

Meeting the Challenges of Asthma: Conference Summary

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Summary

Asthma is actually a complex set of wheezing disorders driven by dysregulated inflammation in the airways. The profound redundancy of the inflammatory milieu in the asthmatic airway has resulted in an as yet incomplete understanding of the pathophysiology. Despite tremendous research efforts over the past several decades, defining the asthma phenotype, unraveling its genetics, and accurately diagnosing the condition remain difficult. Application of standardized testing for diagnosis and management of asthma, such that control is maintained and risk of future impairment in the form of exacerbations minimized, is vital. Newer techniques and biomarkers are being developed that may help identify ongoing airway inflammation in a noninvasive and clinically useful fashion. Knowledge of the current treatment armamentarium and its accurate application to maximize effectiveness and reduce risk is also important for all practitioners. New immunomodulatory medications and treatments are being developed that may offer hope for those patients whose asthma is refractory to current treatments. The development and dissemination of new evidence-based guidelines, and strong patient self-management, may help reduce the substantial morbidity suffered by the asthmatic population. This Journal Conference addressed the current state of the art in asthma diagnosis and management. Key words: asthma, epidemiology, diagnosis, environment, treatment, spirometry, guidelines, disease management, status asthmaticus, corticosteroid, β agonist. [Respir Care 2008;53(6):787–795. © 2008 Daedalus Enterprises]

Introduction

Asthma continues to be among the most common chronic conditions in both children and adults. It affects over 14

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million individuals in the United States, and is largely a disease of morbidity rather than mortality.¹ The pathophysiology of asthma remains incompletely understood, despite a tremendous increase in research efforts over the past 2 decades. Some of the difficulty with asthma definition and treatment arises from the broad heterogeneity recently recognized as a primary feature of the disorder. In fact, a recent editorial in *The Lancet* called for abandoning the term "asthma," and suggested instead the more accu-

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rate term “heterogeneous wheezing disorders.”² Asthma is clearly a syndrome with multiple phenotypes and genotypes, and substantial gene by environment influence in inception, perpetuation, and exacerbation. Moreover, currently available treatments offer symptom control but not cure, and are effective for most but by no means all asthmatics.

This Journal Conference focused on describing the current state of knowledge and conundrums surrounding asthma diagnosis and management. The exemplary faculty panel of experts delivered scholarly presentations, followed by intense and pointed discussions. It is my great pleasure to summarize a most enlightening and informative conference.

Defining the Problem

Fernando Martinez initiated the conference with a discussion of “Trends in Asthma Prevalence, Admission Rates, and Asthma Deaths.”³ A key message was that heterogeneity in asthma phenotypes is reflected in the prevalence and natural history of asthma, which vary considerably. A worldwide increase in asthma prevalence occurred up until the 1990s, but with wide variability, depending on global location, and the prevalence has leveled off in some but not all areas of the world.⁴ Since there is no single validated manner to identify or diagnose asthma, inconsistencies in nationally reported figures are due to disease misclassification, overlap with other respiratory conditions, and increased awareness of asthma as a health problem worldwide. In the United States the rate of lifetime asthma diagnosis (based on data from the National Health Information Survey published in 2005) is 11.2% in the total population, but the rate is higher in non-Hispanic African Americans (13.5%), Puerto Rican Hispanics (22.3%), and people in the lowest income strata (13.6%), compared to those in the highest (10%).⁵

There are multiple asthma and wheezing phenotypes, particularly in children, in whom wheezing is a common symptom but does not always lead to a lifelong condition consistent with asthma. The Tucson Children’s Respiratory Study provided substantial data on the natural history of wheezing phenotypes in infants, children, and adolescents,⁶ and the data suggest that early-life changes in pulmonary function influence the wheezing phenotype and are likely to persist into adulthood, and, in some but not all cases, worsen with time. Infants with the lowest lung function typically have transient wheezing syndromes, have improvement in pulmonary function over time, and are unlikely to be wheezing by age 6 years. However, those who experience a decrease in lung function in the first few years of life go on to have chronic asthma. These data highlight the importance of early-life events, lung function, and the possible importance of early detection and

accurate classification to have the best chance of instituting the most effective treatment and, hopefully, altering the course of the disease. However, studies on asthma prevention or modification, with either extreme environmental controls or medical treatment with inhaled corticosteroid (ICS), have failed to prevent the development of asthma or recurrence of symptoms.⁷ Future efforts to decrease asthma prevalence and alter its natural history will require novel strategies and treatments.

