



INSTITUTE FOR CLINICAL  
SYSTEMS IMPROVEMENT

## Health Care Guideline: Diagnosis and Management of Asthma

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**Ninth Edition  
June 2010**

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- health care teaching institutions;
- health care information technology departments;
- medical specialty and professional societies;
- researchers;
- federal, state and local government health care policy makers and specialists; and
- employee benefit managers.

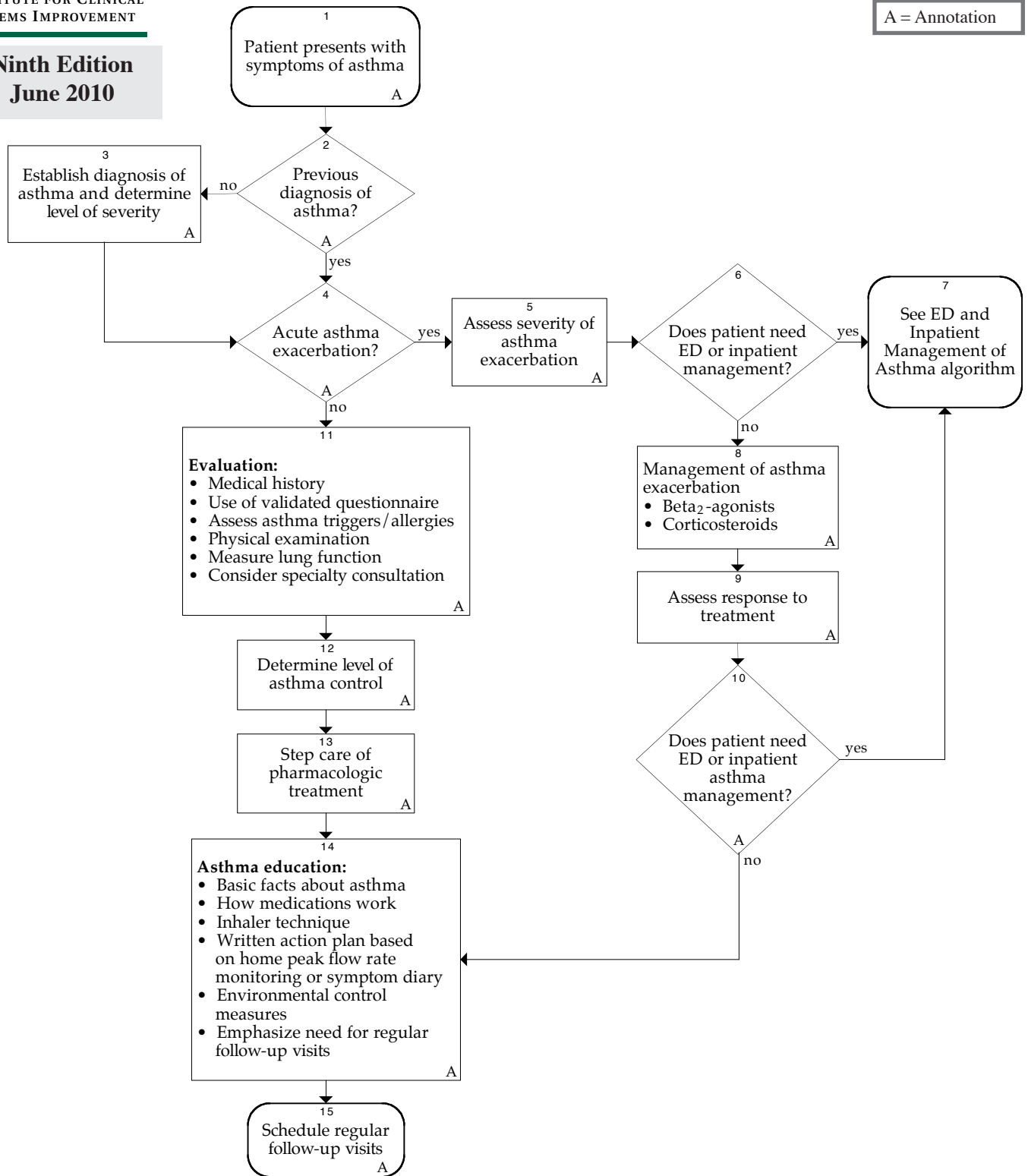
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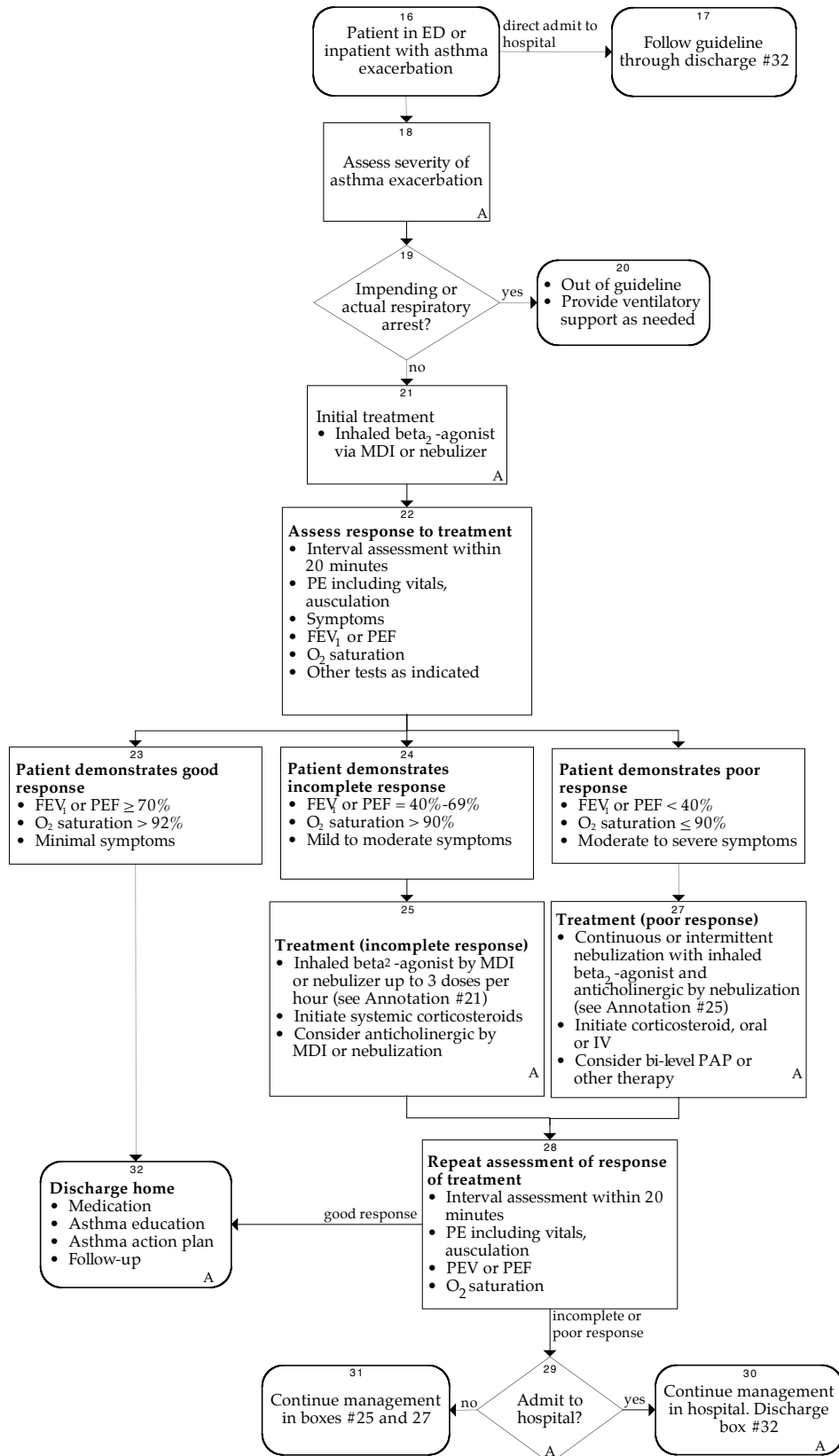
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# Emergency Department or Inpatient Management Algorithm



A = Annotation

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## Foreword

### Scope and Target Population

This guideline addresses the diagnosis, emergent, inpatient and outpatient management of acute and chronic asthma in all patients over five years of age who present with asthma-like symptoms or have been diagnosed with asthma.

### Clinical Highlights and Recommendations

- Conduct interval evaluations of asthma including medical history and physical examination, assessment of asthma triggers and allergens, measurement of pulmonary function, and consideration of consultation and/or allergy testing. (*Annotation #11*)
- Assess control using objective measures and a validated asthma control tool. (*Annotation #12*)
- Match therapy with asthma control. (*Annotation #13*)
- Provide asthma education to patients and parents of pediatric patients. Education should include basic facts about asthma, how medications work, inhaler technique, a written action plan including home peak flow rate monitoring or a symptom diary, environmental control measures, and emphasis on the need for regular follow-up visits. (*Annotation #14*)
- Patients should receive appropriate follow-up as per Diagnosis and Management of Asthma guideline. (*Annotation #15*)

### Priority Aims

1. Promote the accurate assessment of asthma severity and control through the use of objective measures of lung function and symptoms. (*Annotations #3, 4, 5*)
2. Promote long-term control of persistent asthma through the use of inhaled corticosteroid drug therapy. (*Annotation #13*)
3. Promote the partnership of patients with asthma and/or their parents with health care professionals through education and the use of written action plans. (*Annotation #14*)
4. Improve the timely and accurate assessment of patients presenting with an asthma exacerbation. (*Annotations #5, 9, 30*)
5. Improve the treatment and management of ER and inpatient asthma. (*Annotations #5, 21, 25, 27*)
6. Schedule follow-up visits to ensure asthma control is maintained and appropriate therapy is administered. (*Annotations #15, 32*)

## Key Implementation Recommendations

The following system changes were identified by the guideline work group as key strategies for health care systems to incorporate in support of the implementation of this guideline.

1. Facilitate timely and accurate diagnosis of asthma and asthma severity and control.
2. Educate providers in the use of spirometry as a diagnostic tool.
3. Educate providers and patients in the importance of developing and maintaining an asthma action plan and assessing adherence.

## Related ICSI Scientific Documents

### Guidelines

- Chronic Obstructive Pulmonary Disease
- Diagnosis and Treatment of Respiratory Disease in Children and Adults

### Order Sets

- Admission for Asthma

## Disclosure of Potential Conflict of Interest

ICSI has adopted a policy of transparency, disclosing potential conflict and competing interests of all individuals who participate in the development, revision and approval of ICSI documents (guidelines, order sets and protocols). This applies to all work groups (guidelines, order sets and protocols) and committees.

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Gail Brottman has received grant funding for AHRQ.

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Molly Ekstrand has received honoraria and some travel expenses from the American Lung Association of Minnesota, the American Pharmacists Association and the Minnesota Pharmacists Association.

No other work group members have potential conflicts of interest to disclose.

## Introduction to ICSI Document Development

This document was developed and/or revised by a multidisciplinary work group utilizing a defined process for literature search and review, document development and revision as well as obtaining and responding to ICSI members.

For a description of ICSI's development and revision process, please see the Development and Revision Process for Guidelines, Order Sets and Protocols at <http://www.icsi.org>.

## Evidence Grading System

### A. Primary Reports of New Data Collection:

- Class A: Randomized, controlled trial
- Class B: Cohort study
- Class C: Non-randomized trial with concurrent or historical controls  
Case-control study  
Study of sensitivity and specificity of a diagnostic test  
Population-based descriptive study
- Class D: Cross-sectional study  
Case series  
Case report

### B. Reports that Synthesize or Reflect upon Collections of Primary Reports:

- Class M: Meta-analysis  
Systematic review  
Decision analysis  
Cost-effectiveness analysis
- Class R: Consensus statement  
Consensus report  
Narrative review
- Class X: Medical opinion

Citations are listed in the guideline utilizing the format of (*Author, YYYY [report class]*). A full explanation of ICSI's Evidence Grading System can be found at <http://www.icsi.org>.

# Algorithm Annotations

## 1. Patient Presents with Symptoms of Asthma

### Definition of Asthma

Asthma is a chronic inflammatory disorder of the airways. It is characterized by:

- Airway inflammatory cells, including eosinophils, macrophages, mast cells, epithelial cells and activated lymphocytes that release various cytokines, adhesion molecules and other mediators.
- Inflammation resulting in an acute, subacute or chronic process that alters airway tone, modulates vascular permeability, activates neurons, increases secretion of mucus, and alters airway structure reversibly or permanently.
- Airway hyperresponsiveness in response to allergens, environmental irritants, viral infections and exercise.
- Airflow obstruction caused by acute bronchial constriction, edema, mucus plugs and frequently, permanent remodeling.

### Symptoms

- Wheezing
- Breathlessness
- Cough, productive or dry
- Chest discomfort

### Pattern of symptoms

- Perennial/seasonal
- Episodic/continual
- Diurnal

### Severity of symptom classification

- Number of symptom episodes per week
- Number of nocturnal symptoms per month
- Objective measures of lung function (forced expiratory volume in one second [FEV<sub>1</sub>], peak expiratory flow rate [PEFR], PEF variability)

### Symptoms of Asthma

Symptoms suggestive of asthma include episodic wheezing and cough with nocturnal, seasonal or exertional characteristics. Infants and children with frequent episodes of "bronchitis" are likely to have asthma. Atopic and positive family histories for asthma, particularly when associated with previously mentioned symptoms, should encourage one to consider a diagnosis of asthma.

