Asthma in Ambulatory Care: Use of Objective Diagnostic Criteria

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Asthma, a disease of reversible airway hyperactivity, is responsible for 6.5 million visits to ambulatory care offices each year. In spite of treatment advances, asthma-related deaths have increased 31% from 1980 to 1987. The severity of asthma is often determined solely by history and physical examination, which can result in either overestimation or underestimation of disease severity. To optimize management, objective quantitative criteria should be added to the diagnostic evaluation. The use of peak flow meters provides physicians with easily obtainable objective measurements to augment their diagnostic armamentarium in the treatment of asthma.

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Although important advances have been made in the pathophysiology and treatment of asthma in the last decade, the attack rates of asthma and the mortality figures have been increasing. A large number of asthmatic patients are treated in outpatient and office settings, and many continue to receive therapy based solely on the physician's subjective assessment of the attack.

Research has shown that often neither the physician nor the patient estimate of severity correlates well with objective measurements. Therefore, quantifiable criteria need to be employed by the office-based physician to more accurately gauge the seriousness of each asthmatic episode and to assist in treatment. This article reviews the means by which asthma can be objectively evaluated in the office setting.

Clinical Assessment

Asthma is a disease of reversible airway reactivity that is consistently underdiagnosed.[1] It is traditionally evaluated by three measures: the patient's assessment of the attack, a physical examination, and the physician's subjective appraisal. Unfortunately, multiple studies have shown that both physicians and patients tend to underestimate the severity of asthma attacks.[2,3] According to Siegel and associates, most asthma-related deaths in children result from undertreatment.[4]

The presence and degree of wheezing is a major criterion by which the intensity of an asthmatic episode is judged, even though studies have shown that the degree of bronchospasm does not correlate with auscultatory findings.[5] In one study, although 90% of treated asthmatics became symptom-free, 40% were still wheezing, and pulmonary function tests showed that the forced expiratory volume in one second (FEV_1) was only 55% to 60% of predicted values.[6] Decreases in intensity of wheezing may not signal that the patient is improving, but rather that less air is moving; conversely, as the "tight" asthmatic improves, wheezes may become more audible.[7] In other patients, asthma may not present with wheezing at all, but instead with cough or exertional dyspnea.[8]

Respiratory rate is another measurement by which asthma intensity is gauged. In one study of 109 asmatic adults presenting to an emergency department, 17% of the patients who presented with severe asthma (FEV_1 less than 1.0 L) had an initial respiratory rate of less than 20 breaths per minute (BPM). Of those with moderate asthma (FEV_1 less than 1.6 L), 28% had a respiratory rate of less than 20 BPM. When looking at all cases of

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asthma with tachypnea, there was no statistically significant difference in the percentages or degree of tachypnea in the moderate to severe groups.[9]

Pulsus paradoxus typically indicates significant hypercarbia and hypoxemia (PCO_2 greater than 45 mm Hg, PO_2 less than 60 mm Hg). However, in one study of subjects with severe asthma, only 50% had pulsus paradoxus.[10] In another study by Carden et al,[9] 33% of the patients with severe asthma had no evidence of pulsus paradoxus. After treatment, 71% of the patients with persistent airway compromise (FEV_1 less than 1.6 L) had no pulsus paradoxus.[9] In individuals presenting with all three findings (pulsus paradoxus, tachypnea greater than 20 BPM, and tachycardia greater than 100 per minute), 90% had severe asthma. However, all three measurements occurred together in only 43% of asthmatic patients studied, regardless of severity.[9]

Cyanosis is the most dramatic physical finding associated with severe asthma. In most asthmatic subjects, cyanosis does not become apparent until oxygen saturation falls to 75%, which correlates with a PAO_2 of 40 mm Hg. In one study, 3600 asthmatic white men were observed for the presence of cyanosis. Three percent of the observers were unable to note cyanosis with a recorded oxygen saturation of only 71% to 75%, 10% noted no cyanosis at 76% to 80% saturation, and 25% erroneously reported mild cyanosis with a verified saturation of 96% to 100%.[11]

After considering these variables, physicians must determine the seriousness of each asthmatic episode. However, in one group of 64 asthmatic subjects judged to have mild to moderate asthma by physical assessment alone, 22% had a PAO_2 less than 60 mm Hg, and 14% had a $PACO_2$ greater than 45 mm Hg.[12]

Diagnostic Tests

Ancillary tests frequently are used to supplement the physician's physical assessment of asthma. Most of these tests add little to the evaluation of asthmatic exacerbations.