Much of the difficulty in diagnosing and managing asthma arises from problems in defining asthma. Lisa Moores discussed “Clinical Asthma Syndromes and Important Asthma Mimics.”⁸ She reviewed key components of the asthma definition and reminded us of the tremendous overlap with other respiratory syndromes and disorders. Asthma is currently defined as reversible airflow obstruction that causes cough, wheeze, and shortness of breath, and that is episodic and accompanied by airway hyperresponsiveness to various stimuli. Dysregulated airway inflammation is believed to be the root cause, but the inflammation results from a panoply of inflammatory mediators, cytokines, chemokines, proteases, and inflammatory cells types, with variable degrees of intensity and expression among patients. The result is multiple disease phenotypes initiated and perpetuated by a wide range of triggers and characterized by variable symptom intensity and natural history. The overlap with chronic obstructive pulmonary disease in adults is especially complex and often confusing. Clear distinction between asthma and chronic obstructive pulmonary disease, when possible, is important, because the treatment and prognosis are different. To further complicate the asthma definition and recognition, a number of conditions can mimic, exacerbate, or co-exist with asthma. Many are common (eg, gastroesophageal reflux, chronic obstructive pulmonary disease, vocal cord dysfunction) and some are rare (eg, cystic fibrosis, bronchiolitis obliterans). Accurate distinction requires a thorough medical history, clinical skill, and appropriate diagnostic testing.

Assessing the Patient

Though much of asthma recognition and monitoring relies on symptom report, objective measurements to help diagnose asthma, classify asthma severity, and monitor response to therapy are vital to effective and safe asthma management. Various devices, tests, and questionnaires have been developed and validated for assessing the asthmatic patient. However, much work remains to be done to identify the optimal measurements. Also, further research is needed on biomarkers that may accurately and noninvasively measure airway inflammation, which should help provide more individualized and effective asthma management.

Spirometry has long been the primary objective measurement in making the diagnosis of asthma. In his presentation, "Making the Diagnosis of Asthma," Paul Enright reminded us that some spirometric measurements are more useful than others.⁹ Since many asthmatics, particularly children and younger adults, have a normal forced expiratory volume in the first second (FEV₁) at baseline, the ratio of FEV₁ to forced vital capacity is probably a more sensitive measure of airflow obstruction. Demonstration of bronchodilator response to objectively identify reversible airflow obstruction is paramount in the diagnosis of asthma, but is often not documented in the course of routine clinical care, especially in the primary care setting. If the baseline pulmonary function test results are normal, inhalation challenge test with methacholine, or other agents, such as mannitol or adenosine monophosphate, more likely to simulate "natural bronchoconstriction" by stimulating inflammatory mediator release, can be used to identify airway hyperresponsiveness. It is cost-effective to use an algorithm to choose the appropriate sequence of tests to identify reversible airway obstruction and distinguish between asthma and other lung diseases. It is important to assess the pre-test probability of an asthma diagnosis when interpreting pulmonary function test results, especially if the results from inhalation challenge test or bronchodilator response are borderline.