Eliciting symptoms should emphasize characterizing the current classification scheme that describes frequency per week, changes in physical activity, diurnal variation, and seasonal variation. It is important to recognize that patients with asthma are heterogeneous, falling into every age group, from infancy to older age, and

presenting a spectrum of signs and symptoms that vary in degree and severity from patient to patient, as well as within an individual patient over time (*National Heart, Lung, Blood Institute EPR-3, 2007 [R]*).

## **2. Previous Diagnosis of Asthma?**

At each evaluation, it is important to consider whether or not a previous diagnosis was correct.

- History and physical consistent with diagnosis.
- Response to therapy consistent with symptoms.

## **3. Establish Diagnosis of Asthma and Determine Level of Severity**

### **Key Points:**

- The diagnosis of asthma is based on the patient's medical history, physical examination, pulmonary function tests and laboratory test results.
- Spirometry is recommended for the diagnosis of asthma.
- The level of asthma severity is determined by both impairment and risk.

### **Asthma triggers**

- Viral respiratory infections
- Environmental allergens
- Exercise, temperature, humidity
- Occupational and recreational allergens or irritants
- Environmental irritants (perfume, tobacco smoke, wood-burning stoves)
- Drugs (aspirin, non-steroidal anti-inflammatory drugs [NSAIDs], beta-blocker) and food (sulfites)

### **Other historical components**

- Emergency department visits and hospitalization
- Medication use (especially oral steroids)
- Lung function, PEFr variability
- Associated comorbidities, e.g., rhinitis, sinusitis, gastroesophageal reflux (GERD)

### **Clinical testing**

- Accurate spirometry is recommended in every patient five years of age or older at the time of diagnosis.
- Additional studies done, tailored to the specific patient.
  - Allergy testing (e.g., skin testing, blood testing, in vitro-specific IgE antibody testing)
  - Chest radiography, to exclude alternative diagnosis
  - Bronchial provocation testing if spirometry is normal or near normal
  - Sinus x-rays or CT scan

## Algorithm Annotations

- GERD evaluation
- CBC with eosinophils, total IgE, sputum exam

Spirometry is the cornerstone of the laboratory evaluation that enables the clinician to demonstrate airflow obstruction and establish a diagnosis of asthma with certainty. Spirometry is essential for assessing the severity of asthma in order to make appropriate therapeutic recommendations. The use of objective measures of lung function is recommended because patient-reported symptoms often do not correlate with the variability and severity of airflow obstruction. Testing should be performed in compliance with the American Thoracic Society standards. Obstructive and restrictive ventilatory defects can generally be determined using forced expiratory volume in one second ( $FEV_1$ )/forced vital capacity (FVC) ratio (*American Thoracic Society, 1991 [R]*).

Spirometry is generally valuable in children five years of age or older; however, some children cannot conduct the maneuver, depending on developmental ability. Spirometry measurements ( $FEV_1$ , FVC,  $FEV_1/FVC$ ) before and after the patient inhales a short-acting bronchodilator should be undertaken for patients in whom the diagnosis of asthma is being considered. Airflow obstruction is indicated by reduced  $FEV_1$  and  $FEV_1/FVC$  values relative to reference or predicted values. Significant reversibility is indicated by an increase of 12 percent or greater and 200 mL in  $FEV_1$ , after inhaling a short-acting bronchodilator.

Investigation into the role of allergy, at least with a complete history, should be done in every patient, given high prevalence of positive skin tests among individuals with asthma and the benefits of limiting exposure to known allergens. History may help to distinguish seasonal allergies but may be inadequate for periennial allergies. Eosinophil count and IgE may be elevated in asthma; however, neither test has sufficient specificity or sensitivity to be used alone in a diagnosis. The chest x-ray and electrocardiogram are usually normal in asthma but may be useful to exclude other pulmonary or cardiac conditions. Sputum examination may be helpful if sputum eosinophilia or infection are suspected.

There are several clinical scenarios in children that have a frequent association with asthma and should strongly suggest asthma as a possible diagnosis. These include recurrent pulmonary infiltrates (especially right middle lobe infiltrates) with volume loss that clear radiologically within two to three days, and the diagnosis of pneumonia without fever. Asthma may cause some radiologic uncertainty since mucus plugging and atelectasis may be interpreted as infiltrates.

Diagnostic spirometry and a methacholine challenge test, if necessary, are important to clinching the diagnosis. The patient's history and response to therapy should guide other diagnostic tests when considering alternative diagnoses. Follow-up spirometry every one to two years in mild asthmatics will reconfirm the diagnosis and objectify serial change and level of control. More frequent monitoring should be considered for the moderate and severe persistent categories.

See Table 1, "Classifying Asthma Severity in Children 5-11 Years."

See Table 2, "Classifying Asthma Severity in Youths and Adults."

### **Differential Diagnostic Possibilities for Asthma**

#### **Upper airway disease**

- Allergic rhinitis and sinusitis (*Corren, 1992 [A]; Rachelefsky, 1984 [D]*)

#### **Obstruction involving large airways**

- Foreign body in trachea or bronchus
- Vocal cord dysfunction
- Vascular rings or laryngeal webs

**Algorithm Annotations**

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- Laryngotracheomalacia, tracheal stenosis or bronchostenosis
- Enlarged lymph nodes or tumor (benign or malignant)
- Bronchiectasis of various causes, including cystic fibrosis

**Obstruction of small airways**

- Viral bronchiolitis or obliterative bronchiolitis
- Cystic fibrosis
- Bronchopulmonary dysplasia
- Pulmonary infiltrates with eosinophilia
- Chronic obstructive pulmonary disease (chronic bronchitis or emphysema)

**Other causes**

- Pulmonary embolism
- Congestive heart failure
- Cough secondary to drugs (angio-tension-converting enzyme [ACE] inhibitors)
- Aspiration from swallowing mechanism dysfunction or gastroesophageal reflux
- Recurrent cough not due to asthma

Table 1. Classifying Asthma Severity in Children 5-11 Years

- **Classifying severity in children who are not currently taking long-term control medication.**

Components of Severity		Classification of Asthma Severity (Children 5–11 years of age)			
		Intermittent	Persistent		
			Mild	Moderate	Severe
Impairment	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 beta <sub>2</sub> -agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week but not daily	Daily	Several times per day
	Interference with normal activity	None	Minor limitation	Some limitation	Extremely limited
	Lung function	<ul style="list-style-type: none"> <li>• Normal FEV<sub>1</sub> between exacerbations</li> <li>• FEV<sub>1</sub> &gt;80% predicted</li> <li>• FEV<sub>1</sub>/FVC &gt;85%</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> = &gt;80% predicted</li> <li>• FEV<sub>1</sub>/FVC &gt;80%</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> = 60–80% predicted</li> <li>• FEV<sub>1</sub>/FVC = 75–80%</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> &lt;60% predicted</li> <li>• FEV<sub>1</sub>/FVC &lt;75%</li> </ul>
Risk	Exacerbations requiring oral systemic corticosteroids	0–1/year (see note)	≥2 in 1 year (see note) →		
		← 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 <sub>1</sub>			

- Level of severity is determined by both impairment and risk. Assess impairment domain by patient's/caregiver's recall of the previous 2–4 weeks and spirometry. Assign severity to the most severe category in which any feature occurs.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma severity. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate greater underlying disease severity. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

Source: National Heart, Lung, Blood Institute EPR-3, 2007. See figure 3-4c, pg. 74 for classifying severity in patients after asthma becomes well controlled.

Table 2. Classifying Asthma Severity in Youths and Adults

- **Classifying severity for patients who are not currently taking long-term control medications.**

Components of Severity		Classification of Asthma Severity (Youths ≥12 years of age and adults)			
		Intermittent	Persistent		
Impairment	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 beta <sub>2</sub> -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	<ul style="list-style-type: none"> <li>• Normal FEV<sub>1</sub> between exacerbations</li> <li>• FEV<sub>1</sub> &gt;80% predicted</li> <li>• FEV<sub>1</sub>/FVC normal</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> ≥80% predicted</li> <li>• FEV<sub>1</sub>/FVC normal</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> &gt;60% but &lt;80% predicted</li> <li>• FEV<sub>1</sub>/FVC reduced 5%</li> </ul>	<ul style="list-style-type: none"> <li>• FEV<sub>1</sub> &lt;60% predicted</li> <li>• FEV<sub>1</sub>/FVC reduced &gt;5%</li> </ul>
Risk	Exacerbations requiring oral systemic corticosteroids	0–1/year (see note)	≥2/year (see note) →		
		← 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 <sub>1</sub>			

- Level of severity is determined by assessment of both impairment and risk. Assess impairment domain by patient's/caregiver's recall of previous 2–4 weeks and spirometry. Assign severity to the most severe category in which any feature occurs.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma severity. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate greater underlying disease severity. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

Source: National Heart, Lung, Blood Institute EPR-3, 2007. See figure 3-4c, pg. 74 for classifying severity in patients after asthma becomes well controlled.

#### 4. Acute Asthma Exacerbation?

Symptoms of an acute asthma episode include progressive breathlessness, cough, wheezing or chest tightness. An acute asthma episode is characterized by a decrease in expiratory airflow that can be documented and quantified by measurement of lung function (spirometry or peak expiratory flow rate [PEFR]). Indications for emergency care include:

- Peak flow less than 40% predicted normal
- Failure to respond to a beta<sub>2</sub>-agonist
- Severe wheezing or coughing
- Extreme anxiety due to breathlessness
- Gasping for air, sweaty, or cyanotic
- Rapid deterioration over a few hours
- Severe retractions and nasal flaring
- Hunched forward

## **5. Assess Severity of Asthma Exacerbation**

### **Key Points:**

- Severity should be promptly assessed using objective measures of lung function.
- Patients experiencing an acute asthma exacerbation need a focused history and physical examination and measurement of airflow.

Patients presenting with an acute exacerbation of their asthma should receive prompt evaluation to assess the severity of their symptoms. Treatment should begin as rapidly as possible even while still assessing severity.

Assessment of asthma severity should include history, physical examination, an objective measure of lung function, either FEV<sub>1</sub> or PEF<sub>R</sub>, oxygen saturation and other tests as indicated.

### **History**

- Symptoms consistent with asthma
- Severity of symptoms, limitations and sleep disturbance
- Duration of symptoms
- Current medical treatment plan
- Adherence to medical treatment plan
- Rescue medication use:
  - Recent use of short-acting beta<sub>2</sub>-agonists
  - Number of bursts of oral steroids in past year
- Review Asthma Action Plan and daily charting of peak flows
- Previous emergency department (ED) visits or hospitalization
- Record triggers:
  - Upper respiratory infection (URI)
  - Bronchitis, pneumonia, sinusitis
  - Exposure to allergens or irritants
  - Assessment of tobacco use and/or second-hand exposure
  - Exercise
  - GERD

Clinicians treating asthma exacerbations should be familiar with the characteristics of patients at risk for life-threatening deterioration.

See Table 3, "Risk Factors for Death from Asthma."

**Table 3. Risk Factors for Death from Asthma**

Past history of sudden severe exacerbations
Prior intubation for asthma
Prior admission for asthma to an intensive care unit
Three or more emergency care visits for asthma in the past year
Hospitalization or an emergency care visit for asthma within the past month
Use of more than two canisters per month of inhaled short-acting beta <sub>2</sub> -agonist
Current use of systemic corticosteroids or recent withdrawal from systemic corticosteroids
Difficulty perceiving airflow obstruction or its severity
Serious psychiatric disease or psychosocial problems
Low socioeconomic status and urban residence
Illicit drug use
Sensitivity to alternaria

*(National Heart, Lung, Blood Institute EPR-3, 2007 [R])*

### **Lung Function**

- Spirometry (FEV<sub>1</sub>) – preferred, FEV<sub>1</sub>/FVC
- or
- Peak expiratory flow rate (PEFR)
- Pulse oximetry

### **Physical Exam**

- Vital signs: Temperature, blood pressure, pulse rate, respiratory rate, pulsus paradoxus
- Alertness
- Ability to talk
- Use of accessory muscles
- Auscultation of chest
- Color

### **Laboratory Studies**

Treatment with bronchodilators should not be delayed for laboratory studies. Tests which may be useful include:

- Arterial blood gases (ABG's)
- Chest x-ray (CXR)
- Complete blood count (CBC)
- Electrocardiogram (EKG)
- Electrolytes
- Theophylline level (if appropriate)

**Table 4. Assessment of Severity should be based on the following table.**

<b>Classifying Severity of Asthma Exacerbations</b>				
	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>	<b>Respiratory Arrest Imminent</b>
<b>Symptoms</b>				
Breathlessness	While walking Can lie down	While at rest Prefers sitting	While at rest Sits upright	
Talks in	Sentences	Phrases	Words	
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
<b>Signs</b>				
Respiratory rate	Increased	Increased	Often > 30/min.	
Use of accessory muscles; suprasternal retractions	Usually not	Commonly	Usually	Paradoxical thoracoabdominal movement
Wheeze	Moderate, often only end expiratory	Loud; throughout exhalation	Usually loud; throughout inhalation and exhalation	Absence of wheeze
Pulse/minute	< 100	100-120	> 120 > 110 5-8 years old	Bradycardia
Pulsus paradoxus	Absent < 10 mmHg	May be present 10-25 mmHg	Often present > 25 mmHg (adult) 20-40 mmHg (child)	Absence suggests respiratory muscle fatigue
<b>Functional Assessment</b>				
FEV <sub>1</sub> or PEF % predicted or % personal best	> 70%	Approx. 40%-69% or response lasts < 2 hours	< 40% predicted or personal best	< 25% Note: PEF may not be needed in very severe attacks
PaO <sub>2</sub> (on air)  and/or PCO <sub>2</sub>	Normal (test not usually necessary)  < 42 mmHg (test not usually necessary)	> 60 mmHg (test not usually necessary)  < 42 mmHg (test not usually necessary)	< 60 mmHg: possible cyanosis  ≥ 42 mmHg: possible respiratory failure	
SaO <sub>2</sub> % (on air) at sea level	> 95% (test not usually necessary)  Hypercapnia (hypoventilation) develops more readily in young children than in adults and adolescents.	90%-95% (test not usually necessary)	< 90	
<p>Note:</p> <ul style="list-style-type: none"> <li>• The presence of several parameters, but not necessarily all, indicates the general classification of the exacerbation.</li> <li>• Many of these parameters have not been systematically studied, so they serve only as general guides.</li> </ul>				

Adapted from: National Heart, Lung, Blood Institute EPR-3, 2007

## 8. Management of Asthma Exacerbation

### Key Points:

- Treatment is begun with inhaled short-acting beta<sub>2</sub>-agonists administered by meter dose inhaler (MDI)/spacer or nebulizer.
- Further intensification of therapy is based on severity, response and prior history, but typically includes a short course of oral corticosteroids.