Roentgenograms have minimal prognostic value in asthma other than being useful in excluding other problems. Hyperinflation is seen 45% of the time, but does not indicate the degree of airway compromise.[13]

White blood counts are elevated in only 50% of asthma exacerbations, and high eosinophilic counts are present in only 33% of cases. Neither of these values is specific to asthma.[14]

Electrocardiograms may reflect changes in acute asthma, but these occur in less than 30% of cases, are not specific to the disease, and do not correlate to severity of the attack.[7,15]

Pulse oximetry is a noninvasive method of gauging oxygen saturation but is of limited usefulness because it does not measure $PACO_2$ and is therefore an inadequate measure of ventilation.[16] Although any reading above 90% saturation indicates an actual arterial oxygen pressure of 60 to 100 mm Hg, a person can be hypoxic with a saturation of less than 92% to 93%. Thus, oximetry may be useful in detecting severe hypoxemia (90% correlates to PAO_2 of 60 mm Hg), but is less so in following the course of therapy with a saturation greater than 90%.

Although arterial blood gas (ABG) analysis has been considered the reference standard for analysis of hypoxemia and hypercarbia, it is seldom conducted in office settings because of the prohibitive cost. Even in hospitals, ABGs for asthma are used much less frequently,[17,18] as it is now known that gases do not always accurately reflect clinical status. Adrenergic medications, which open previously unventilated lung areas, allow air into nonprofused tissue, thus creating a temporary increase in ventilation-perfusion ratios (V/Q). This increase is reflected as a transient worsening of ABGs, even as FEV_1 and peak expiratory flow rate (PEFR) are improving.[19]

Pulmonary Function Tests

Pulmonary function testing is now considered the cornerstone of diagnosing asthma severity. It provides quantifiable values by which asthma severity can be estimated and rational medical intervention instituted.[17,7]

Before 1980, the principal method of testing pulmonary function was spirometry, the most useful measurement of which is FEV_1. In practice, the use of formal spirometry is limited by cost and, of more practical concern, patient compliance. The procedure requires an individual to take a maximal inspiration and then exhale for 6 to 10 seconds to residual volume. This process can be irritating to normal airways, and patients with moderate disease may not be able to finish even one graph because of fatigue and breathlessness. Repeat spirograms subsequently may be unobtainable. For these reasons, spirometry is less than ideal in the acute situation.

The use of PEFR meters for assessing asthma has become a standard tool in many hospitals and outpatient departments. To use the meter, the patient takes the device in one hand, inhales deeply, and exhales as hard as possible (Figure). This is effort-dependent but because it requires only one-half second to perform, it is much less tiring than spirometry and can be repeated as needed. Most manufacturers recommend that PEFR be measured on children only if they are 5 or more years old, but much