Although asthma remains a clinical diagnosis supported by an objective measurement of reversible obstruction, the latest national guidelines emphasize the importance of monitoring asthma control to provide optimal management. What are the best techniques and tools for doing this, and how can they be applied to asthma clinical management? Chris Sorkness discussed "Traditional and New Approaches to Asthma Monitoring."¹⁰ The 2007 edition of the National Asthma Education and Prevention Program (NAEPP) Expert Panel Report, Guidelines for the Diagnosis and Management of Asthma, defines asthma control as "the degree to which the manifestations of asthma (symptoms, functional impairments, and risks of untoward events) are minimized and the goals of therapy are met."¹¹ Decreasing impairment is defined as preventing symptoms, infrequent use of short-acting β agonists (SABAs), maintaining near-normal lung function and activity, and achieving patient satisfaction with care. Managing risk refers to minimizing the following: frequency of exacerbations, loss of lung function, decrease in linear growth (in children), and adverse reactions to medication. Current techniques for monitoring asthma control include FEV₁, which predicts the risk of exacerbations and measures change in lung function over time.¹² Validated questionnaires that are short, patient-based, and that convert easily to a numerical score can be used in the clinical setting to quickly assess symptom control. Home monitoring of peak expiratory flow (PEF) was once thought to be mandatory and

useful for all patients with persistent asthma, but PEF monitoring was found to have little added utility, compared to symptom monitoring alone, for most patients.¹¹ Daily PEF monitoring is best reserved for patients who have poor symptom-perception, those with extreme motivation to use the PEF device in conjunction with adjustment of treatment plan, and to help monitor response to treatment of an acute episode.

The 2007 NAEPP guidelines¹¹ also call for monitoring asthma with minimally invasive measurement of biomarkers and pharmacogenetics, but caution that more research is needed before these modalities are ready for routine clinical use. Several biomarkers have been studied in fair detail in recent years, including methacholine responsiveness, sputum eosinophils, and exhaled nitric oxide, all of which are believed to reflect the degree of airway inflammation and therefore to serve as an "inflammometer" for asthma, without the need to directly visualize or sample the lower airways. Treatment algorithms that used decrease in airway hyperresponsiveness and/or eosinophil number in induced sputum to adjust treatment had better symptom-reduction and exacerbation-reduction outcomes than did those that used symptoms and pulmonary function alone.^{13,14}

Exhaled nitric oxide has the advantage of being far less invasive, quicker, and easier to measure than induced sputum or methacholine challenge (albeit the currently approved equipment for measuring exhaled nitric oxide is far more expensive). Although reduction in exhaled nitric oxide signals improved asthma control and predicts response to treatment with ICS in some patients (those with the highest baseline exhaled nitric oxide), the measurement is not useful with all asthmatics (eg, those with noneosinophilic asthma).¹⁵ Further studies are needed to determine the utility and limitations of exhaled nitric oxide and to identify other noninvasively measurable biomarkers. Identification of specific genetic polymorphisms that predict response/nonresponse to medications may be the "holy grail" of asthma management, but asthma has multiple phenotypes and a broad genetic basis, so that goal may be difficult to attain.

Gene by environment scenarios in the inception, perpetuation, and exacerbation of asthma involve complex interactions that apply differently in high-risk and lower-risk populations. Managing asthma also must include monitoring the environment in which the asthmatic lives. Control is always likely to be inadequate if the patient suffers persistent exposure to known asthma triggers. Gregory Diette explored the current knowledge on "Environmental Issues in Managing Asthma."¹⁶ Although the role of environmental allergens and irritants in causing asthma remains controversial, ample high-level evidence supports the 2007 NAEPP guidelines in their statement that, "exposure of patients who have asthma to allergens to which

they are sensitive has been shown to increase asthma symptoms and precipitate asthma exacerbations,” and that, “for at least those patients who have persistent asthma, the clinician should evaluate the potential role of allergens, particularly indoor inhaled allergens.”¹¹ Various common allergens and irritants produce these effects, most notably the indoor allergens from cockroach, dust mite, cat dander, rodent urine, and tobacco smoke. Asthmatics residing in low-income housing, which is often old and in less-than-optimal repair, have a higher risk of such exposures and morbidity. Although the evidence is somewhat variable, the 2006 report from the United States Surgeon General concluded that, “children exposed to secondhand smoke are at an increased risk for. . . more severe asthma; and that smoking by parents causes respiratory symptoms and slows lung growth in their children.”¹⁷ Advising asthmatics not to smoke, and, most importantly, counseling parents of asthmatic children not to smoke is likely to improve asthma control.

