Assessing asthma control

An evidence-based approach to improve skills and outcomes

Abstract: The goal of asthma therapy is to achieve and maintain good asthma control. By utilizing evidence-based guidelines recommended by the National Asthma Education Prevention Program Expert Panel-3 Report, nurse practitioners can improve assessment of asthma control, and ultimately improve asthma outcomes.

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Asthma is a common chronic disorder of the airways that is complex and characterized by variable and recurring symptoms, airflow obstruction, bronchial hyperresponsiveness, and underlying inflammation.[1] According to the CDC and the National Center for Health Statistics Report on Asthma Prevalence, Healthcare Use and Mortality from 2005 to 2009, asthma prevalence is in 8.2% of the U.S. population (24.6 million people).[2] The CDC recently reported that asthma prevalence in children increased from 8.7% in 2001 to 9.6% in 2009.[3] Prevalence is greater among females, children, non-Hispanic Black and Puerto Rican ethnicities, and those below poverty level.[2]

Asthma exacerbations are costly; 35% to 50% of medical costs for asthma are due to acute exacerbations.[2] Loss of asthma control results in significant productivity loss and high indirect costs. In 2007, there were 1.7 million asthma-related ED visits reported along with 456,000 hospitalizations due to asthma. In 2008, 10.5 million school days were missed due to asthma along with 14.2 million work days.[2] Impairment of quality of life is a significant and an

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often overlooked outcome of uncontrolled asthma.[4] A prior history of an asthma exacerbation has been consistently found to be the most important predictor for a future exacerbation.[5,6] In addition, asthma exacerbations have been associated with a greater reduction in lung function.[7]

In most instances, achieving and maintaining good asthma control is a realistic and achievable goal. Asthma exacerbations can be prevented, symptoms can be minimized, and lung function can be maximized. By utilizing measurements of control recommended in evidence-based guidelines for the diagnosis and management of asthma, healthcare providers can improve assessment of asthma control, and ultimately, improve asthma outcomes.

National Asthma Education Prevention Program Expert Panel-3 update

The National Heart, Lung, and Blood Institute coordinates the National Asthma Education and Prevention Program (NAEPP). Initial NAEPP guidelines for the assessment and management of asthma were released in 1991, and the most recent update, *Expert Panel Report 3*(EPR-3): *Guidelines for the Diagnosis and Management of Asthma*, was released in 2007.[1] The latest update recognized the heterogeneity/variability of asthma and introduced an asthma severity and control classification system that reflects the dynamic nature of asthma.

A stepwise approach to asthma management was developed to guide healthcare providers in their decision-making process. On initial diagnosis of asthma, the appropriate step therapy is determined by the assessment of asthma severity. On follow-up visits, appropriate step therapy is determined by the assessment of asthma control. Routine and accurate assessment of asthma control emphasized in the EPR-3 update represents a paradigm shift with regard to long-term treatment of asthma. One of the desired outcomes of this change was to dispel the myth that a particular severity level correlates with a certain level of control. For instance, mild asthma does not automatically mean asthma will stay mild and be well controlled. Severe asthma exacerbations may occur at any level of asthma severity.

Since no single outcome measure is sufficient to measure control, the EPR-3 recommends using multiple measurements of control, including report of symptoms, quality-of-life measures, validated asthma control questionnaires, lung function, biomarkers, and historical data regarding asthma control.[1]

Classification of asthma control

Asthma control is classified in the EPR-3 update as well controlled, not well controlled, and poorly controlled in ages 0 through 4 years old, 5 through 11 years old, and 12 years and older. Both asthma severity and asthma control are described in terms of two distinct domains: impairment and risk. Impairment is defined as the frequency and intensity of symptoms and functional limitations that a person is experiencing or has recently experienced. Risk is the likelihood of an asthma exacerbation or progressive loss of lung function. Well-controlled asthma is achieved when both impairment and risk domains are minimized, and the goals of therapy are met. Periodic visits and ongoing monitoring are required to determine if asthma control and goals have been achieved.[1] (See *Classification of asthma control [0 through 4 years of age, 5 through 11 years of age, and 12 years of age and older].*)

