical Care Medicine, Respiratory Digest, and Respiratory Medicine, and is on the Editorial Board of *MD Consult—Respiratory & Critical Care Medicine.*

Robert Cohn, MD, is Associate Professor of Pediatrics at Case Western Reserve University and Chairman of the Department of Pediatrics at MetroHealth Medical Center, Cleveland, Ohio. Dr. Cohn has had a long-standing interest in asthma and currently sits on the editorial board of the *Journal of Asthma.* He serves an invited reviewer on a number of pediatric and respiratory journals and has published extensively these fields.

Karen L. Gregory, MS, APRN-BC, CNS, RRT, AE-C is an acute care clinical nurse specialist with a specialty in asthma, allergy and pulmonary medicine. She is also a registered respiratory therapist and certified asthma educator. Ms Gregory obtained her undergraduate and graduate degrees from the University of Oklahoma Health Science Center. Her degree in Respiratory Therapy was obtained from Rose State College. She currently works at the Oklahoma Allergy and Asthma as an Advanced Practice Nurse and Asthma Educator, as well as teaching research at the University of Oklahoma College of Nursing. Ms. Gregory is president of the Association of Asthma Educators and serves as a faculty member of the American Association for Respiratory Care Asthma Preparatory Course. Throughout her career she has held active memberships and leadership positions in her professional organizations serving on boards, committees, and projects including assisting with the establishment of two professional organizations. Research projects include on quality of life, adherence, and asthma management in the rural setting for the adult and pediatric population with asthma.

Timothy R. Myers, BS, RRT-NPS is Clinical & Research Operations Manager at the Asthma Center at Rainbow Babies & Children's Hospital and the Department of Pediatrics Pulmonary Division, Case Western Reserve University, Cleveland, Ohio. Among other roles, he is responsible for designing and implementing research studies and assisting with preparation of research grants and manuscripts for publication. Tim has a long list of publications in respiratory and pediatric journals and presents many lectures, courses, workshops, and seminars in the field. He lives in Avon, Ohio.

Timothy B. Op't Holt, EdD, RRT, AE-C, FAARC, is Director of "Breath of Life" COPD and the Asthma Education and Therapy Program at Victory Health Partners Clinic in Mobile, Alabama, and Consultant to the Ohio Department of Human Services. At the University of South Alabama, he is Professor, Department of Respiratory Care and Cardiopulmonary Sciences, and Facilitator, Problem-Based Learning Program, at Ohio State University's College of Medicine. He is the author or co-author of 8 books and 30 studies in journals such as *AARC Times, Respiratory Care Journal, and the American Journal of Respiratory and Critical Care Medicine* as well as presented over 35 papers at international conferences.

Essential Practices is a serial education program distributed free-of-charge to health professionals. *Essential Practices* is published by Saxe Healthcare Communications. The goal of *Essential Practices* is to present clinically- and evidenced-based practices to assist the clinician in making an informed decision on what is best for his/her patient. Opinions expressed in *Essential Practices* are those of the authors and not necessarily of the editorial staff of Saxe Healthcare Communications. The publisher disclaims any responsibility or liability for such material. We welcome opinions and subscription requests from our readers.

Please direct your correspondence to:

Saxe Healthcare Communications
P.O. Box 1282
Burlington, VT 05402
info@saxecommunications.com
Fax: 802.872.7558

You must take this test online at: http://www.saxetesting.com/crce/

Questions

1. **What is the primary feature of asthma that defines its chronicity?**
   a. Airway hyperreactivity
   b. Mucus hypersecretion
   c. Underlying inflammation
   d. Airway bronchoconstriction

2 **The primary mechanism that results in bronchoconstriction during an acute asthma exacerbation is:**
   a. Eosinophil activation
   b. Airway smooth muscle spasm
   c. Mucus plugging
   d. Up-regulation of nitric oxide

3. **Which of the following is *not* considered a methodology to establishing a diagnosis of asthma?**
   a. Studies to exclude alternate diagnoses
   b. Medical history and physical examination
   c. Spirometry
   d. Complete blood count (CBC)

4. **A definite diagnosis is typically established in through which diagnostic test that is referred to as the "Gold Standard"?**
   a. Chest x-ray
   b. Spirometry
   c. Exercise challenge testing
   d. Exhaled nitric oxide testing

5. **Which of the following levels of severity would a patient be placed based on the following criteria: Symptoms that occur 2 times per week during the day, 2 times per week at night and an $FEV_1 = 80\%$ predicted?**
   a. Intermittent
   b. Severe persistent
   c. Moderate persistent
   d. Mild persistent