Outdoor air also contains numerous irritants that can exacerbate asthma, including particulate matter (fine and coarse), ozone, and nitrogen and sulfur dioxides. Some of these irritants, notably diesel particulates and ozone, can act in an additive fashion with allergen exposure and trigger asthma symptoms and airway obstruction.¹⁸ The response of asthmatic airways to environmental exposures is variable. How does the environment affect one group more than others? The answer is no doubt multifactorial and relates to differences in genetic susceptibility; the amount, duration, and timing (early vs later in life) of exposure; and interactions with other environmental risks, such as viral respiratory infections. This complex interaction of asthma factors and morbidity requires further investigation, but until the knowledge base is more solidified, clean indoor and outdoor air for asthmatics is the best recommendation.

The Asthma Management Armamentarium

The Journal Conference then shifted to the topic of current and future pharmacologic management of asthma. The topics included the recent controversy about inhaled β agonists (particularly long-acting β agonists [LABAs]), the role of the most effective controller medications currently available (ICSs), novel drugs and treatments in the research and testing “pipeline,” optimal aerosol delivery devices, and the treatment of life-threatening asthma. There is substantial controversy over all of these topics.

Controversy about the appropriate and safe use of inhaled β agonists has existed for decades. Data suggest that the risks associated with inhaled β agonists depend on the drug used, how it is used, patient characteristics, and other medications being used. Jim Donohue tackled the “Safety and Efficacy of β Agonists,” with emphasis on what is

currently known about the pharmacogenetics and what might be special about LABAs.¹⁹ Studies in the early 1990s suggested that regular use of the β agonist fenoterol might produce adverse effects, most notably an increase in the risk of serious asthma exacerbation and in some cases death. These data mostly came from studies in New Zealand, where a sharp rise in asthma deaths was correlated with the marketing of fenoterol; then there was a decline in the death rate when fenoterol was withdrawn from the market.²⁰ Although the mechanism of injury from regular β agonist use remains uncertain, possibilities include tachyphylaxis and β receptor down-regulation, uncoupling and desensitization, or adverse cardiac events such as fatal arrhythmia. Concern that a similar effect might occur with the regular use of albuterol (the most commonly used reliever medication in the United States) prompted study by the Asthma Clinical Research Network, a multicenter clinical network funded by the National Institutes of Health. The results indicated that in the majority of patients with mild asthma the regular (versus as-needed) use of a SABA was not associated with risk of deterioration in lung function, as measured by PEF.²¹ However, an interesting subgroup of patients demonstrated a paradoxical effect. Study participants who had the Arg/Arg 16 polymorphism in the β -adrenergic receptor gene had a decline in PEF with regular SABA use, whereas those with other polymorphisms did not.²² That result was subsequently supported by the prospective β Adrenergic Response by Genotype (BARGE) trial.²³ This important work highlighted the role of pharmacogenetics in determining response to and safety of β agonists in certain individuals.

LABAs now play a central role in asthma management, and are recommended add-on therapy to ICSs in the 2007 NAEP guidelines¹¹ and the Global Initiative for Asthma guidelines.²⁴ But are LABAs safe? Controversy about LABAs began after case reports of deaths associated with salmeterol. The unfortunately named SMART (Salmeterol Multicenter Research Trial) examined regular use of the LABA salmeterol, compared to placebo.²⁵ Although the results were somewhat flawed by difficulties with recruitment, the SMART found a higher risk of respiratory-related deaths in patients who took daily salmeterol than in those who took placebo, particularly in the African American patients, who also appeared to have more poorly controlled asthma. Those data, and similar data from the United Kingdom, resulted in a “black box warning” on all LABA-containing products marketed in the United States. Though much remains to be learned about for whom and under what circumstances inhaled SABA and LABA are indicated or contraindicated, it is clear that SABA should only be used intermittently as rescue medication, and LABA should be used only in conjunction with an ICS. Any patient who appears not to respond favorably to SABA or

LABA should be taken seriously and considered for alternative therapy.