According to the EPR-3 guidelines, asthma is considered well controlled if symptoms (daytime and nighttime) rarely occur, use of the short-acting beta$_2$-agonist (SABA) is rare (except to prevent exercise-induced bronchospasm [EIB]), the patient can participate in all normal activities without asthma symptoms, and there is minimal risk of an asthma exacerbation. "Rare" daytime symptoms and use of SABA means 2 days/week or less. Nighttime symptoms vary somewhat depending on the age group. Normal lung function and a score corresponding to well-controlled asthma on a validated asthma control questionnaire are two other indicators of well-controlled asthma. Normal lung function is an FEV_1 (forced expiratory volume in the first second of exhalation after full inspiration) or a peak expiratory flow (PEF) greater than 80% of predicted or personal best.[1] (See *Criteria for well-controlled asthma.*)

Asthma is classified as not well controlled when symptoms occur several times per week, and more frequent use of quick relief medication is needed. PEF ranges from 60% to 80% of predicted or personal best, and nighttime symptoms occur more frequently. Very poorly-controlled asthma is characterized by daily symptoms and daily use of quick relief medication. PEF is less than 60% of predicted or personal best. The goals of asthma, as defined above, are not achieved when asthma is not well controlled. It is the healthcare provider's responsibility to assess the level of reduced control in both impairment and risk domains to determine the appropriate step therapy needed.[1] The criteria for well-controlled, not well-controlled, and very poorly-controlled asthma are noted in *Classification of asthma control*. Though the classification system and corresponding step therapies may appear overwhelming, there are more similarities than differences among the various age groups.

The frequency of visits needed to monitor asthma control requires clinical judgment. The EPR-3 guidelines suggest scheduling visits every 2 to 6 weeks for patients just starting treatment or who require a step-up in therapy to achieve or regain control. Patients who are currently well

controlled and have a history of being well controlled can schedule visits every 1 to 6 months. Those with uncontrolled and/or severe, persistent asthma will need closer monitoring. Encourage patients to use self-assessment tools to monitor asthma, such as symptom diaries, peak flow monitoring with asthma action plans, and self-assessment forms.[1]

Assessment of impairment domain

Assessment of impairment due to asthma includes the measurements of both the frequency and the intensity of the symptoms. Measuring daytime and nighttime symptoms, ability to participate in usual activities, frequency of the use of a SABA, lung function, and use of validated questionnaires can assess this.[1,8]

According to the EPR-3 guidelines, obtaining an objective measure of airflow obstruction is an important tool in the assessment of impairment for patients who are capable of performing maneuvers correctly. Patients' report of symptoms may not correlate with objective pulmonary function. In patients 5 years and older, spirometry testing should be performed during the initial assessment, after treatment is initiated, and once symptoms have stabilized to determine if the goals of improved pulmonary function have been attained. Future spirometry should be performed at follow-up visits and with symptoms or suspected loss of control. The two key spirometry values of particular interest are the FEV1 and the forced vital capacity (FVC). Asthma is associated with a reduced forced expiratory volume, particularly in the first second of exhalation, and usually with a reduction of greater than or equal to 15% to 20% of predicted or personal best.[1]

Peak flow meters are useful for monitoring control, particularly at home. They are hand-held devices that measure PEF. A decline in expiratory flow from personal best values usually indicates airway obstruction. Patients and healthcare providers gain useful, objective information regarding asthma control. Trends and triggers may be identified, and patients may learn to correlate subjective and objective findings. For those who do not perceive a worsening of their asthma control, it may provide early objective indicators, so treatment can be initiated sooner.[9] Though peak flow meters may be more easily accessible in some settings, it is important to remember that the preferred method for

Classification of asthma control (0 through 4 years of age)[1]