(McFadden, 2003 [R])

### Treatment

Usual initial treatment is with short-acting beta<sub>2</sub>-agonist (albuterol) administered by nebulizer or MDI/spacer.

### Alternatives:

Epinephrine: (1:1,000)

Adult: 0.3-0.5 mg subcutaneous or IM every 20 minutes up to three doses

Pediatrics: 0.01 mg/kg up to 0.3-0.5 mg subcutaneous or IM every 20 minutes up to three doses

Ipratropium added to nebulized beta<sub>2</sub>-agonist (albuterol)

- Nebulized dose for adults and those over 12 years of age is 0.5 mg every 4 hours. Not FDA approved for any indication in those under 12 years of age.
- Ipratropium is not currently FDA approved for use in asthma.

Levalbuterol

- Dose for adolescents 12 years of age and over and adults is 0.63 mg (via nebulizer) three times daily (every six to eight hours); may increase to 1.25 mg via neb three times daily (every six to eight hours) if patient does not exhibit adequate response.
- Dose for children 6-11 years of age is 0.31 mg (via nebulizer) three times daily. Routine dosing should not exceed 0.63 mg three times daily.

Corticosteroids

- Strongly consider systemic corticosteroids in patients with acute asthma exacerbation. Corticosteroids aid symptom resolution and prevent asthma relapse (*Chapman, 1991 [A]; Fanta, 1983 [A]; Harris, 1987 [A]; Scarfone, 1993 [A]*).

Note: Do not use LABA monotherapy in acute asthma exacerbations. See <http://www.fda.gov/Drugs/DrugSafety/ucm187806.htm>.

- Initiate inhaled corticosteroids to prevent future exacerbations.

Antibiotics are not recommended for the treatment of acute asthma except for those patients with signs of acute bacterial infection, fever and purulent sputum.

## 9. Assess Response to Treatment

### Good response:

- PEF<sub>R</sub> or FEV<sub>1</sub> greater than or equal to 70% predicted normal
- No wheezing on auscultation

### Incomplete response:

- PEF<sub>R</sub> or FEV<sub>1</sub> 40%-69% predicted normal
- Mild wheezing
- Consider hospitalization, particularly for high-risk patients (see chart in annotation #4)

### Poor response:

- PEF<sub>R</sub> or FEV<sub>1</sub> less than 40% predicted
- No improvement in respiratory distress
- Strongly consider hospitalization

## 10. Does Patient Need ED or Inpatient Asthma Management?

Studies suggest that most children who require hospitalization can be identified by a repeat assessment one hour after initial treatment (*Kelly, 2004 [D]; Wilson, 2003 [D]*). After one hour, those children who continue to meet the criteria for a severe exacerbation have greater than 86% chance of requiring hospitalization; those who meet the criteria for moderate exacerbation at one hour have an 84% chance of requiring hospitalization; and those whose assessment has remained the same or dropped to the mild level have only an 18% chance of requiring hospitalization. These severity assessment studies highlight the importance of regular, multifaceted assessments and close observation of children and adolescents who present to the office or ED with acute asthma exacerbations (*National Heart, Lung, Blood Institute EPR-3, 2007 [R]*).

## 11. Evaluation

### Key Points:

Evaluation of asthma should include the following:

- Medical history
- Use of a validated asthma questionnaire
- Assess asthma triggers/allergens
- Physical examination
- Measure lung function
- Consider specialty consultation

### Medical History

- Disruption of usual activities (work, school, home)
- Sleep disturbance
- Level of usage of short-acting beta<sub>2</sub>-agonist

**Algorithm Annotations**

- Adherence to medical treatment plan
- Interval exacerbation of symptoms (either treated by self or a health care provider)
- Symptoms suggesting comorbid conditions or alternative diagnosis
- Side effects of medications

Reassessment of medical history can elicit factors that effect overall asthma control and sense of well-being (*Juniper, 1993 [D]*). The key symptoms that should alert the clinician include disruptive daytime symptoms and disturbances of sleep, and symptoms early in the morning that do not improve fifteen minutes after using short-acting beta<sub>2</sub>-agonist. The quantity of short-acting beta<sub>2</sub>-agonist that is being used should be discussed since overuse can be a marker of the potentially fatality-prone asthmatic (*Spitzer, 1992 [C]*). The use of a quality-of-life tool or questionnaire can assist to elicit history (*Juniper, 1992 [D]*).

**Use of a Validated Questionnaire**

The self-assessment questionnaires that can be completed at office visits are intended to capture the patient's and family's impression of asthma control, self-management skills and overall satisfaction with care. Several multidimensional instruments have been developed for assessment and monitoring of asthma. (<http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm>)

(*Skinner, 2004 [D]*; *Yawn, 2008 [C]*)

**Assess Asthma Triggers/Allergens**

- Inquire about exposure to triggers and allergens (e.g., occupational, pets, smoke).
- Allergy testing is recommended for patients with persistent asthma who are exposed to perennial indoor allergens.

<b>Comparison of Skin Tests with In Vitro Tests</b>	
<b>Advantages of Skin Tests</b>	<b>Advantages of In Vitro Tests</b>
<ul style="list-style-type: none"> <li>• Less expensive than in vitro tests</li> <li>• Results are available within one hour</li> <li>• Equally sensitive as in vitro tests</li> <li>• Results are visible to the patient. This may encourage compliance with environmental control measures</li> </ul>	<ul style="list-style-type: none"> <li>• Do not require knowledge of skin testing technique</li> <li>• Do not require availability of allergen extracts</li> <li>• Can be performed on patients who are taking medications that suppress the immediate skin test (antihistamines, antidepressants)</li> <li>• No risk of systemic reactions</li> <li>• Can be done for patients who have extensive eczema</li> </ul>

Source: National Heart, Lung, Blood Institute EPR-3, 2007

Studies of emergency department visits and near death show allergens as a factor in asthma exacerbation. Asthma triggers in the workplace also need to be considered. About 15% of asthma in adults is work related (*Blanc, 1987 [C]*; *Malo, 1992 [C]*; *O'Hollaren, 1991 [D]*; *Pollart, 1988 [C]*).

**Physical Examination**

- Assess signs associated with asthma, concurrent illness or medication side effects
- Height in children
- Head, eyes, ears, nose, throat, lungs, heart, skin

## Algorithm Annotations

It is important to discuss any potential medication side effects as this often has a direct relationship to compliance. Common side effects from inhaled steroids include oral candidiasis and dysphonia. Beta<sub>2</sub>-agonists may cause tachycardia, tremor or nervousness. Individuals on long-term oral corticosteroids or frequent bursts of steroids need to be monitored for complications of corticosteroids use such as osteoporosis, hypertension, diabetes and Cushing's syndrome.

The height of individuals on corticosteroids should be monitored over time. The potential effect on linear growth in children is important because these drugs tend to be used over long periods of time. Cumulative data in children suggest that low-to-medium doses of inhaled corticosteroids may have the potential of decreasing growth velocity, but this effect is not sustained in subsequent years of treatment, is not progressive and may be reversible (*Childhood Asthma Management Program Research Group, The, 2000 [A]; National Heart, Lung, Blood Institute EPR-3, 2007 [R]*).

Inhaled glucocorticoids used to treat asthma have been shown to have deleterious effects on bone mineral density and markers of bone mineral metabolism. The risk of fracture attributable to inhaled or nasal glucocorticoids is uncertain (*Lung Health Study Research Group, The, 2000 [A]*).

The remainder of the physical exam either supports or refutes conditions and comorbidities discussed above (see history).

### Measure Lung Function

It is important to measure lung function at each visit. The two main methods are spirometry and peak expiratory flow rate (PEFR). Spirometry is more precise and yields more information than PEFR. It is helpful to verify the accuracy of the peak flow meter. It is useful when certain physical limitations affect accuracy of PEFR (example: very young or elderly, neuromuscular or orthopedic problems) (*Enright, 1994 [R]; Miles, 1995 [R]*).

#### Spirometry is recommended:

- for initial diagnosis or to reassess or confirm diagnosis;
- after treatment is initiated or changed, and once symptoms and PEFR have stabilized, to document attainment of "near normal pulmonary function"; and
- at least every one to two years to assess maintenance of airway function – more often as severity indicates.

Regular monitoring of pulmonary function is particularly important for asthma patients who do not perceive their symptoms until obstruction is severe (*Connolly, 1992 [C]; Kikuchi, 1994 [C]*).

#### PEFR

- Used for follow-up, not for diagnosis

PEFR provides a simple, quantitative and reproducible measure of severity of airflow obstruction. The results are more reliable if the same type of meter, and preferably the patient's own, is used.

During interval assessment, the clinician should question the patient and review records to evaluate the frequency, severity and causes of exacerbation. Triggers that may contribute should be reviewed. All patients on chronic maintenance medication should be questioned about exposure to inhalant allergens.

### **Consider Specialty Consultation**

Referral is recommended for consultation or care to a specialist in asthma care (allergist or pulmonologist, or other physicians who have expertise in asthma management, developed through additional training and experience) (*Zieger, 1991 [C]*) when:

- Patient has had a life-threatening asthma exacerbation.
- Patient is not meeting the goals of asthma therapy after three to six months of treatment. An earlier referral or consultation is appropriate if the physician concludes that the patient is unresponsive to therapy.
- Signs and symptoms are atypical, or there are problems in differential diagnosis.
- Other conditions complicate asthma or its diagnosis (e.g., sinusitis, nasal polyps, aspergillosis, severe rhinitis, VCD, GERD, chronic obstructive pulmonary disease [COPD]).
- Additional diagnostic testing is indicated (e.g., allergy skin testing, rhinoscopy, complete pulmonary function studies, provocative challenge, bronchoscopy).
- Patient requires additional education and guidance on complications of therapy, problems with adherence, or allergen avoidance.
- Patient is being considered for immunotherapy.
- Patient requires step 4 care or higher. Consider referral if patient requires step 3 care.
- Patient has required more than two bursts of oral corticosteroids in one year or has an exacerbation requiring hospitalization.
- Patient requires confirmation of a history that suggests that an occupational or environmental inhalant or ingested substance is provoking or contributing to asthma. Depending on the complexities of diagnosis, treatment or the intervention required in the work environment, it may be appropriate in some cases for the specialist to manage the patient over a period of time or to co-manage with the PCP.

## **12. Determine Level of Asthma Control**

### **Key Points:**

- The level of control is based on the most severe impairment or risk category.
- The level of asthma control (well controlled, not well controlled, or poorly controlled) is the degree to which both dimensions of the manifestations of asthma – impairment and risk – are minimized by therapeutic intervention.
- The level of control at the time of follow-up assessment will determine clinical actions – that is, whether to maintain or adjust therapy.

See Table 5, "Assessing Asthma Control in Children 5-11 Years of Age," and Table 6, "Assessing Asthma Control in Youths 12 Years of Age through Adults."

Table 5. Assessing Asthma Control in Children 5-11 Years of Age

Components of Control		Classification of Asthma Control (Children 5–11 years of age)		
		Well Controlled	Not Well Controlled	Very Poorly Controlled
<b>Impairment</b>	Symptoms	≤2 days/week but not more than once on each day	>2 days/week or multiple times on ≤2 days/week	Throughout the day
	Nighttime awakenings	≤1x/month	≥2x/month	≥2x/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting beta <sub>2</sub> -agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	Lung function ▪ FEV <sub>1</sub> or peak flow ▪ FEV <sub>1</sub> /FVC	>80% predicted/ personal best >80%	60–80% predicted/ personal best 75–80%	<60% predicted/ personal best <75%
<b>Risk</b>	Exacerbations requiring oral systemic corticosteroids	0–1/year	≥2/year (see note)	
	Reduction in lung growth	Evaluation requires long-term followup.		
	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.		

Key: EIB, exercise-induced bronchospasm; FEV<sub>1</sub>, forced expiratory volume in 1 second; FVC, forced vital capacity; ICU, intensive care unit

**Notes:**

- The level of control is based on the most severe impairment or risk category. Assess impairment domain by patient's/caregiver's recall of previous 2–4 weeks and by spirometry/or peak flow measures. Symptom assessment for longer periods should reflect a global assessment, such as inquiring whether the patient's asthma is better or worse since the last visit.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate poorer disease control. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have not-well-controlled asthma, even in the absence of impairment levels consistent with not-well-controlled asthma.