Regardless of the phenotype, the asthmatic airways are in a state of chronic inflammation, characterized by the presence of a wide variety of pro-inflammatory chemokines, cytokines, growth factors, lipid mediators, adhesion molecules, enzymes, and increased numbers of resident and invading inflammatory cells. ICSs are well established as the mainstay of asthma therapy in both children and adults and are the recommended first-line therapy in the current national¹¹ and international guidelines.²⁴ I reviewed "Inhaled Corticosteroids in Asthma Management."²⁶

Substantial and consistent evidence exists that ICSs improve pulmonary function and decrease asthma symptoms, exacerbations, hospitalizations, airway hyperresponsiveness, and airway inflammation, as measured by number of inflammatory cells (eosinophils and lymphocytes) and mediators (cytokines and chemokines).¹¹ Regardless of the differences in the chemical structure of the various ICSs, they all work via the same molecular mechanism: the active form of the steroid must bind to a cytoplasmic receptor, translocate to the nucleus, and bind to transcription complexes, which alters the synthesis of pro-inflammatory mediators. Differences in the chemical structure of ICSs result in pharmacokinetic and pharmacodynamic property differences that can be advantageous for clinical efficacy and safety. For instance, pro-drugs, such as the ICS ciclesonide, are activated only by enzymes found in the lower respiratory tract, which increases local efficacy while greatly decreasing the potential for local and systemic adverse effects.²⁷

Even though ICSs are highly effective in controlling asthma, as many as 30% of asthmatic patients have an incomplete response to a standard dose or even a higher dose of ICS. It is important to remember that the dose-response curve for ICSs flattens out at a relatively modest dose (eg, 400–800 μg of budesonide) and a higher dose does not provide further clinical improvement but does increase adverse effects.^{11,28,29} Relative steroid resistance can occur because of genetic differences in receptor subtype, alterations in steroid metabolism, comorbid conditions, or exposures. For instance, there is increasing evidence that obese individuals and those who smoke cigarettes are relatively resistant to low or moderate doses of ICS, but may improve with high doses. On the other hand, some patients with mild asthma may be able to achieve acceptable, albeit not optimal, asthma control with intermittent rather than daily ICS.³⁰ ICS may have a role in the treatment of asthma exacerbations. Clearly ICSs are the cornerstone of asthma controller treatment, but the incomplete and heterogeneous response demonstrated by a large minority of patients indicates that other drugs will be necessary for some patients.

As indicated in the discussion of the inadequacies of ICS and the potential adverse effects of LABA, these drugs are not effective in all asthma phenotypes. Gene Colice presented an up-to-date summary of "New Drugs for Asthma"³¹ that might one day fill the void in the asthma management pharmacopoeia. Over the past decade there have been fewer than a dozen new medications approved for use by the Food and Drug Administration. All but two of them (montelukast and omalizumab) have been in existing drug classes or new combinations of existing drug (ICS, LABA, SABA). Drugs likely to enter the United States market over the next 5 years will also be combinations of existing and newer ICSs (eg, ciclesonide) and LABAs. Although these new medications have in some instances improved control for some groups of asthmatic patients, many patients do not respond favorably to any combination of existing treatments. Omalizumab, a humanized monoclonal antibody that binds serum immunoglobulin E, may result in fewer exacerbations and reduce the need for other controller medications (including oral steroids) for some highly allergic patients with severe asthma.³² However, not all allergic asthmatics respond well to this extremely expensive, injected treatment.

Substantial research is underway to identify new classes of treatments that would address several key aspects of asthma pathophysiology: immunomodulation, antigen processing, cellular trafficking, and intracellular signaling. Agents aimed at these processes might better control asthma and alter its natural history. For instance, vaccines that use synthetic oligodeoxynucleotides with immunostimulatory sequences could shift at-risk patients from mounting a T-helper-cell type 2 (Th2) to Th1 response and thereby decrease the production of mediators associated with asthma.