6. **Which of the following classes of medications would be considered to be a long-term controller medication for daily routine maintenance therapy?**
   a. Anticholinergics
   b. Systemic corticosteroids
   c. Leukotriene modifier
   d. Short-acting beta-agonist

7. **The Center for Disease Control estimates that asthma prevalence in children is approximately what percentage compared to the adult counterparts?**
   a. 50%
   b. 20%
   c. 33%
   d. 25%

8. **Which one of the following is *not* considered to be linked to monitoring of asthma?**
   a. Severity
   b. Control
   c. Responsiveness to treatment
   d. Hospitalizations

9. **Which of the following is considered a component of asthma control that should be monitored on a regular frequency?**
   a. Impairment
   b. Number of exacerbations
   c. Fe_{NO}
   d. Systemic corticosteroid bursts

10. **Which of the following has a significant impact on the development of asthma in children?**
    a. Co-Morbidities
    b. Obesity
    c. Allergen exposure
    d. Obstructive sleep apnea (OSA)

11. **Which of the following would be a practical example of a monitoring tool that could be utilized by the patient in the home environment?**
    a. Spirometry
    b. Written asthma action plan
    c. Peak flow meter
    d. Exhaled nitric oxide

12. **When evaluating and treating the asthmatic patient for inflammation, it is important to evaluate the upper airway for the presence of:**
    a. Rhinitis
    b. Otitis media
    c. Obstructive apnea
    d. Angioedema

13. **To reduce the potential for dust mites, the relative humidity is best kept below what level?**
    a. 80%
    b. 50%
    c. 70%
    d. 60%

14. **A patient with an FEV_1 of 75% predicted would be classified at what level of chronic asthma severity?**
    a. Severe persistent
    b. Mild persistent
    c. Intermittent
    d. Moderate persistent

15. **There are multiple components to effective asthma self management for patients in the ambulatory setting; which of the following would be an essential tool for asthma self management?**
    a. MDI
    b. Referral to asthma specialist
    c. Written asthma action plan
    d. Three classes of medications

This program has been approved for 2.0 contact hours of continuing education (CRCE) by the American Association for Respiratory Care (AARC). AARC is accredited as an approver of continuing education in respiratory care.

To earn credit, do the following:

1. Read the educational offering (both articles).
2. Complete the post-test for the educational offering online at www.saxetesting.com/crce. The questions are the same as above
3. Complete the learner evaluation.
4. To earn 2.0 contact hours of continuing education, you must achieve a score of 75% or more. If you do not pass the test, you may take it again one more time. You will not be charged to take the test a second time.
5. Upon completion, you may print out your certificate immediately. If you are an AARC member, your results are automatically forwarded to the AARC.
6. Accreditation expires Apr. 6, 2017. Please consult http://www.saxecommunications.com/crce/index.html for current annual renewal dates.
7. **This article is no longer sponsored. You may still take this test and receive accreditation, however there is a nominal fee ($10.00) to cover the cost of accreditation and scoring. You may take this test 2 times at no additional charge.**

Participant's Evaluation

The goal of this program is to educate healthcare professionals on the management of OSA

1. What is the highest degree you have earned? Circle one. 1. Diploma 2. Associate 3. Bachelor 4. Masters 5. Doctorate
2. Indicate to what degree the program met the objectives:

Objectives

Upon completion of the course, the reader was able to:

1. Describe how asthma is diagnosed and differentiated from mimicking conditions and comorbidities.
   Strongly Agree 1 2 3 4 5 6 Strongly Disagree
2. Discuss environmental controls to help prevent asthma exacerbation.
   Strongly Agree 1 2 3 4 5 6 Strongly Disagree
3. Describe the step-wise approach to therapy for asthma.
   Strongly Agree 1 2 3 4 5 6 Strongly Disagree
4. Discuss the teaching points the asthma educator should reinforce with each patient visit.
   Strongly Agree 1 2 3 4 5 6 Strongly Disagree

Please indicate your agreement with the following statement. "The content of this course was presented without bias of any

Strongly Agree 1 2 3 4 5 6 Strongly Disagree

Answers

	A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	8	☐	☐	☐	☐
2	☐	☐	☐	☐	9	☐	☐	☐	☐
3	☐	☐	☐	☐	10	☐	☐	☐	☐
4	☐	☐	☐	☐	11	☐	☐	☐	☐
5	☐	☐	☐	☐	12	☐	☐	☐	☐
6	☐	☐	☐	☐	13	☐	☐	☐	☐
7	☐	☐	☐	☐					

This article is no longer sponsored. You may still take this test and receive accreditaion, however there is a nominal fee ($10.00) to cover the cost of accreditation and scoring.

All tests must be taken online at www.saxetesting.com/crce/