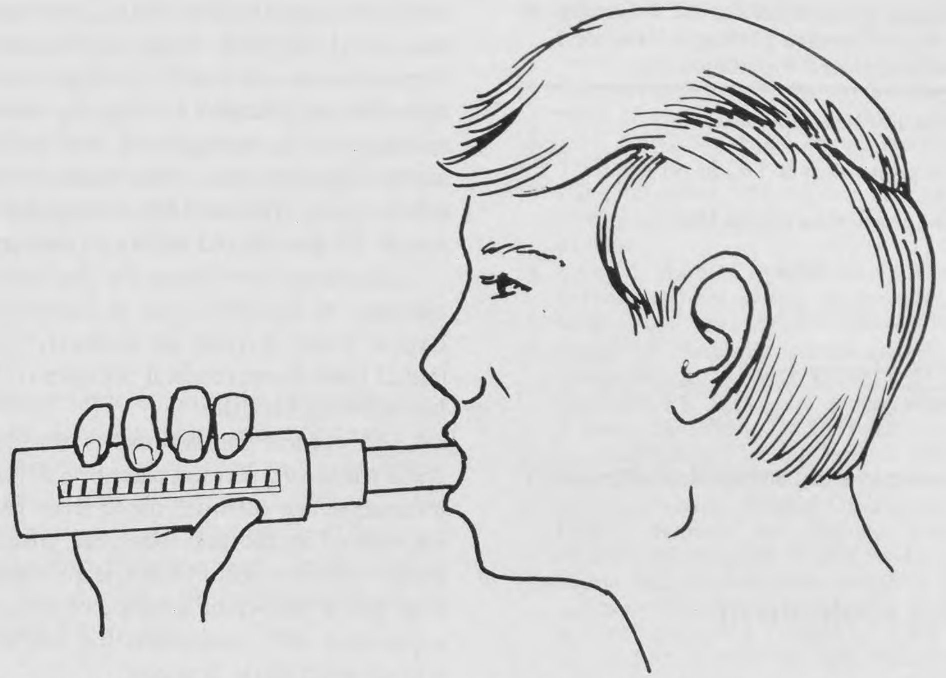

Figure. A child uses the Wright Flow Meter to measure peak expiratory flow. Patients are instructed to take a deep breath and blow once into the device as hard and fast as possible.

younger children can perform a peak flow if they understand the principle of blowing out a birthday candle.

To determine if PEFR meters correlate well with formal spirometry, Nowak et al[20] prospectively examined 109 cases of acute asthma in asthmatic subjects between 16 and 40 years of age. Pulmonary status was measured pre- and post-treatment using PEFR and FEV_1. The study found excellent correlation between formal spirometry and the Mini-Wright PEFR meter at all stages of therapy.[20] PEFR accurately distinguished between severe, intermediate, and mild asthmatic groups. For example, those with initially mild to moderate asthma (initial PEFR greater than 100 L per minute) but poor response to medication (discharge PEFR less than 300 L per minute) had poor outcomes and frequent return visits.

PEFR meters have also been compared with ABGs in prediction of asthma severity as well as utility of ongoing management. Various authors have found that a $PaCO_2$ greater than 45 mm Hg was never present unless PEFR was less than 130 L per minute or less than 25% of predicted values.[18] Nowak et al[19] also found that pulmonary function testing with PEFR may be more sensitive than ABGs. In one group, virtually all asthmatic adults with a PaO_2 less than 60 mm Hg and/or a $PaCO_2$ greater than 42 mm Hg could be identified because their PEFRs were less than 200 L per minute. Also, 17% of the patients demonstrated a temporary worsening of their PaO_2 while FEV_1 and PEFR were improving.[19,21]

These results suggest that ABGs are not indicated with a PEFR greater than 200 L per minute or 30% predicted. In addition, no patient with a PEFR greater than 25% predicted had a pH less than 7.35.[20]

The most important finding in this study was that ABGs were not greatly different in those asthmatic subjects who were discharged from the emergency department and those who were admitted to the hospital. In the same sample, PEFR accurately distinguished between the two groups.

Other studies expanding on the use of PEFR values have identified that an inability to initiate a PEFR is an absolute indication for admission, even if response to therapy is seen later.[22]

Failure to increase PEFR greater than 30% after 4 hours of therapy and deterioration in PEFR greater than 15% during treatment are also indications for admission.[22]

Therapeutic Indices

Some authors have collated all of the previously mentioned measurements into a comprehensive scoring system for predicting asthma severity. The best known of these is the Fischl Index.[23] A score of 4 or more indicates the need for hospital admission (Table). However, all these criteria, except for PEFR, may be absent in the patient who is a severe asthmatic. Rigid adherence to this

Table. Criteria Used in the Fischl Index for the Prediction of Asthma Severity with Each Criterion Having a Value of 1 (Score of 4 or more indicates need for admission)

• Pulse greater than 120 beats per minute
• Respiratory rate greater than 30 breaths per minute
• Pulsus paradoxus greater than 18 mm Hg
• PEFR less than 120 L per minute
• Moderate use of accessory muscles
• Moderate to severe wheezing

PEFR denotes peak expiratory flow rate.

scale as an admission tool would overlook many severely ill patients.[24,25]

Implications for Outpatient Management

Physicians in office-based practices are faced with a variety of issues in the management of asthmatic patients. The severity of the attack must be assessed quickly and a decision made immediately on whether to stabilize and transfer the patient or attempt in-office therapy. If therapy is instituted in the office, objective measurements to guide management must be established. PEFR graphs, which are available from various manufacturers, can provide these values. Based on patient age, height, and sex, these graphs show the average 100% predicted PEFR values for asymptomatic individuals.