Components of control		Well controlled	Not well controlled	Very poorly controlled
Impairment	Symptoms	≤2 days/week	>2 days/week	Throughout the day
	Nighttime awakenings	≤1×/month	>1×/month	>1×/week
	Interference with normal activity	None	Some limitation	Extremely limited
	SABA use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
Risk	Exacerbations requiring oral corticosteroids	0-1/year	2-3/year	>3 /year
	Treatment-related adverse reactions	Medication adverse reactions 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 overall assessment of risk.		
Recommended action for treatment		• Maintain current treatment. • Regular follow-ups every 1-6 months • Consider step down if well controlled for at least 3 months.	• Step up 1 step. • Reevaluate in 2-6 weeks. • If no clear benefit in 4-6 weeks, consider alternative diagnoses or adjusting therapy. • For adverse reactions, consider treatment options.	• Consider short course of oral systemic corticosteroids. • Step up 1-2 steps. • Reevaluate in 2 weeks. • If no clear benefit in 4-6 weeks, consider alternative diagnoses or adjusting therapy. • For adverse reactions, consider alternative treatment options.

Classification of asthma control (5 through 11 years of age)[1]

Components of control		Well controlled	Not well controlled	Very poorly controlled
Impairment	Symptoms	≤2 days/week but not more than 1×/day	>2 days/week or multiple times on ≤2 days/week	Throughout the day
	Nighttime awakenings	≤1×/month	≥2×/month	≥2×/week
	Interference with normal activity	None	Some limitation	Extremely limited
	SABA use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	Lung function • FEV1 or PEF • FEV1/FVC	>80% predicted/ personal best >80%	60%-80% predicted/ personal best 75%-80%	<60% predicted/ personal best <75%
Risk	Exacerbations requiring oral corticosteroids	0-1/year	≥2/year	≥2/year
	Treatment-related adverse reactions	Medication adverse reactions 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 overall assessment of risk.		
	Reduction in lung growth	Requires long-term follow up.		
Recommended action for treatment		• Maintain current step • Regular follow-ups every 1-6 months • Consider step down if well controlled for at least 3 months	• Step up at least 1 step • Reevaluate in 2-6 weeks • For adverse reactions, consider treatment options	• Consider short course oral systemic corticosteroids • Step up 1-2 steps • Reevaluate in 2 weeks • For adverse reactions, consider alternative treatment options

measuring airflow obstruction is with spirometry. Peak flow meters can underestimate the degree of airflow limitation and have a wide variability of predicted values based on the manufacturer.[10]

Validated questionnaires assess the degree to which asthma control is present through patients' or parents' recall of symptoms, their need for relief medication, physical activity levels, and quality-of-life indicators in the recent 2 to 4 weeks. The EPR-3 guidelines recommend routinely including them in follow-up visits. Patients (or parents) can complete them in the exam room while waiting for the healthcare provider. Three validated questionnaires are listed in the guidelines: the Asthma Therapy Assessment Questionnaire© (ATAQ), the Asthma Control Questionnaire© (ACQ), and the Asthma Control Test (ACT). The Asthma Control Test was included in the 2007 EPR-3 Asthma Guidelines for ages 12 and older. Since publication of the 2007 EPR-3 Asthma Guidelines, an ACT was developed for ages 4 through 11. The questionnaires for both age groups were developed by QualityMetric Inc. and supported by the American Lung Association. A score of 20 and above (best score is 25) indicates well-controlled asthma. Asthma specialists routinely administer the ACT. Though less common in primary care, its use is increasing due to its convenience and adherence to best-practice recommendations.[11-14]

Assessment of risk domain

Assessment of the risk domain in asthma control is emphasized not only in the EPR-3 guidelines but the American Thoracic Society (ATS) and the European Respiratory Society (ERS) guidelines on asthma control and exacerbations.[15] Helen Reddel, MB, PhD, from the Woolcock Institute of Medical Research in Camperdown, Australia, and co-chair of the ATS/ERS Task Force on Asthma Control and Exacerbations commented on the importance of the addition of future risk to the definition of asthma control. Dr. Reddel stated it was important, "because some medications can

improve symptoms while not treating the underlying disease; some patients are at increased risk of asthma attacks despite having few symptoms; and medication side effects should be taken into account when deciding a patient's need for treatment."[16]