Source: National Heart, Lung, Blood Institute EPR-3, 2007

Table 6. Assessing Asthma Control in Youths 12 Years of Age Through Adults

Components of Control		Classification of Asthma Control (Youths ≥12 years of age and adults)		
		Well-Controlled	Not Well-Controlled	Very Poorly Controlled
Impairment	Symptoms	≤2 days/week	>2 days/week	Throughout the day
	Nighttime awakening	≤2x/month	1–3x/week	≥4x/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting beta <sub>2</sub> -agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	FEV <sub>1</sub> or peak flow	>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	0–1/year	≥2/year (see note) Consider severity and interval since last exacerbation	
	Progressive loss of lung function	Evaluation requires long-term followup care		
	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.		

\*ACQ values of 0.76–1.4 are indeterminate regarding well-controlled asthma.

Key: EIB, exercise-induced bronchospasm; FEV<sub>1</sub>, forced expiratory volume in 1 second.

Notes:

- The level of control is based on the most severe impairment or risk category. Assess impairment domain by patient’s recall of previous 2–4 weeks and by spirometry/or peak flow measures. Symptom assessment for longer periods should reflect a global assessment, such as inquiring whether the patient’s asthma is better or worse since the last visit.
- At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense exacerbations (e.g., requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate poorer disease control. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have not-well-controlled asthma, even in the absence of impairment levels consistent with not-well-controlled asthma.

Source: National Heart, Lung, Blood Institute EPR-3, 2007

### 13. Step Care of Pharmacologic Treatment

The aim of asthma therapy is to maintain control of asthma with the least amount of medication and hence minimize the risk for adverse effects. The stepwise approach to therapy – in which the dose and number of medications and frequency of administration are increased as necessary and decreased when possible – is used to achieve this control. Since asthma is a chronic inflammatory disorder of the airways with recurrent exacerbations, therapy for persistent asthma emphasizes efforts to suppress inflammation over the long-term and prevent exacerbations. See the following tables for Management Approach for Asthma.

Based on data comparing leukotriene receptor antagonists (LTRAs) to inhaled corticosteroids, inhaled corticosteroids are the preferred treatment option for mild persistent asthma in adults and children. LTRAs are an alternative, although not preferred, treatment.

*(Bleecker, 2000 [A]; Ducharme, 2002 [M]; National Heart, Lung, Blood Institute EPR-3, 2007 [R]; Szeftler, 2005 [A])*

#### **Vaccinations**

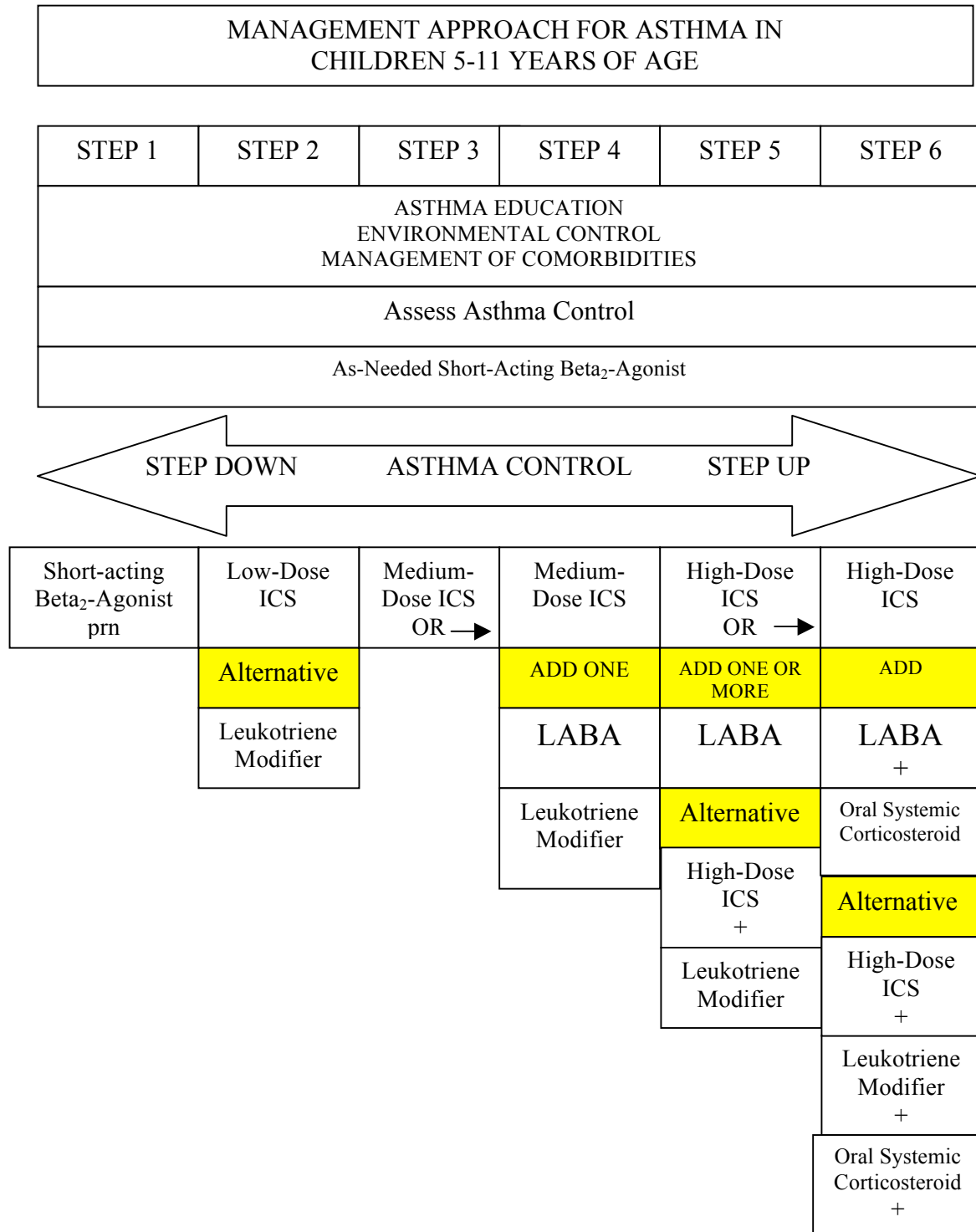
NOTE: Annual influenza vaccinations are recommended for patients with persistent asthma (*National Heart, Lung, Blood Institute, 1997 [R]*). Asthma is an independent risk factor for invasive pneumococcal disease. (*Talbot, 2005 [B]*). The Advisory Committee on Immunization Practices (ACIP) recommends that persons aged 19 through 64 years who have asthma should receive a single dose of PPSV23. (<http://www.cdc.gov/vaccines/recs/provisional/downloads/pneumo-oct-2008-508.pdf>)

See Appendix B, "Usual Dosages for Quick-Relief Medications."

See Table 7, "Management Approach for Asthma in Children 5-11 Years of Age" and Table 8, "Management Approach for Asthma 12 Years of Age and Older."

Algorithm Annotations

Table 7.



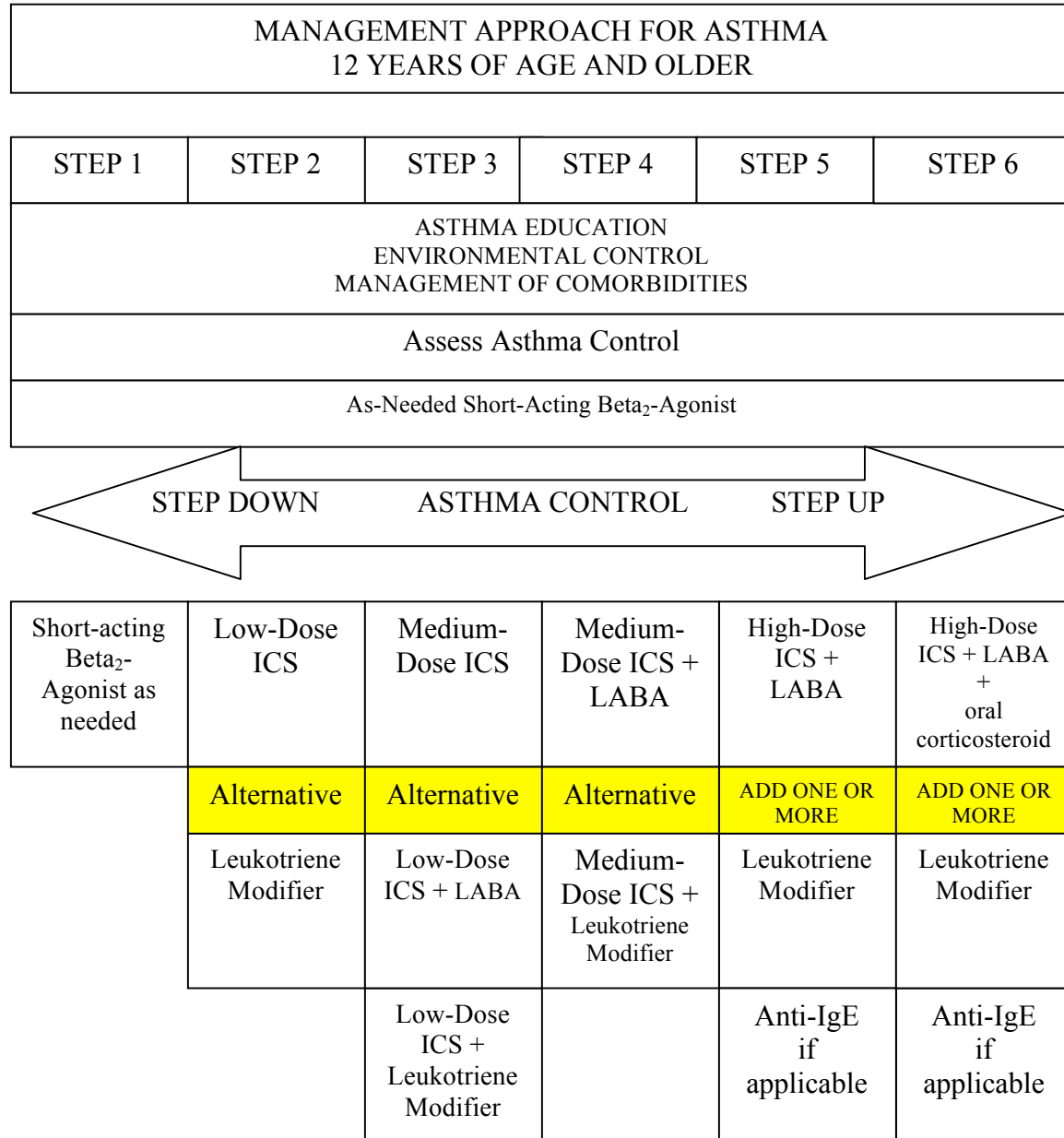
Adapted from: Global Initiative for Asthma, 2006; National Heart, Lung, Blood Institute EPR-3, 2007.

ICS = Inhaled corticosteroids

LABA = Long-acting beta<sub>2</sub>-agonist

Algorithm Annotations

Table 8.



Adapted from: Global Initiative for Asthma, 2006; National Heart, Lung, Blood Institute EPR-3, 2007.

ICS = Inhaled corticosteroids

LABA = Long-acting beta<sub>2</sub>-agonist

## **14. Asthma Education**

### **Key Points:**

- Asthma self-management education is essential to provide patients with the skills necessary to control asthma and improve outcomes.
- Asthma self-management education should be integrated into all aspects of asthma care, and it requires repetition and reinforcement.

### **Asthma self-management should include:**

- Begin at the time of diagnosis and continue through follow-up care.
- Involve all members of the health care team.
- Introduce the key educational messages by the principal clinician, and negotiate agreements about the goals of treatment, specific medications, and the actions patients will take to reach the agreed-upon goals to control asthma.
- Reinforce and expand key messages (e.g., the patient's level of asthma control, inhaler techniques, self-monitoring, use of a written asthma action plan) by all members of the health care team.
- Occur at all points of care where health professionals interact with patients who have asthma, including clinics, medical offices, emergency departments and hospitals, pharmacies, homes and community sites (e.g., schools, community centers).

Regular review, by an informed clinician, of the status of the patient's asthma control is an essential part of asthma self-management education. Teach and reinforce at **every** opportunity.

- Basic facts about asthma
  - The contrast between asthmatic and normal airways
  - What happens to the airways in an asthma attack
  - What defines well-controlled asthma and the patient's current level of control
- How medications work
  - Long-term control: medications that prevent symptoms, often by reducing inflammation
  - Quick relief: short-acting bronchodilator relaxes muscles around airways
  - Stress the importance of long-term control medications and not to expect quick relief from them
- Inhaler technique (patient should repeat demonstration)
  - Metered-dose inhaler (MDI) or nebulizer use
  - Spacer/valved holding chamber use with MDI
  - Dry powder inhaler
- Environmental control measures
  - Identifying and avoiding exposure to allergens or other environmental triggers
- Written asthma action plan

## Algorithm Annotations

This guideline recommends the use of written action plans as part of an overall effort to educate patients in self-management and is especially beneficial for patients with moderate or severe persistent asthma and patients with a history of severe exacerbations.

All asthma patients should be given a written asthma action plan that includes two aspects: daily management, and how to recognize and handle worsening asthma. Written action plans are particularly recommended for patients who have moderate or severe persistent asthma, a history of severe exacerbations, or poorly controlled asthma. Review and refine the plan at follow-up visits.

- When and how to take actions
  - Symptom self-monitoring and recognizing early signs of deterioration
  - When and how to handle signs and symptoms of worsening asthma
  - When and where to seek care
  - Discuss plan for children at school, including management of exercise-induced bronchospasm.
- Emphasize need for regular follow-up visits and asthma treatment adherence

Supervised self-management (using patient education and adjustments of anti-inflammatory medication based on PEFR or symptoms coupled with regular medical review, utilization and adherence to medication) reduces asthma morbidity. This reduction includes lost workdays, unscheduled office visits, and ED and hospital admissions (*Gibson, 2000 [M]; Ignatio-Garcia, 1995 [A]; Lahdensuo, 1996 [A]*).