The use of objective measurements will help avoid both premature discharge and unnecessary hospitalization. Measurements are especially critical in an office setting, where prolonged treatment of a single patient can have an adverse impact on time management and patient flow. The PEFR meter is the simplest and most economical method of obtaining objective reproducible data on which to base therapy.

In some cases, treatment decisions can be made solely on the basis of PEFR measurements. Specifically, an individual unable to initiate a PEFR should be considered severely asthmatic and transferred as soon as possible. Patients who are unable to obtain a PEFR greater than 100 L per minute (or more than 25% predicted) are at risk of underlying hypercarbia and should be transferred. Patients with a PEFR of 25% to 40% predicted may respond to therapy but probably will require more time to improve than is available in an office. Those with a PEFR greater than 70% typically improve quickly and usually will not require transfer or prolonged office care. Those with a PEFR between 40% and 70% predicted fall into a gray zone. These patients may need up to 4 hours of treatment before a final disposition is reached.[17] In these cases physician determination on whether to treat or transfer may be influenced by time management and patient load considerations. Any asthmatic who shows a worsening of PEFR greater than 10% to 15% during the course of therapy should be transferred for more definitive treatment.

Excellent flow sheets for decision-making and management in the office and at home are available in the Expert Panel Report on Asthma,[17] which can be obtained from most medical libraries or from the National Institutes of Health.

All clinical measurements should be modified toward the more serious category if there is a history of intubation for asthma, more than two hospitalizations for asthma in the previous year, more than three emergency visits for asthma in the previous year, recent steroid use, a history of syncope or seizures due to asthma, a previous ICU admission for asthma, or a history of serious psychiatric illness.[17]

Unlike emergency physicians, family physicians are in a unique position to intervene in the spiral of increasing asthma morbidity by providing ongoing education as well as developing anticipatory measures that can decrease the incidence of severe attacks. One of these modalities is home PEFR monitoring. Most insurance carriers now reimburse for the cost (usually less than $50) of these devices.

Patients with asthma can easily perform home peak flow tests and record the results in a log book. A "personal best" score for each patient can be established from this record. Circadian day-night variations can also be charted. Individual instructions can be given to each patient regarding when it is appropriate to call the physician or seek medical aid. This guideline is usually written as a "zone system," which is analogous to traffic signals and easy to remember.[26] Mild asthma (green zone) is 80% to 100% predicted or 80% to 100% personal best with less than a 20% day-night fluctuation. Moderate asthma (yellow zone) is a PEFR of 60% to 80% predicted or 60% to 80% personal best with a 20% to 30% circadian fluctuation. Severe asthma (red zone) is a PEFR of less than 60% predicted or personal best with a greater than 30% circadian fluctuation.[17,26]

This monitoring system can be accompanied by specific instructions for home intervention by activity modification or self-medication before calling the physician, which may completely abort the attack or limit its severity at the time medical attention is sought. Most important, these guidelines give the physician objective criteria by which to assess the patient over the telephone. Self-monitoring also allows the patient to participate in his or her own therapy, and may increase compliance with medication. Long-term home monitoring may detect patterns of exacerbations related to exercise, work exposures, or seasonal allergens. Dedicated patients can measure PEFR before and after potential exposures or exercise as well as record responses to self-medication. Finally, the size and portability of the PEFR meter makes it applicable for transport to school.[27,28]

Conclusions

Despite advances in our understanding of the pathophysiology of asthma, its prevalence and mortality rates are rising. To reverse this trend, physicians must avoid underestimating the severity of asthma exacerbations. This goal can be accomplished only if subjective data are augmented with objective measurements. In the ambulatory care setting, this can be achieved most effectively through the use of PEFR meters.

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