Assessment of the risk domain consists of gathering historical data, such as visits to an urgent care center, unscheduled primary care visits, emergency care, and hospitalizations due to asthma symptoms. Of particular concern are the patients with frequent and/or severe exacerbations in whom a provider has found it necessary to prescribe oral corticosteroids for asthma. In general, patients who have had two or more exacerbations requiring systemic corticosteroids in the past year may be considered the same risk as patients whose asthma is not well controlled, even if the patient is not currently impaired. Current impairment status is insufficient to appropriately assess control. The patient may not currently be impaired but could still be at high risk for another exacerbation. Treatment should be chosen with the goal of preventing future exacerbations.[1]

Relying on a patient's report of historical and current asthma control is usually insufficient to measure risk of future exacerbation. Objective measurements, particularly lung function, are needed. Though it is used to assess the impairment domain of asthma control, the FEV1 is also used in the assessment of the risk domain. A reduced FEV1 is associated with an increased risk of an exacerbation, independent of symptoms.[17] Home monitoring of PEF indicating significant reduction in peak flow (less than 80% of personal best) suggests airway obstruction and a need for a change in therapy. If spirometry is not available in the primary care

Classification of asthma control (12 years of age and older)[1]

Components of control		Well controlled	Not well controlled	Very poorly controlled
Impairment	Symptoms	≤2 days/week	>2 days/week	Throughout the day
	Nighttime awakenings	≤2×/month	1-3×/week	≥4×/week
	Interference with normal activity	None	Some limitation	Extremely limited
	SABA use for symptom control (not EIB prevention)	≤2 days/week	>2 days/week	Several times per day
	Lung Function • FEV1 or PEF	>80% predicted/ personal best	60%-80% predicted/ personal best	<60% predicted/ personal best
	Validated Questionnaires ATAQ ACQ ACT	 0 ≤0.75 ≥20	 1-2 ≥1.5 16-19	 3-4 N/A ≤15
Risk	Exacerbations requiring oral corticosteroids	0-1/year	≥2/year	≥2/year
		Consider severity and interval since last exacerbation		
	Progressive loss of lung function	Evaluation requires long-term follow up		
	Treatment-related adverse reactions	Medication adverse reactions 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 overall assessment of risk.		
Recommended action for treatment		• Maintain current step • Regular follow-ups every 1-6 months • Consider step down if well controlled for at least 3 months	• Step up 1 step • Reevaluate in 2-6 weeks • For adverse reactions, consider treatment options	• Consider short course oral systemic corticosteroids • Step up 1-2 steps • Reevaluate in 2 weeks • For adverse reactions, consider alternative treatment options

Criteria for well-controlled asthma[1]

Impairment	0-4 Years	5-11 Years	12 Years and older
Symptoms	≤2 days/week	≤2 days/week	≤2 days/week
Nighttime awakenings	≤1×/month	≤1×/month	≤2×/month
Interference with normal activities	None	None	None
SABA	≤2 days/week	≤2 days/week	≤2 days/week
FEV1 or PEF	n/a	>80% predicted or personal best	>80% predicted or personal best
ACT score	≥20*	≥20	≥20
Risk			
Exacerbations requiring oral corticosteroids. Consider severity and intensity.	0-1/year	0-1/year	0-1/year

*ACT available for children 4 to 11 years

practice setting, options include ordering an outpatient procedure or referring to an asthma healthcare provider. Ideally, a baseline spirometry measurement should be obtained. This may not be realistic if the patient requires immediate treatment for acute symptoms and spirometry cannot be obtained for several days. Though peak flow meters are used for monitoring rather than for diagnosing asthma, it would be helpful to obtain a PEF rate to trend posttreatment values if spirometry is not accessible.