### **Encourage adherence by:**

- choosing a treatment regimen that achieves outcomes and addresses preferences that are important to the patient/caregiver, and
- reviewing the success of the treatment plan with the patient/caregiver at each visit and making adjustments as needed.

Tailor the asthma self-management teaching approach to the needs of each patient.

- Maintain sensitivity to cultural beliefs and ethnocultural practices.
- Consider language and health literacy.

### **Develop an active partnership with the patient and family by:**

- establishing open communications,
- identifying and addressing patient and family concerns about asthma and asthma treatment,
- identifying patient/parent/child treatment preferences regarding treatment and barriers to its implementation,
- developing treatment goals together with patient and family, and
- encouraging active self-assessment and self-management of asthma.

Sample Asthma Action Plans are attached in Appendix E, "Example of Asthma Action Plan."

See Minnesota Department of Health Action Plan at <http://www.mnasthma.org/AAP/>

## 15. Schedule Regular Follow-Up Visits

Asthma is a chronic inflammatory lung disease, and all chronic diseases need regular follow-up visits. Practitioners need to assess whether or not control of asthma has been maintained and if a step down in therapy is appropriate. Further, practitioners need to monitor and review the daily self-management and action plans, the medications, and the patient's inhaler and peak flow monitoring techniques.

Regularly scheduled follow-up visits are essential to ensure that control is maintained and the appropriate step down in therapy is considered. The exact frequency of visits is a matter of clinical judgment. If asthma is uncontrolled or a change in medication or clinical status has occurred, the patient should be followed in two to six weeks for an evaluation. A stable asthma patient should be followed at regular intervals of one to six months.

## Emergency Department or Inpatient Management Algorithm Annotations

### 18. Assess Severity of Asthma Exacerbation

See Annotation #5.

### 21. Initial Treatment

Also see Annotation #8, "Management of Asthma Exacerbation."

Usual treatment is with short-acting beta<sub>2</sub>-agonist by metered-dose inhaler or nebulizer:

Albuterol HFA (90 micrograms per puff) 4-8 puffs

Albuterol solution 2.5 to 5 mg by nebulizer

Levalbuterol 1.25-2.5 mg by nebulizer

### 25. Treatment (Incomplete Response)

#### Key Points:

- Systemic corticosteroids should be used for all patients who do not favorably respond to the initial beta<sub>2</sub>-agonist therapy.
- Anticholinergic therapy may increase lung function and may decrease hospital admission rate.

#### Corticosteroids

Parenteral and enteral administration of corticosteroids requires about 6-24 hours to be effective. Intravenous (IV) and oral routes of corticosteroid administration appear to be equivalent (*Barnett, 1997 [A]; Becker, 1999 [A]; Cunningham, 2005 [A]; Engel, 1990 [A]; Harrison, 1986 [A]; Jonsson, 1988 [A]; Ratto, 1988 [A]*). Medium to high doses of corticosteroids appear to be better than low doses; however, there is still a large range, roughly 160 mg methylprednisolone per day or 2 mg/kg/day in children. There is no evidence to support very high doses of steroids (*Bowler, 1992 [A]; Rodrigo, 1999 [M]*). The National Asthma Education and Prevention Program guidelines recommend that patients admitted to the hospital should receive IV or oral steroids (*National Heart, Lung, Blood Institute EPR-3, 2007 [R]*).

## Algorithm Annotations

There may be a role for inhaled high-dose corticosteroids in the emergency department in addition to the IV or oral route; however, the data do not support this as standard of care at this time (*Edmonds, 2002 [M]; Edmonds, 2003 [M]; Rodrigo, 2005 [A]*).

In adult asthmatic cases where intolerance or non-compliance with oral steroid therapy is a concern, consider the use of intramuscular (IM) methylpredisone (*Lahn, 2004 [A]*).

### **Anticholinergics**

Inhaled ipratropium bromide: adding multiple high doses of ipratropium bromide (0.5 mg nebulizer solution or 8 puffs by MDI in adults; 0.25-0.5 mg nebulizer solution or 4-8 puffs by MDI in children) to a selective short-acting beta<sub>2</sub>-agonist produces additional bronchodilation, resulting in fewer hospital admissions, particularly in patients who have severe airflow obstruction (*Plotnick, 2000 [M]; Rodrigo, 2005 [A]*).

## **27. Treatment (Poor Response)**

See Appendix A, "Dosages of Drugs for Asthma Exacerbations in the Emergency Medical Care or Hospital."

### **Key Points:**

- Early intervention with Bi-level positive airway pressure may prevent mechanical intubations.
- Heliox may be a secondary therapy in asthma patients who do not respond to first-line therapies.
- Ketamine should be considered for use only in severe asthma exacerbations.
- Magnesium sulfate may be beneficial in the treatment of acute asthma.
- Reassess patients shortly after inpatient admission.

### **Intermittent Nebulization Versus Continuous Nebulization**

Intermittent nebulization versus continuous nebulization in the treatment of acute asthma has been evaluated quite extensively. The data would suggest that these treatments are equally efficacious; however, there may be a trend toward improvement in patients with severe asthma using continuous nebulization. In a subgroup analysis of patients whose initial FEV<sub>1</sub> was less than 50% predicted, there was a statistically significant improvement in FEV<sub>1</sub> in patients treated with continuous nebulization versus intermittent nebulization (*Lin, 1993 [A]*). Similarly, in another subgroup analysis of patients whose initial PEF<sub>R</sub> was less than 200, there was a statistically significant improvement in PEF<sub>R</sub> and a decrease in hospital admissions in patients treated with continuous versus intermittent nebulization (*Rudnitsky, 1993 [A]*). However, in another subgroup of patients whose FEV<sub>1</sub> was less than 50% predicted, there was no difference in improvement in FEV<sub>1</sub> or hospital admissions in patients treated with continuous versus intermittent nebulization (*Besbes-Quanes, 2000 [A]*).

A meta-analysis suggests equivalence of continuous versus intermittent albuterol in treating asthma. This is determined by spirometry measurement and rates of admission to the hospital (*Rodrigo, 2002 [M]*). There does not seem to be any advantage of higher doses of albuterol for continuous nebulization. There was no difference in lung function in patients treated with 7.5 mg or 15 mg of albuterol (*Stein, 2003 [A]*). Utilizing albuterol and ipratropium bromide continuously versus albuterol alone demonstrated a trend toward improvement in reducing the length of stay in the emergency department and in hospital admission rates (*Weber, 1999 [A]*).

### **Bi-level Positive Airway Pressure (Bi-Level PAP)**

Bi-level PAP therapy should be considered for patients presenting with an acute asthma exacerbation. Accumulating studies have shown a benefit in using Bi-level PAP for patients presenting with non-cardiogenic respiratory failure. These studies included, but were not limited to, patients with asthma exacerbations.

A study (*Soroksky, 2003 [A]*) compared Bi-level PAP ventilation plus conventional therapy versus conventional therapy in patients presenting with an acute asthma exacerbation. Patients in the Bi-level PAP group showed a statistically significant improvement in lung function (measured by FEV<sub>1</sub>), improved faster, and were less likely to require admission to the hospital and mechanical intubations.

### **Heliox**

Heliox, a blend of helium and oxygen, is a low-density gas that has been shown in some studies to improve deposition of albuterol into distal airways when compared with nebulized albuterol with oxygen alone. To date, only small-sized randomized controlled trials have been performed. At best, these studies showed mild improvement in spirometry measures and perceived dyspnea scores in patients receiving heliox-driven albuterol nebulization versus patients receiving albuterol nebulization with oxygen alone. These improved measures were more prominent in patients with moderate to severe asthma exacerbations.

There is not enough evidence from large, prospective, randomized controlled trials to recommend heliox as first-line therapy in patients with asthma exacerbations. However, it is recommended that heliox be considered (*Ho, 2003 [M]; Rodrigo, 2003 [M]*) as a secondary therapy in patients with a severe asthma exacerbation who are not responding to first-line therapies.

### **Ketamine**

Ketamine and propofol are anesthetic agents with neuro-regulatory properties resulting in bronchodilation. The use of ketamine has shown benefit in improving airway parameters (*Petrello, 2001 [D]*), but increased side effects have resulted in longer hospitalizations (*Lau, 2001 [M]*). Increased side effects of increased secretions, dysphoria and hallucinations are noted. Clinical data suggests that in the non-intubated patient that the side effects may cancel benefit. Some reported case reports suggest benefit in intubated patients (*Lau, 2001 [M]*). Well-controlled studies are required to make a clear strong recommendation for use. Use of ketamine has been pursued only in severe asthmatic exacerbations.

### **Magnesium Sulfate**

In vitro, magnesium acts as a smooth muscle dilator and may have some anti-inflammatory effects by decreasing super-oxide production in neutrophils. Its efficacy has not been consistently demonstrated in randomized control trials. It has not been demonstrated to cause any harmful effects. In a recent multi-center trial, IV magnesium sulfate improved pulmonary function only in patients with severe asthma, (FEV<sub>1</sub> less than 25%). It did not shorten length of hospital stay (*Silverman, 2002 [A]*). In a systematic review, magnesium sulfate did not demonstrate improvement in PEF, or in hospital length of stay. However, in a subset of patients with severe asthma exacerbations, PEF, FEV<sub>1</sub> and length of stay were improved (*Rowe, 2000 [M]*). There is insufficient evidence to support the routine use of IV magnesium in the emergency department setting (*Cheuk, 2005 [M]; Kaye, 2002 [R]*). However since it is safe and inexpensive, it should be considered for use in patients with severe asthma exacerbations.

### **Leukotriene Modifiers**

The evaluation of leukotrienes for acute asthma care is in its infancy. Pulmonary function has been shown to improve more rapidly when a leukotriene administered orally is added to the standard therapy of asthma care (beta<sub>2</sub>-agonists/corticosteroids) in emergency department settings (*Emerman, 2001 [R]; Silverman, 1999 [A]*). More studies are needed to confirm these reports.

## Algorithm Annotations

Montelukast in acute asthma management has been shown to improve pulmonary function in randomized controlled trials (*Camargo, 2003 [A]; Cylly, 2003 [A]*). However, statistical significance could not always be maintained.

The evidence is too preliminary to recommend leukotriene modifiers in acute asthma exacerbations.

## 29. Admit to Hospital?

Also see Annotation #10, "Does Patient Need ED or Inpatient Asthma Management?"

The decision when to discharge from the emergency department (ED) or admit to the hospital must be individualized and depends on response to treatment, pulmonary function and socioeconomic factors. It is important to consider risk factors for asthma-related death (*National Heart, Lung, Blood Institute EPR-3, 2007 [R]*). Actual length of stay in the ED will vary; some departments have the ability for more extended treatment and observation, provided there is sufficient monitoring and nursing care.

Response to initial treatment in the ED can be based on a repeat assessment approximately 60-90 minutes after initiating bronchodilator therapy, which is a better predictor of the need for hospitalization than is the severity of an exacerbation on presentation (*Rodrigo, 1993 [C]*). Evaluation includes the patient's subjective response, physical findings, O<sub>2</sub> saturation and measurement of airflow. Other aspects to consider include duration and severity of symptoms, course and severity of prior exacerbations, medications used at the time of the exacerbation, access to medical care and medications, adequacy of support and home conditions, and presence of psychiatric illness. Pretreatment O<sub>2</sub> saturation less than or equal to 70%, persisting respiratory acidosis, or severe obstruction that does not improve with the administration of sympathomimetics indicates the need for hospitalization (*Higgins, 2003 [R]*).

Discharge is appropriate if FEV<sub>1</sub> or PEFr has returned to greater than or equal to 70% personal best or predicted, and symptoms are minimal or absent. Patients with an incomplete response (FEV<sub>1</sub> or PEFr 40%-69%), and with mild symptoms should be assessed individually and may be appropriate for discharge with consideration of the above factors. It is recommended that patients with a rapid good response be observed for 30-60 minutes after the most recent dose of bronchodilator to ensure stability of response before being discharged home.

## 30. Continue Management in Hospital

Patients being admitted from the ED with an acute asthma exacerbation should be reassessed shortly after admission, with special emphasis on whether the patient is showing any clinical signs of improvement or deterioration (see Annotation #5, "Assess Severity of Asthma Exacerbation"). Objective data should include repeating of the patient's FEV<sub>1</sub> or PEFr. A complete physical exam should include emphasis on the patient's respiratory rate, air entry on lung exam, and the presence/absence of signs of increased work of breathing, such as supraclavicular or intercostal retractions.

Consider other illnesses and comorbidities. These may also cause dyspnea, chest tightness and wheezing.

- Viral pneumonitis
- Pneumothorax
- Pulmonary embolism
- Vocal cord dysfunction syndrome
- COPD
- Pulmonary edema
- Endobronchial obstruction (tumor or foreign body)

**Algorithm Annotations**

- Acute hypersensitivity pneumonitis
- Epiglottitis

(*ten Brinke, 2005 [D]*)

## 32. Discharge Home

### Key Points:

- At discharge, provide patients with necessary medications and education in how to use them, instruction in self-assessment, an action plan for managing recurrence of airflow obstruction, and a follow-up appointment.

It is recommended that follow-up with an asthma care provider occur within one week of discharge.

### Medications

See Table 9, "Hospital Discharge Checklist for Patients with Asthma Exacerbations."