Development of other monoclonal antibodies, such as those directed against CD23 (cluster of differentiation 23), which inhibits immunoglobulin E production, is being considered. Other targets include alteration of deoxyribonucleic-acid transcription to block inflammatory mediator production, and agents that inhibit airway-specific phosphodiesterases, G-protein-coupled receptors or STAT-6 (signal transducer and activator of transcription protein), or block transendothelial migration from the vascular compartment to the airways. Whether any of these drugs will reach clinical use remains to be seen and is not likely to occur soon.

Another novel asthma treatment, bronchial thermoplasty, takes advantage of the fact that airway smooth muscle is extremely sensitive to heat. Radiofrequency energy is applied to the bronchial lumen via a catheter during bronchoscopy. The heat produced reduces airway smooth-muscle mass and, presumably, airway hyperresponsiveness, while leaving the other airway structures intact. This seem-

ingly radical technique decreased asthma exacerbations in one trial.³³

Monoclonal antibodies against tumor necrosis factor alpha are currently used to treat inflammatory bowel disease, and have also been shown to decrease asthma exacerbations in some patients with severe asthma.³⁴ Both bronchial thermoplasty and monoclonal antibodies have substantial risk and expense, and are still investigational.

Direct delivery of aerosolized asthma medication to the airways has been recommended for hundreds of years, beginning with the inhalation of smoke from burning herbs, progressing through the use of atropine cigarettes, and continuing today with a variety of nebulizers, pressurized inhalers, and powder inhalers. Dean Hess reviewed "Aerosol Delivery Devices in the Treatment of Asthma" and made a several key recommendations.³⁵ Multiple aerosol delivery devices are currently available, and advances in design have been made in all categories. Small-volume nebulizers have been redesigned to increase efficiency and maximize the generation of particles in the respirable range (1–5 μm). Breath-actuated nebulizers have become more readily available and easier for patients to use. Heliox has been explored as the driving gas to enhance particle deposition in the small airways, with some success.

The switch to hydrofluoroalkane as the propellant in metered-dose inhalers required reformulation of the β agonists and ICSs, if such reformulation was chemically and economically feasible. Dose adjustment was necessary in some cases, because the hydrofluoroalkane propellant created a higher percentage of respirable particles than did the chlorofluorocarbon propellant and thus increased deposition in the small airways.

Valved holding chambers and spacers have also been improved. Some are now made of nonelectrostatic materials, to minimize loss of drug from static electrical attraction of the aerosol particles to the chamber/spacer wall.³⁶

Use of powder inhalers continues to slowly increase in the United States market. Currently, 2 inhaled steroids and one LABA are available in powder form, in handy, easy-to-use inhalers. Dean Hess presented data from a recent systematic review that indicated that there is no significant difference between the various types of inhalers in any efficacy outcome in any patient group.³⁷ The various inhalers work equally well in patients who can use them properly. The key to success with any inhaler is to address the many patient-centered questions before prescribing. Patient skills, understanding, preferences, availability of medication, and cost should all be evaluated in the choice of aerosol-delivery system. Finding the best match between patient and device may be more important than development of new systems.

Just under 5,000 individuals die in the United States every year secondary to asthma.^{1,5} Though this number is small compared to the death rate from other chronic con-

ditions such as heart disease, most authorities would agree that it is 5,000 too many. Most asthma exacerbations can be avoided or treated on an out-patient basis. However, in some asthmatics life-threatening attacks do occur. Neil MacIntyre addressed the frustrating topic of "Life-Threatening Asthma: Pathophysiology and Management" in the intensive care unit.³⁸ Benjamin Medoff presented up-to-date information about "Invasive and Noninvasive Ventilation in Patients with Asthma."³⁹

Over the past several decades, little has changed in the management of severe status asthmaticus, and controversy as to how to treat it remains. Identification of the patient prone to severe asthma episodes can be aided by recognizing the warning signs, such as previous serious attack or intensive-care-unit hospitalization, access to care, therapy-adherence issues, blunted hypoxic drive, sense of dyspnea, or symptom perception, large diurnal PEF variability, exposure to certain allergens (eg, *Alternaria* fungus), under-treatment, over-treatment (excessive β agonist use), or impaired mental health.⁴⁰ The treatment options for life-threatening asthma are not so different from those used to manage any acute episode: inhaled β agonist; systemic corticosteroid; oxygen; inhaled anticholinergic; and several other adjunctive treatments, such as theophylline, heliox, magnesium sulfate, and intravenous montelukast. Many intensive-care-unit patients receive all of these treatments during their hospital stays.