EPR-3 also recommends monitoring adherence to pharmacotherapy, inhaler technique, and adverse reactions from medications in the risk domain of asthma control.[1] The risk of a gradual loss of asthma control or an acute exacerbation may be great for a patient who is nonadherent to an inhaled corticosteroid (ICS), particularly if there is a history of exacerbations. Poor adherence to ICS is a well-documented risk factor not only for an acute asthma exacerbation but also for asthma death.[17] Williams and colleagues measured adherence to ICSs with 298 participants and found an estimated 24% of severe asthma exacerbations were attributable to nonadherence to ICSs, consistent with other studies.[18] Proper training of inhalation technique is essential to maximize delivery of asthma medication. Improper technique may contribute to a loss of asthma control and misperceived need for step-up therapy.[9] Adverse reactions from asthma medications should be monitored. Though tremors, sore throat, and dysphonia are usually mild adverse reactions from inhaled asthma medications, they may affect adherence, and increase a patient's risk for exacerbation. Potential systemic risks associated with ICS, such as growth effects in children, should be monitored routinely. The risks are particularly increased with high-dose ICSs and/or recurrent systemic corticosteroids. Recommendations to limit risk include using the lowest effective dose, ensuring proper inhaler technique, and utilizing corticosteroid-sparing strategies.[19] According to the Food Drug Administration (FDA), patients on long-acting beta$_2$-agonists (LABAs) should be monitored for a worsening of asthma and risk for asthma death related to LABAs. They should not be used as monotherapy, should be used for the shortest duration needed to achieve control, and discontinued, if possible, once asthma control is achieved.[20] Close monitoring is essential, since loss of asthma control may occur when LABAs are discontinued due to recently achieved asthma control.[21,22]

Other tools for monitoring the risk domain of asthma control include biomarkers of inflammation, such as fractional exhaled nitric oxide (FeNO) and sputum eosinophils. Since EPR-3, studies have shown FeNO to be a useful adjunct tool for monitoring asthma control, particularly in specialist care. Increased FeNO levels (greater than 35 parts per billion) in patients with asthma have been associated with increased airway inflammation, greater airway reactivity, and eosinophilic inflammation.[23] Exhaled nitric oxide can be used to predict future asthma exacerbations, ICS response, and relapse after discontinuation of therapy. Lower levels have been shown to reflect well-controlled asthma, and step-down therapy may be considered.[22,24,25] However, the level considered significantly increased has varied in studies. Further evaluation is needed to clearly define cutoff points for elevated FeNO values.[26] Sputum eosinophil counts increase with allergic inflammation, correlating with asthma disease severity and control. Unfortunately, inducing and analyzing sputum is not a practical clinical option for determining airway inflammation and asthma control.[23]

Case scenario

Mr. J is a 23-year-old man who presents for a routine follow-up visit for his asthma. His last office visit was 2 years ago, though he was due to return 1 1/2 years ago. He states his asthma has been "doing great" but requests a refill of his albuterol, since he is now in the lawn and landscaping business, and grass pollen usually flares his asthma. When questioned further, he admits to using a friend's albuterol inhaler at least daily for chest tightness and to being prescribed prednisone two times this past year for his asthma. His ACT score is 20, indicating good control. His physical exam, as expected, is normal.

Other tools for monitoring the risk domain of asthma control include biomarkers of inflammation.

Mr. J's personal best FEV1 is 97% predicted; today it is 58% predicted. He has not used his asthma controller in over a year "because he felt good." Prior history reveals similar nonadherence to controller medication with significant reduction in FEV1 (as low as 35% predicted). He has a peak flow meter and an asthma action plan. However, he does not use them. He tends to underestimate the severity of his asthma and has a poor perception of dyspnea, including episodes of severe exacerbations.

Despite Mr. J's report of well-controlled asthma, his asthma is poorly controlled. He is at high risk for a near-fatal or fatal asthma exacerbation. Additional measurements of asthma control provided the missing, yet extremely important data needed to more accurately assess asthma control, and provide the necessary treatment to achieve control.

At Mr. J's follow-up visit 6 weeks later, he had been taking his ICS/LABA twice daily, rarely needed his albuterol, and his FEV1 was 92% predicted. Of particular importance, he felt better and understood why taking his medication was important.