- Inhaled beta<sub>2</sub>-agonist every two to six hours.
- Systemic corticosteroids are almost always the treatment of choice in patients with acute asthma exacerbation. Corticosteroids aid symptom resolution and prevent asthma relapse.
- Initiate or increase anti-inflammatory medication:
  - Inhaled corticosteroids
    - The role of inhaled corticosteroids after an emergency department visit is controversial (*Edmonds, 2003 [M]; Rowe, 1999 [A]*). However, it is the consensus of this group that inhaled corticosteroids should be encouraged at the time of discharge.
  - Consider leukotriene modifiers as an additive therapy.
- Antibiotics are not routinely used but may be warranted if patient has signs of acute bacterial infection, fever and purulent sputum.
- Long-acting beta<sub>2</sub>-agonists as monotherapy are NOT recommended.

See Annotation #14 for asthma education and action plan.

See Annotation #15 for follow-up care.

**Table 9. Hospital Discharge Checklist for Patients with Asthma Exacerbations**

<b>Intervention</b>	<b>Dose/Timing</b>	<b>Education/Advice</b>
Inhaled medications (MDI + spacer/holding chamber)	Select agent, dose and frequency (e.g., albuterol)	Teach purpose. Teach technique.
Beta <sub>2</sub> -agonist	2-6 puffs every 3-4 hours as needed	Emphasize need for spacer/holding chamber.
Corticosteroids	Medium dose	Check patient technique.
Oral medications	Select agent, dose and frequency (e.g., prednisone 20 mg twice daily for 3-10 days)	Teach purpose. Teach side effects.
Peak flow meter	Measure a.m. and p.m. PEF and record best of three tries each time	Teach purpose. Teach technique. Distribute peak flow diary.
Follow-up visit	Make appointment for follow-up care with primary clinician or asthma specialist	Advise patient (or caregiver) of date, time and location of appointment within 7 days of hospital discharge.
Action plan	Before or at discharge	Instruct patient (or caregiver) on simple plan for actions to be taken when symptoms, signs and PEF values suggest recurrent airflow obstruction.

Source: National Heart, Lung, Blood Institute EPR-2, 1997

## Special Populations

### Asthma in pregnancy

The treatment plan of asthma management in pregnancy should include reducing medication toxicity, teratogenicity and preserving uteroplacenta circulation. Changes in the mother's asthma status are expected in almost half of patients, with half of these expecting a worsening of asthma status, particularly if previous pregnancies had similar outcomes. Typical changes of pregnancy – those of increased heart rate, respiratory rate and decreases in baseline CO<sub>2</sub> levels – can lead to underdiagnosing asthma severity if not recognized (*Sakornbut, 2003 [R]*).

The treatment of acute asthma in pregnancy follows the guidelines for acute asthma care, keeping in mind the goals of the management and changes in physiology.

Albuterol is the preferred short-acting beta<sub>2</sub>-agonist and has not been linked to adverse fetal outcomes in follow-up studies. Inhaled corticosteroids (ICS) are the preferred treatment for long-term control medication. Budesonide is the preferred ICS because more data are available on using budesonide in pregnant women than are available on other ICSs, and the data are reassuring (*NAEPP, 2005 [R]*; *National Heart, Lung, Blood Institute EPR-3, 2007 [R]*). Systemic steroids, if used in the first trimester, may, though rarely, increase the frequency of cleft palate and possibly be associated with development of preeclampsia and prematurity. However, the risk to both mother and fetus of an unmanaged severe asthmatic attack overshadows the medication observed risks (*Schatz, 2009 [R]*).

## Appendix A – Dosages of Drugs for Asthma Exacerbations in Emergency Medical Care or Hospital

Medication	Dosages		
	Adult Dose	Child Dose*	Comments
<b>Short-Acting Inhaled Beta<sub>2</sub>-Agonists</b>			
<b>Albuterol</b>			
Nebulizer solution (5.0 mg/mL, 2.5 mg/3 mL, 1.25 mg/3 mL, 0.63 mg/3 mL)	2.5-5 mg every 20 minutes for 3 doses, then 2.5-10 mg every 1-4 hours as needed, or 10-15 mg/hour continuously	0.15 mg/kg (minimum dose 2.5 mg) every 20 minutes for 3 doses, then 0.15-0.3 mg/kg up to 10 mg every 1-4 hours as needed, or 0.5 mg/kg/hour by continuous nebulization	Only selective beta <sub>2</sub> -agonists are recommended. For optimal delivery, dilute aerosols to minimum of 3 mL at gas flow of 6-8 L/min. May mix with ipratropium nebulizer solution.
MDI (90 mcg/puff)	4-8 puffs every 20 minutes up to 4 hours, then every 1-4 hours as needed	4-8 puffs every 20 minutes for 3 doses, then every 1-4 hours inhalation maneuver. Use spacer/holding chamber	As effective as nebulized therapy if patient is able to coordinate.
<b>Bitolterol</b>			
Nebulizer solution (2 mg/mL)	See albuterol dose	See albuterol dose; thought to be half as potent as albuterol on a mg basis	Has not been studied in severe asthma exacerbations. Do not mix with other drugs.
MDI (370 mcg/puff)	See albuterol dose	See albuterol dose	Has not been studied in severe asthma exacerbations.
<b>Levalbuterol (R-albuterol)</b>			
Nebulizer solution (0.63 mg/3 mL, 1.25 mg/3 mL)	1.25-2.5 mg every 20 minutes for 3 doses, then 1.25-5 mg every 1-4 hours as needed, or 5-7.5 mg/hour continuously	0.075 mg/kg (minimum dose 1.25 mg) every 20 minutes for 3 doses, then 0.075-0.15 mg/kg up to 5 mg every 1-4 hours as needed, or 0.25 mg/kg/hour by continuous nebulization	0.63 mg of levalbuterol is equivalent to 1.25 mg of racemic albuterol for both efficacy and side effects.
<b>Pirbuterol</b>			
MDI (200 mcg/puff)	See albuterol dose	See albuterol dose; thought to be half as potent as albuterol on a mg basis	Has not been studied in severe asthma exacerbations.
<b>Systemic (Injected) Beta<sub>2</sub>-Agonists</b>			
Epinephrine 1:1,000 (1 mg/mL)	0.3-0.5 mg every 20 minutes for 3 doses subcutaneous	0.01 mg/kg up to 0.3-0.5 mg every 20 minutes for 3 doses subcutaneous	No proven advantage of systemic therapy over aerosol.
Terbutaline (1 mg/mL)	0.25 mg every 20 minutes for 3 doses subcutaneous	0.01 mg/kg every 20 minutes for 3 doses then every 2-6 hours as needed subcutaneous	No proven advantage of systemic therapy over aerosol.

\* Children younger than 12 years of age.

Adapted from National Heart, Lung, Blood Institute EPR-3, 2007

**Continued**

Medication	Dosages		
	Adult Dose	Child Dose*	Comments
<b>Anticholinergics</b>			
<b>Ipratropium bromide</b>			
Nebulizer solution (0.25 mg/mL)	0.5 mg every 30 minutes for 3 doses then every 2-4 hours as needed	0.25 mg every 20 minutes for 3 doses, then every 2 to 4 hours	May mix in same nebulizer with albuterol. Should not be used as first-line therapy; should be added to beta <sub>2</sub> -agonist therapy.
MDI (18 mcg/puff)	8 puffs every 20 minutes as needed up to 3 hours	4-8 puffs every 20 minutes as needed up to 3 hours	Dose delivered from MDI has been studied but its efficacy is inconclusive.
<b>Ipratropium with albuterol</b>			
Nebulizer solution (Each 3 mL vial contains 0.5 mg ipratropium bromide and 2.5 mg albuterol)	3 mL every 30 minutes for 3 doses, then every 2-4 hours as needed	1.5 mL every 20 minutes for 3 doses, then every 2-4 hours	May be used up to 3 hours in the initial management of severe exacerbation.
MDI (Each puff contains 18 mcg ipratropium bromide and 90 mcg of albuterol)	8 puffs every 20 minutes as needed up to 3 hours	4-8 puffs every 20 minutes as needed up to 3 hours	
<b>Systemic Corticosteroids</b>			
	Initiate dosing at: <i>(Dosages and comments apply to all three corticosteroids)</i>		
Prednisone	120-180 mg/day in 3 or 4 divided doses for 48 hours, then 60-80 mg/day until PEF reaches 80% of predicted or personal best	1 mg/kg every 6 hours for 48 hours then 1-2 mg/kg/day (maximum = 60 mg/day) in 2 divided doses until PEF 80% of predicted or personal best	For outpatient “burst” use 40-60 mg in single or 2 divided doses for adults for a total of 5-10 days. Children: 1-2 mg/kg/day, maximum 60 mg/day for 3-10 days.
Methylprednisolone			
Prednisolone			

\* Children younger than 12 years of age

**Note**

No advantage has been found for higher dose corticosteroids in severe asthma exacerbations, nor is there any advantage for intravenous administration over oral therapy, provided gastrointestinal transit time or absorption is not impaired. The usual regimen is to continue the frequent multiple daily dose until the patient achieves an FEV<sub>1</sub> or PEF of 50 percent of predicted or personal best and then lower the dose to twice daily. This usually occurs within 48 hours. Therapy following a hospitalization or emergency department visit may last from 3 to 10 days. If patients are then started on inhaled corticosteroids, studies indicate there is no need to taper the systemic corticosteroid dose. If the follow-up systemic corticosteroid therapy is to be given once daily, one study indicates that it may be more clinically effective to give the dose in the afternoon at 3 p.m., with no increase in adrenal suppression.

National Heart, Lung, Blood Institute EPR-3, 2007

## Appendix B – Usual Dosages for Quick-Relief Medications

Medication	Dosage Form	Adult Dose	Child Dose	Comments
<b>Inhaled Short-Acting Beta<sub>2</sub>-Agonists (SABAs)</b>				
<i>MDIs</i>				
Albuterol	90 mcg/puff, 200 puffs/canister	• 2 puffs 5-30 minutes prior to exercise	• 1-2 puffs 5 minutes prior to exercise	<ul style="list-style-type: none"> <li>• An increasing use or lack of expected effect indicates diminished control of asthma.</li> <li>• Not recommended for long-term daily treatment. Unscheduled use exceeding 2 days/week indicates the need for additional long-term controller therapy.</li> <li>• Differences in potency exist so that all products are essentially equal in efficacy on a per-puff basis.</li> <li>• May double usual dose for mild exacerbations.</li> <li>• Non-selective agents (e.g., epinephrine, isoproterenol, metaproterenol) are not recommended due to their potential for excessive cardiac stimulation, especially in high doses.</li> <li>• Spacer/holding chambers are recommended with MDI.</li> </ul>
Albuterol HFA	90 mcg/puff, 200 puffs/canister	<ul style="list-style-type: none"> <li>• 2 puffs every 4-6 hours as needed</li> </ul>	• Safety and efficacy not established	
Pirbuterol	200 mcg/puff, 400 puffs/canister		<ul style="list-style-type: none"> <li>• 2 puffs every 4-6 hours as needed</li> </ul>	
Levalbuterol	45 mcg/puff, 200 puffs/canister			
<i>DPI</i>				
Albuterol	<i>Nebulizer solution</i> 5 mg/mL (0.5%) <i>Premixed Vials</i> 2.5 mg/3 mL (0.088%) 1.25 mg/3mL (0.042%) 0.63 mg/3 mL and 1.25 mg/3 mL	1.25-5 mg (.25-1 cc) in 3 cc of saline every 4-8 hours as needed	1.25-5 mg, in 3 cc of saline every 4-8 hours as needed	<ul style="list-style-type: none"> <li>• May mix with cromolyn or ipratropium nebulizer solutions, or budesonide inhalant suspension. May double dose for severe exacerbations.</li> <li>• Compatible with budesonide inhalant suspension 3 times daily</li> </ul>
Levalbuterol nebulization		12 yrs and older is 0.63 mg to 1.25 mg every 8 hours as needed	6-11 years is 0.31 mg to 0.63 mg every 8 hours as needed	
<b>Anticholinergics</b>				
<i>MDIs</i>				
Ipratropium HFA	17 mcg/puff, 200 puffs/canister	2-3 puffs every 6 hours 0.25 mg every 6 hours	Safety and efficacy not established	<ul style="list-style-type: none"> <li>• Evidence is lacking for anticholinergics producing added benefit to beta<sub>2</sub>-agonists in long-term control asthma therapy.</li> </ul>
	<i>Nebulizer/solution</i> .25 mg/mL (0.025%)			
<b>Systemic Corticosteroids</b>				
			(Applies to all three systemic corticosteroids)	
Methylprednisolone	2, 4, 8, 16, 32 mg tablets	<ul style="list-style-type: none"> <li>• Short course "burst": 40-60 mg/day as single or 2 divided doses for 3-10 days</li> </ul>	<ul style="list-style-type: none"> <li>• Short course "burst": 40-60 mg/day as single or 2 divided doses for 3-10 days</li> </ul>	<ul style="list-style-type: none"> <li>• Short courses or "bursts" are effective for establishing control when initiating therapy or during a period of gradual deterioration.</li> <li>• The burst should be continued until patient achieves 70% PEF personal best or symptoms resolve. This usually requires 3-10 days but may require longer. There is no evidence that tapering the dose following improvement prevents relapse if sufficient doses of inhaled corticosteroids are used simultaneously.</li> </ul>
Prednisolone	5 mg tabs, 5 mg/5 cc, 15 mg/5 cc			
Prednisone	1, 2.5, 5, 10, 20, 50 mg tabs; 5 mg/cc; 5 mg/5 cc			