Controversy remains over the dose of SABA to give and how to give it. Albuterol via small-volume nebulizer, continuously nebulizing 6–15 mg/h is probably the most effective dose.^{11,41} Do higher doses contribute anything but adverse effect? Once all necessary receptors to achieve maximum effect are occupied, more albuterol will only produce tremor, tachycardia, hypokalemia, and lactic acidosis. Ipratropium may provide no benefit if the patient failed to respond to it in the emergency department.⁴² Excessive corticosteroid dose (> 2 mg/kg/d) is also likely to cause a serious adverse event such as psychosis or muscle weakness. Magnesium sulfate infusion may also help relieve smooth-muscle contraction and is relatively safe, but may only work in a subset of patients.⁴³ Treatments and procedures such as airway lavage, surfactant instillation, and general anesthesia are all controversial and unproven.

For the critically ill asthmatic who experiences respiratory failure, intubation and mechanical ventilation may be necessary. Noninvasive ventilation may be considered if there are no contraindications and the patient is cooperative.⁴⁴ Dealing with the intubated asthmatic is a difficult "dance." Benjamin Medoff discussed the pathophysiology of the lung in status asthmaticus and emphasized the need to understand the heterogeneity of the obstructive process and the role of applied and intrinsic positive end-expiratory pressure (PEEP).³⁹ The goals of managing the intubated asthmatic include minimizing air trapping, avoiding

alveolar overdistention, providing adequate oxygenation (88–92%), and adequate ventilation ($\text{pH} > 7.25$), which can be accomplished in several ways, with various ventilation modes (pressure control or volume control), little or no applied PEEP, and great attention to detail and patient monitoring.⁴⁵ The paramount factors are adjusting the respiratory rate to allow adequate exhalation time, countering intrinsic PEEP to permit adequate ventilator triggering, and avoiding barotrauma. Continuing medical management during mechanical ventilation is vital. Delivery of β agonist to the intubated airway is probably best accomplished with a metered-dose inhaler with spacer. Another option is a trial of injected epinephrine; this treatment is controversial but may benefit some patients.

Improving Outcomes in Asthma Management

Systematically operationalizing asthma treatment with evidence-based guidelines is important to achieving good outcomes. Tim Myers presented “Guidelines for Asthma Management: A Review and Comparison of 5 Current Guidelines.”⁴⁶ He reminded us that clinical guidelines are “systematically developed statements designed to help practitioners and patients make decisions regarding the appropriate health care for specific circumstances.”⁴⁷ Such guidelines have been issued by medical governing bodies in the United Kingdom, Canada, the United States, Australia/New Zealand, and the international community over the past 2 decades. The most recent NAEPP¹¹ and Global Initiative for Asthma²⁴ guidelines are both highly evidence-based and carefully graded the evidence used in formulating the recommendations. Both documents offer authoritative, well-researched recommendations for the diagnosis and management of asthma in children and adults, and provide information on dealing with special cases, such as the pregnant asthmatic.

One important and complex issue is the dissemination and implementation of guidelines—an issue that plagued the first edition of the NAEPP guidelines over 15 years ago. The respiratory therapist (RT) may be ideally positioned to aid in the important role of implementing the guidelines. RTs work in all settings where care is provided to asthmatics—clinics, hospitals, emergency departments, home care, and schools—and can play a pivotal role in asthma care delivery, training, and education. It is therefore imperative that RTs be familiar with the asthma guidelines and provide the highest-quality care.