Challenges in the assessment of asthma control

Asthma can be variable with regard to the natural history, severity, risk for adverse reactions, response to therapy, and outcome. Clinically, the heterogeneous nature of asthma has been apparent for years. There have been gaps in the understanding and ability to incorporate the heterogeneity and variability of asthma into clinical practice. Fortunately, due to a significant increase in research findings in recent years, these gaps are closing.[25]

One might assume that the level of inflammation in airways would correlate with asthma symptoms and asthma severity. However, the presence of inflammation is quite variable within and between those with asthma. Bronchoscopies performed in patients with asthma, who were symptom-free and with normal lung function, revealed low-grade, allergic-type inflammation in the bronchi.[9] Airway remodeling, defined as structural changes, including hypertrophy and hyperplasia of the airway smooth muscle, is also highly variable and doesn't necessarily correlate with the severity of asthma or progression of the disease. Chronic airway inflammation is present in many patients, and healthcare providers are often unaware of these findings.[1] Daily use of ICSs can reduce the inflammation in persistent asthma and has had a significant impact on the achievement of asthma control and reduction of asthma exacerbations. However, an ICS may fail to reduce symptoms sufficiently or fail to reduce the risk of an exacerbation. Close monitoring of asthma to determine if asthma control has been achieved with the current treatment plan is essential.[22]

Patients, parents, and healthcare providers usually underestimate the severity of asthma and overestimate the control. Subjective reports of symptoms are often not reliable when determining level of control.[26,27] Britto and colleagues found only 25% of adolescents ages 12 to 22 in a primary care clinic accurately perceived their impairment-related control; 74% overestimated their control; and only 1% underestimated their control.[27] Stout and colleagues, in their study of 640 children ages 8 to 11 years old enrolled in two multicenter studies, found an underestimation of disease severity when assessment of asthma was based on symptoms alone; these findings are similar to those found in studies with adults. The addition of objective pulmonary function tests changed assessment decisions with an increase in EPR-3 classification in level of asthma severity.[28]

Studies have revealed distinct characterizations in patients with asthma who experience near-fatal episodes. They tend to have a reduced adherence to asthma medication, poor asthma control, and a reduced perception of dyspnea. These patients often have severe or difficult-to-control asthma yet cannot perceive when their asthma has become critically dangerous. These patients cannot be distinguished by lung function, airway hyperresponsiveness, duration of asthma, smoking status, ethnicity, or prevalence of atopy. This makes assessment of asthma control particularly challenging.[17]

The physical exam provides little, if any, value in non-acute asthma, since it is usually normal. Spirometry testing may not be readily accessible. Validated questionnaires

provide useful information from the patient's (or parent's) perception of asthma control. However, they may not be available, or there may be discrepancies between the patient's report of current asthma control, the asthma questionnaire score, and the spirometry measurement. Explanations for the discrepancies include a lack of understanding of the questionnaire, poor quality spirometry, and overestimating or underestimating asthma control. Though the evaluation process takes longer than expected when this happens, it also provides an opportunity for further exploration and an excellent opportunity for education.

Moving forward

The EPR-3 guidelines represent a paradigm shift in asthma treatment from a one-time assessment of asthma severity to ongoing assessment of asthma control. The guidelines provide a framework for an evidence-based approach to the assessment of asthma control, which includes monitoring the impairment and risk domains of asthma. Since decisions regarding asthma therapy are based on the assessment of asthma control, it is essential that healthcare providers appropriately assess control.

A subjective report from the patient is insufficient, and multiple measurements of control are needed. Validated asthma control questionnaires (such as the ACT) and objective measurements (including spirometry) improve accuracy of asthma control assessment. Refer to an asthma specialist if clarification of the level of asthma control is needed and/or if asthma needs better control. Additional indirect and direct measurements of control can be performed, including use of inflammatory biomarkers. Research is ongoing to further understand the mechanisms behind the loss of asthma control, the variability within and between individuals with asthma, and the varied response to pharmacologic therapy. Advances in these areas should lead to significant improvements in the assessment of asthma control, and ultimately, the achievement and maintenance of well-controlled asthma. NP

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