National Heart, Lung, Blood Institute EPR-3, 2007

## Appendix C – Usual Dosages for Long-Term Medications

Medication	Dosage Form	Adult Dose	Child Dose*	Comments
Inhaled Corticosteroids ( <i>See Estimated Comparative Daily Dosages for Inhaled Corticosteroids.</i> )				
Systemic Corticosteroids				
<i>(Applies to all three corticosteroids)</i>				
<b>Methylprednisolone</b>	2, 4, 8, 16, 32 mg tablets	7.5-60 mg daily in a single dose in a.m. or every other day as needed for control	0.25-2 mg/kg daily in single dose in a.m. or every other day as needed for control	<ul style="list-style-type: none"> <li>For long-term treatment of severe persistent asthma, administer single dose in a.m. either daily or on alternate days (alternate-day therapy may produce less adrenal suppression).</li> <li>Short courses or “bursts” are effective for establishing control when initiating therapy or during a period of gradual deterioration.</li> <li>The burst should be continued until patient achieves 70% PEF personal best or symptoms resolve. This usually requires 3-10 days but may require longer. There is no evidence that tapering the dose following improvement prevents relapse.</li> </ul>
<b>Prednisolone</b>	5 mg tablets, 5 mg/5 cc, 15 mg/5 cc	Short-course “burst” to achieve control 40-60 mg per day as single or 2 divided doses for 3-10 days	Short-course “burst”: 1-2 mg/kg/day, maximum 60 mg/day for 3-10 days	
<b>Prednisone</b>	1, 2.5, 5, 10, 20, 50 mg tablets; 5 mg/cc, 5 mg/5 cc			
Inhaled Long-Acting Beta <sub>2</sub> -Agonists (LABA)				
<b>Salmeterol</b>	DPI 50 mcg/blister	1 blister every 12 hours	1 blister every 12 hours	<ul style="list-style-type: none"> <li>Should not be used for symptom relief or exacerbations. Use with corticosteroids.</li> <li>Each capsule is for single use only; additional doses should not be administered for at least 12 hours.</li> <li>Capsules should be used only with the Aerolizer™ inhaler. Avoid swallowing the capsule.</li> </ul>
<b>Formoterol</b>	DPI 12 mcg/single-use capsule	1 capsule every 12 hours	1 capsule every 12 hours	

Continued

Medication	Dosage Form	Adult Dose	Child Dose*	Comments
<b>Combined Medication</b>				
<b>Fluticasone/ Salmeterol</b>	DPI 100 mcg/50 mcg, 250 mcg/50 mcg or 500 mcg/50 mcg	1 inhalation twice daily; dose depends on severity of asthma	1 inhalation twice daily; dose depends on severity of asthma	<ul style="list-style-type: none"> <li>• Low dose combination therapy for patient not controlled on low- to medium-dose inhaled corticosteroids.</li> <li>• Medium dose combination therapy for patients not controlled on medium-to-high dose inhaled corticosteroids.</li> </ul>
	HFA MDI 45 mcg/21 mcg 115 mcg/21 mcg 230 mcg/21 mcg	2 puffs twice daily; dose depends on severity of asthma	NA	
<b>Budesonide/ Formoterol</b>	HFA MDI 80 mcg/4.5 mcg 160 mcg/4.5 mcg	2 puffs twice daily	2 puffs twice daily; currently approved for use in youths ≥ 12 years of age	<ul style="list-style-type: none"> <li>• 80/4.5 for patients who have asthma not controlled on low- to medium-dose ICS</li> <li>• 160/4.5 for patients who have asthma not controlled on medium- to high-dose ICS</li> </ul>
<b>Cromolyn</b>	MDI 0.8 mg/puff Nebulizer 20/mg ampule	2 puffs 3 times a day 1 ampule 3 times a day	1-2 puffs 3-4 times a day 1 ampule 3 times a day	<ul style="list-style-type: none"> <li>• One dose prior to exercise or allergen exposure provides effective prophylaxis for 1-2 hours.</li> </ul>
<b>Nedocromil</b>	MDI 1.75 mg/puff	2 puffs 3 times a day	1 puff 3 times a day	<ul style="list-style-type: none"> <li>• Once control is achieved, the frequency of dosing may be reduced.</li> </ul>
<b>Leukotriene Receptor Antagonists (LTRAs)</b>				
<b>Montelukast</b>	4 mg or 5 mg chewable tablet 10 mg tablet	10 mg per day	<ul style="list-style-type: none"> <li>• 5 mg per day (6-14 years of age)</li> <li>• 10 mg per day (more than 14 years of age)</li> </ul>	<ul style="list-style-type: none"> <li>• Montelukast exhibits a flat dose-response curve.</li> <li>• Monitor for signs and symptoms of hepatic dysfunction.</li> <li>• For zafirlukast, administration with meals decreases bioavailability; take at least 1 hour before or 2 hours after meals.</li> </ul>
<b>Zafirlukast</b>	10 or 20 mg tablet	40 mg daily (20 mg tablet twice daily)	<ul style="list-style-type: none"> <li>• 20 mg daily (7-11 years of age)</li> </ul>	
<b>Zileuton</b>	600 mg tablet	2,400 mg daily (give tablets 4 times a day)	NA	
<b>Methylxanthines</b>				
<b>Theophylline</b>	Liquids, sustained-release tablets, and capsules	Starting dose 10 mg/kg/day up to 300 mg max; usual max 800 mg/day	Starting dose 10 mg/kg/day; usual max: 16 mg/kg/day	<ul style="list-style-type: none"> <li>• Adjust dosage to achieve serum concentration of 5-15 mcg/mL at steady-state (at least 48 hours on same dosage).</li> <li>• Due to wide interpatient variability in theophylline metabolic clearance, routine serum theophylline level monitoring is important.</li> </ul>
<b>Immunomodulators</b>				
<b>Omalizumab</b>	Subcutaneous injection, 150 mg/1.2 mL following reconstitution with 1.4 mL sterile water for injection	150-375 mg 2-4 weeks, depending on body weight and pretreatment serum IgE level		<ul style="list-style-type: none"> <li>• Do not administer more than 150 mg per injection site.</li> <li>• Monitor for anaphylaxis for 2 hours following at least the first 3 injections.</li> </ul>

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## Appendix D – Estimated Comparative Daily Dosages for Inhaled Corticosteroids

Drug	Low Daily Dose		Medium Daily Dose		High Daily Dose	
	Adult	Child*	Adult	Child*	Adult	Child*
<b>Beclomethasone HFA</b> 40 or 80 mcg/puff	80-240 mcg (1-6 puffs)	80-160 mcg (1-4 puffs)	240-480 mcg (3-12 puffs)	160-320 mcg (2-8 puffs)	> 480 mcg (> 6-12 puffs)	> 320 mcg (> 4-8 puffs)
<b>Budesonide DPI</b> 90, 180 mcg/ inhalation	180-600 mcg (1-3 inhalations)	200-400 mcg (1-2 inhalations)	600-1,200 mcg (3-6 inhalations)	400-800 mcg (2-4 inhalations)	> 1,200 mcg (> 6 inhalations)	> 800 mcg (> 4 puffs)
Inhalation suspension for nebulization (child dose)	NA	0.5 mg	NA	1.0 mg	NA	2.0 mg
<b>Ciclesonide**</b> MDI: 80, 160 mcg/puff inhalation	160 mcg (2 puffs)	NA	320 mcg (2 puffs)	NA	640 mcg (4 puffs)	NA
<b>Fluticasone HFA</b> MDI: 44, 110 or 220 mcg/puff DPI: 50, 100 or 250 mcg/inhalation	88-264 mcg (2-6 puffs)  100-300 mcg	88-176 mcg (2-4 puffs)  100-200 mcg	264-440 mcg (2-6 puffs)  300-500 mcg	176-352 mcg (2-10 puffs)  200-400 mcg	> 440 mcg (> 3-6 puffs)  > 500 mcg	> 352 mcg (2-4 puffs)  > 400 mcg
<b>Mometasone DPI</b> 110, 220 mcg/inhalation	220 mcg (2 inhalations)	110 mcg	440 mcg (2-4 inhalations)	110 mcg	880 mcg (4 inhalations)	110 mcg

\* Children 5-11 years of age

**NOTES:**

- The most important determinant of appropriate dosing is the clinician's judgment of the patient's response to therapy. The clinician must monitor the patient's response on several clinical parameters and adjust the dose accordingly. The stepwise approach to therapy emphasizes that once control of asthma is achieved, the dose of medication should be carefully titrated to the minimum dose required to maintain control, thus reducing the potential for adverse effect.
- Some dosages may be outside package labeling.

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# Appendix E – Example of Asthma Action Plan

## Asthma Action Plan

DATE: \_\_\_\_/\_\_\_\_/\_\_\_\_ PATIENT NAME \_\_\_\_\_  
 WEIGHT: \_\_\_\_\_ EMERGENCY CONTACT \_\_\_\_\_ PHONE \_\_\_\_\_  
 HEIGHT: \_\_\_\_\_ PRIMARY CARE PROVIDER/CLINIC NAME \_\_\_\_\_ PHONE \_\_\_\_\_  
 DOB: \_\_\_\_/\_\_\_\_/\_\_\_\_ WHAT TRIGGERS MY ASTHMA \_\_\_\_\_

**Baseline Severity**  
 \_\_\_\_\_

**Best Peak Flow**  
 \_\_\_\_\_

Always use a **holding chamber / spacer** with/without a mask with your inhaler. (circle choices)

GREEN ZONE	DOING WELL	GO!													
<p><b>You have ALL of these:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Breathing is good</li> <li><input checked="" type="checkbox"/> No cough or wheeze</li> <li><input checked="" type="checkbox"/> Can work/exercise easily</li> <li><input checked="" type="checkbox"/> Sleeping all night</li> </ul> <p><b>Peak Flow</b> is between:                  _____ and _____  <i>80-100% of personal best</i></p>	<p><b>Step 1:</b> Take these controller medicines <b>every day</b>:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">MEDICINE</th> <th style="width: 30%;">HOW MUCH</th> <th style="width: 40%;">WHEN</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table> <p><b>Step 2:</b> If exercise triggers your asthma, take the following medicine <b>15 minutes before</b> exercise or sports.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">MEDICINE</th> <th style="width: 70%;">HOW MUCH</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> </tr> </tbody> </table>		MEDICINE	HOW MUCH	WHEN	_____	_____	_____	_____	_____	_____	MEDICINE	HOW MUCH	_____	_____
MEDICINE	HOW MUCH	WHEN													
_____	_____	_____													
_____	_____	_____													
MEDICINE	HOW MUCH														
_____	_____														

YELLOW ZONE	GETTING WORSE	CAUTION
<p><b>You have ANY of these:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Difficulty breathing</li> <li><input type="checkbox"/> Coughing</li> <li><input type="checkbox"/> Wheezing</li> <li><input type="checkbox"/> Tightness in chest</li> <li><input type="checkbox"/> Difficult to work/exercise</li> <li><input type="checkbox"/> Wake at night coughing</li> </ul> <p><b>Peak Flow</b> is between:                  _____ and _____  <i>50-79% of personal best</i></p>	<p><b>Step 1:</b> Keep taking <b>GREEN ZONE</b> medicines and <b>ADD</b> quick-relief medicine:                  _____ puffs or 1 nebulizer treatment of _____  <i>Repeat after 20 minutes if needed (for a maximum of 2 treatments).</i></p> <p><b>Step 2:</b> Within 1 hour, if your symptoms aren't better or you don't return to the <b>GREEN ZONE</b>, take your <b>oral steroid</b> medicine _____ <b>and</b> call your health care provider today.</p> <p><b>Step 3:</b> If you are in the <b>YELLOW ZONE</b> more than 6 hours, or your symptoms are <b>getting worse</b>, follow <b>RED ZONE</b> instructions.</p>	

RED ZONE	EMERGENCY	GET HELP NOW!				
<p><b>You have ANY of these:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> It's very hard to breathe</li> <li><input type="checkbox"/> Nostrils open wide</li> <li><input type="checkbox"/> Medicine is not helping</li> <li><input type="checkbox"/> Trouble walking or talking</li> <li><input type="checkbox"/> Lips or fingernails are grey or bluish</li> </ul> <p><b>Peak Flow</b> is between:                  _____ and _____  <i>Below 50% of personal best</i></p>	<p><b>Step 1:</b> Take your quick-relief medicine <b>NOW</b>:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">MEDICINE</th> <th style="width: 70%;">HOW MUCH</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> </tr> </tbody> </table> <p>or 1 nebulizer treatment of _____</p> <p><b>AND</b></p> <p><b>Step 2:</b> Call your health care provider <b>NOW</b></p> <p><b>AND</b></p> <p>Go to the emergency room <b>OR CALL 911</b> immediately.</p>		MEDICINE	HOW MUCH	_____	_____
MEDICINE	HOW MUCH					
_____	_____					

DATE: \_\_\_\_/\_\_\_\_/\_\_\_\_ MD/NP/PA SIGNATURE \_\_\_\_\_  
 FOLLOW-UP APPOINTMENT IN \_\_\_\_\_ AT \_\_\_\_\_ PHONE \_\_\_\_\_

Permission to use granted from Minnesota Department of Health (2010).