RTs are not strangers to the field of disease management. Tom Kallstrom provided a discussion of “Disease Management and the Role of the Respiratory Therapist.”⁴⁸ Disease management is defined as a system of coordinated health care interventions and communications for populations with conditions in which patient self-care is important. Key components include prevention, treatment, pa-

tient tracking, and follow-up. Asthma is clearly a disorder well suited to disease management, and the NAEPP guidelines strongly emphasize the need for the provider to form a collaborative partnership with the patient and to teach and promote effective self-management.¹¹ For disease management to be successful, a number of components must be addressed. The target population needs to be identified, at the level of the health care system, clinic, hospital, or even office practice. Evidence-based guidelines that contain proven treatment strategies should be employed. These components clearly exist for asthma. A collaborative practice model for care provision that includes the physician and all support service providers must be established. Emphasis on development of self-management skills, rather than providing pure “asthma education,” is more likely to result in success. Tracking the outcomes of any disease management program and implementing continuous quality improvement is vital to accurately and honestly determine success and value. Providing feedback on process, progress, and effectiveness to both the health care team and the patient is essential to continued investment, improvement, and success. RTs are ideally suited to participate in all of these elements of disease management because of the training, skill set, and commitment to both acute and chronic care held by the RT profession.

Mari Jones reminded us that “Asthma Self-Management Patient Education” and training is vital to successful asthma control and treatment.⁴⁹ The NAEPP guidelines strongly emphasize the importance of education and identify key components: knowing the basic facts about asthma, symptom recognition, understanding what optimal control means, use and purpose of medications and devices, trigger identification, and use of an asthma action plan.¹¹ Except for the prescriptions, patients are in control of all aspects of asthma management. Their level of understanding and acceptance of responsibility for their asthma determines how successful they will be. Important objectives include few to no urgent-care visits or hospitalizations, minimal lost school or work days, low cost of care, high quality of life, appropriate use of controller and rescue medication, near-normal lung function, and patient satisfaction with care. Patients may not always recognize these as important issues, or consistent with their own goals for asthma management. In addition, many patients do not believe that optimal symptom control is achievable, even though controlled trials indicate that complete control is possible for up to 75% of patients.⁵⁰ Data on the optimal manner in which to deliver effective training and education are limited and differ across studies.

The implements of self-management and education exist in several forms, including printed, computer-based, and Internet-based resources, and in-person formal training. Factors to consider when developing materials and programs include patient age, cultural influences, health

beliefs, communication barriers, the patient's access to care, health literacy, and psychosocial issues. The provider's setting, education methods, qualifications, and personality characteristics must also be considered. Different strategies are needed for children and adults. RTs must continue to be asthma-education experts, and are well-positioned with their knowledge of respiratory physiology, device and medication use, interface with physicians, and placement in multiple health care settings. RTs must take advantage of opportunities to acquire new skills, and should strongly consider formal training, such as the Asthma Educator certification. As more data accumulates that self management is cost-effective, health care insurers, including Medicare and Medicaid, can be further pressured to reimburse fairly for patient education. Current Procedural Terminology codes do exist for education.

Summary

This exceptional 41st RESPIRATORY CARE Journal Conference achieved what great meetings do: it summarized the current state of the art in the field, highlighted the remaining major questions, and challenged the experts to work harder on advancing asthma management, so that our patients might breathe easier in the years to come. For now, practicing evidence-based medicine, as outlined in the 2007 NAEPP and Global Initiative for Asthma guidelines, sprinkled with a healthy dose of common sense, patient self-management, appropriate monitoring with objective measurements and careful watch of symptoms, and careful matching of medications to asthma severity will result in the best outcomes. Recognition that there are multiple wheezing phenotypes driven by various genotypes that are activated by environmental exposures and confounded by patient and provider behavior will also help shape care practices and future research. Please read all of the fabulous articles from this Journal Conference to expand your insight and practices on this most common of chronic conditions that has been with us since antiquity and still challenges us today.

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