Appendix E – Example of Asthma Action Plan

# Asthma Action Plan

DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ PATIENT NAME \_\_\_\_\_  
 WEIGHT: \_\_\_\_\_ PARENT/GUARDIAN NAME \_\_\_\_\_ PHONE \_\_\_\_\_  
 HEIGHT: \_\_\_\_\_ PRIMARY CARE PROVIDER/CLINIC NAME \_\_\_\_\_ PHONE \_\_\_\_\_  
 DOB: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ WHAT TRIGGERS MY ASTHMA \_\_\_\_\_

**Baseline Severity**

**Best Peak Flow**

Always use a **holding chamber/spacer with/without** a mask with your inhaler. (circle choices)

GREEN ZONE	DOING WELL	GO!																					
<p><b>You have ALL of these:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Breathing is good</li> <li><input type="checkbox"/> No cough or wheeze</li> <li><input type="checkbox"/> Can work/play easily</li> <li><input type="checkbox"/> Sleeping all night</li> </ul> <p><b>Peak Flow</b> is between:  <input type="text"/> and <input type="text"/>  <i>80-100% of personal best</i></p>	<p><b>Step 1:</b> Take these controller medicines <b>every day</b>:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">MEDICINE</th> <th style="width: 30%;">HOW MUCH</th> <th style="width: 20%;">WHEN</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table> <p><b>Step 2:</b> If exercise triggers your asthma, take the following medicine <b>15 minutes before</b> exercise or sports.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">MEDICINE</th> <th style="width: 30%;">HOW MUCH</th> <th style="width: 20%;">WHEN</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>	MEDICINE	HOW MUCH	WHEN										MEDICINE	HOW MUCH	WHEN							
MEDICINE	HOW MUCH	WHEN																					
MEDICINE	HOW MUCH	WHEN																					

YELLOW ZONE	GETTING WORSE	CAUTION
<p><b>You have ANY of these:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> It's hard to breathe</li> <li><input type="checkbox"/> Coughing</li> <li><input type="checkbox"/> Wheezing</li> <li><input type="checkbox"/> Tightness in chest</li> <li><input type="checkbox"/> Cannot work/play easily</li> <li><input type="checkbox"/> Wake at night coughing</li> </ul> <p><b>Peak Flow</b> is between:  <input type="text"/> and <input type="text"/>  <i>50-79% of personal best</i></p>	<p><b>Step 1:</b> Keep taking <b>GREEN ZONE</b> medicines and <b>ADD</b> quick-relief medicine:                  _____ puffs or 1 nebulizer treatment of _____  <i>Repeat after 20 minutes if needed (for a maximum of 2 treatments).</i></p> <p><b>Step 2:</b> Within 1 hour, if your symptoms aren't better or you don't return to the <b>GREEN ZONE</b>, take your <b>oral steroid</b> medicine _____ <b>and</b> call your health care provider today.</p> <p><b>Step 3:</b> If you are in the <b>YELLOW ZONE more than 6 hours</b>, or your symptoms are <b>getting worse</b>, follow <b>RED ZONE</b> instructions.</p>	

RED ZONE	EMERGENCY	GET HELP NOW!						
<p><b>You have ANY of these:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> It's very hard to breathe</li> <li><input type="checkbox"/> Nostrils open wide</li> <li><input type="checkbox"/> Ribs are showing</li> <li><input type="checkbox"/> Medicine is not helping</li> <li><input type="checkbox"/> Trouble walking or talking</li> <li><input type="checkbox"/> Lips or fingernails are grey or bluish</li> </ul> <p><b>Peak Flow</b> is between:  <input type="text"/> and <input type="text"/>  <i>Below 50% of personal best</i></p>	<p><b>Step 1:</b> Take your quick-relief medicine <b>NOW</b>:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">MEDICINE</th> <th style="width: 30%;">HOW MUCH</th> <th style="width: 20%;">WHEN</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>or 1 nebulizer treatment of _____</p> <p><b>AND</b></p> <p><b>Step 2:</b> Call your health care provider <b>NOW</b>  <b>AND</b>                  Go to the emergency room <b>OR CALL 911</b> immediately.</p>	MEDICINE	HOW MUCH	WHEN				
MEDICINE	HOW MUCH	WHEN						

\_\_\_\_\_ This Asthma Action Plan provides authorization for the administration of medicine described in the AAP.  
 \_\_\_\_\_ This child has the knowledge and skills to self-administer quick-relief medicine at school or daycare with approval of the school nurse.  
 DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ MD/NP/PA SIGNATURE \_\_\_\_\_

This consent may supplement the school or daycare's consent to give medicine and allows my child's medicine to be given at school/daycare.  
 My child (circle one) **may / may not** carry, self-administer and use quick-relief medicine at school with approval from the school nurse (if applicable).

DATE: \_\_\_\_ / \_\_\_\_ / \_\_\_\_ PARENT/ GUARDIAN SIGNATURE \_\_\_\_\_  
 FOLLOW-UP APPOINTMENT IN \_\_\_\_\_ AT \_\_\_\_\_ PHONE \_\_\_\_\_

Permission to use granted from Minnesota Department of Health (2010).

Appendix E – Example of Asthma Action Plan

HENNEPIN COUNTY MEDICAL CENTER  
LEVEL 1 TRAUMA CENTER  
Minneapolis, MN 55415

**ASTHMA ACTION PLAN**



N17150

Name \_\_\_\_\_

MR# \_\_\_\_\_

Birthdate \_\_\_\_\_  
(Addressograph / Label)

Primary Care Provider Name \_\_\_\_\_ Phone \_\_\_\_\_  
 Primary Care Clinic Name \_\_\_\_\_ Phone \_\_\_\_\_  
 No Primary Care Provider  Primary Care Provider Unknown

**ASTHMA SEVERITY (Check one):**  
 Mild Intermittent  Moderate Persistent  
 Mild Persistent  Severe Persistent

**GREEN ZONE**  
 "GO! All clear!"

Peak Flow Range: \_\_\_\_\_ to \_\_\_\_\_ (80-100% of personal best)

**YELLOW ZONE**  
 "Caution..."

Peak Flow Range: \_\_\_\_\_ to \_\_\_\_\_ (50-79% of personal best)

**RED ZONE**  
 "STOP! Medical Alert!"

Peak Flow Range: \_\_\_\_\_ to \_\_\_\_\_ (Below 50% of personal best)

This asthma action plan is good for one year beginning: \_\_\_\_\_ (Date) MD/NP/PA signature \_\_\_\_\_

I give my permission for this asthma action plan to be used by the following, and for them to share information with each other about my child's asthma for one year beginning today, so that they can work together to help my child manage her/his asthma. This plan, when signed and dated, may replace the school's consent to administer medication form, and allows my child's medicine to be given at school.

My child's school / School health office  
 My child's day care provider  
 Insurance case management / Education program  
 If verbal / telephone consent, signatures of persons taking consent / witnessing: Parent / guardian signature \_\_\_\_\_ Date \_\_\_\_\_

1) \_\_\_\_\_ 2) \_\_\_\_\_

When you are in the **GREEN ZONE**, take the following controller medicine(s) every day.

Controller medicines \_\_\_\_\_ How much to take \_\_\_\_\_ When to take it \_\_\_\_\_

Spacer used:  Optichamber;  with mask  without mask **OR**  Inspirase  
 Take this medicine as needed 10-20 minutes before sports or any other strenuous activity.

Medicine \_\_\_\_\_ How much to take \_\_\_\_\_ When to take it \_\_\_\_\_

Student may carry and use this medicine at school after approval by the School Nurse

When you are in the **YELLOW ZONE**, keep taking your **GREEN ZONE** controller medicine(s) every day and add the following reliever medicine(s) to help keep the asthma episode from getting worse.

Reliever medicine \_\_\_\_\_ How much to take \_\_\_\_\_ When to take it \_\_\_\_\_

If you are in the **YELLOW ZONE** for more than 12-24 hours, call your doctor.  
 If your breathing symptoms get worse, call your doctor.

Student may carry and use this medicine at school after approval by the School Nurse

When you are in the **RED ZONE**, start taking your **RED ZONE** medicine(s) and Call Your Doctor NOW!

• Take these medicines until you talk with your doctor.  
 • If your symptoms do not get better and you can't reach your doctor, go to the emergency room or call 911 immediately.

Reliever medicines \_\_\_\_\_ How much to take \_\_\_\_\_ When to take it \_\_\_\_\_

•Medicine is not helping  
 •Breathing is hard and fast  
 •Can't walk  
 •Ribs show  
 •Nose opens wide to breathe

Appendix E – Example of Asthma Action Plan

HENNEPIN COUNTY MEDICAL CENTER  
LEVEL 1 TRAUMA CENTER  
Minneapolis, MN 55415

PLAN DE ACCIÓN PARA EL ASMA



N17150

Nombre \_\_\_\_\_


MR# \_\_\_\_\_

Fecha de nacimiento \_\_\_\_\_  
(Addressograph / Label)

**SEVERIDAD DEL ASMA:**  
 Leve, intermitente  Moderada, persistente  
 Leve, persistente  Severa, persistente

Nombre del proveedor principal de servicios médicos \_\_\_\_\_ Teléfono: \_\_\_\_\_  
Nombre de la clínica principal de servicios médicos \_\_\_\_\_ Teléfono: \_\_\_\_\_  
 No existe proveedor principal de servicios médicos  Se desconoce el nombre del proveedor principal de servicios médicos

**ZONA VERDE**  
"¡Avance! ¡Todo está bien!"



Rango de flujo máximo:  
\_\_\_\_\_ a \_\_\_\_\_  
(80-100% del valor mayor)


Medicinas controladoras \_\_\_\_\_ Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_

Con espaciador:  Optichamber:  con máscara  sin máscara  *Inspirease*  
Tome esta medicina como sea necesario 10-20 minutos antes de hacer deporte u otra actividad exterior.

Medicina \_\_\_\_\_  
Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_

•Es fácil respirar  
•Puede jugar, trabajar y dormir sin síntomas de asma

**ZONA AMARILLA**  
"Precaución..."



Rango de flujo máximo:  
\_\_\_\_\_ a \_\_\_\_\_  
(50-79% del valor mayor)

Medicinas dilatadores \_\_\_\_\_ Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_


La ZONA AMARILLA significa que debe continuar tomando diariamente las medicinas controladoras indicadas para la Zona Verde. Incluya las siguientes medicinas dilatadores para evitar el empeoramiento de los episodios asmáticos:

Medicinas dilatadores \_\_\_\_\_ Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_

Si permanece en la ZONA AMARILLA por más de 12-24 horas, llame al médico.  
Si empeoran los síntomas respiratorios, llame al médico.

•Tos y sibilancia  Presión en el pecho  El alumno puede llevar esta medicina a la escuela y usarla allí después de se lo apruebe la enfermera.

**ZONA ROJA**  
"¡ALTO! ¡Alerta médica!"



Rango de flujo máximo:  
\_\_\_\_\_ a \_\_\_\_\_  
(Por debajo de 50% del valor mayor)

Medicinas dilatadores \_\_\_\_\_ Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_

La ZONA ROJA significa que debe tomar las medicinas para la Zona Roja y llamar a su médico ¡¡¡INMEDIATAMENTE!!!

- Tome estas medicinas mientras logra comunicarse con el médico.
- Si no mejoran los síntomas y no puede comunicarse con el médico, vaya a la Sala de Emergencias o llame inmediatamente al 911.

Medicinas dilatadores \_\_\_\_\_ Cantidad a tomar \_\_\_\_\_  
Cuándo tomarlas \_\_\_\_\_

•La medicina no está ayudando  
•La respiración es difícil y rápida  
•No puede caminar  
•No puede hablar bien  
•Se ven las costillas  
•Se abre bien la nariz para respirar

Este plan de acción para el asma es efectivo por un año a partir de: \_\_\_\_\_ (Fecha) \_\_\_\_\_ Firma de MD/NP/PA \_\_\_\_\_

Yo autorizo el uso de este plan de acción para el asma a las siguientes personas/instituciones con el fin de compartir información sobre el asma de mi niño/a durante un año, a partir de hoy, para que puedan trabajar juntos y ayudar a mi niño/a con el control de su asma. Este plan de acción, una vez firmado y fechado, puede reemplazar el formulario escolar que da consentimiento para suministrar medicina, y permite que se le de a mi niño/a su medicina en la escuela.

La escuela de mi niño/a / La enfermería de la escuela  
 Clínica / Hospital de mi niño/a  
 Proveedor de cuidado infantil \_\_\_\_\_  
 Manejo del caso de seguridad / Programa educativo \_\_\_\_\_  
 Enfermera visitante / Agencia de cuidado en el hogar \_\_\_\_\_

Si se autoriza verbal/telefónicamente, firma de la persona que recibe la autorización y testigo: \_\_\_\_\_ Firma del padre/madre/responsable \_\_\_\_\_

1) \_\_\_\_\_ 2) \_\_\_\_\_

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## **Brief Description of Evidence Grading**

Individual research reports are assigned a letter indicating the class of report based on design type: A, B, C, D, M, R, X.

A full explanation of these designators is found in the Foreword of the guideline.

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This section provides resources, strategies and measurement specifications for use in closing the gap between current clinical practice and the recommendations set forth in the guideline.

The subdivisions of this section are:

- Priority Aims and Suggested Measures
  - Measurement Specifications
- Key Implementation Recommendations
- Knowledge Resources
- Resources Available

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## Priority Aims and Suggested Measures

1. Improve the accurate assessment of asthma severity and control for patients five and older through the use of objective measures of lung function and symptoms. (*Annotations #11, 12*)

Possible measures for accomplishing this aim:

- a. Percentage of patients with spirometry or peak flow at the last visit asthma was addressed.
- b. Percentage of patients with assessment of asthma control using a validated questionnaire at the last visit asthma was addressed.

2. Improve long-term control of asthma through the use of inhaled corticosteroid drug therapy. (*Annotation #13*)

Possible measure for accomplishing this aim:

- a. Percentage of patients with uncontrolled persistent asthma who are on an inhaled corticosteroid medication.

3. Improve the partnership of asthma patients and/or their parents (when applicable) with health care professionals through the use of written action plans and timely and accurate assessment of patients with asthma exacerbation. (*Annotation #14*)

Possible measure for accomplishing this aim:

- a. Percentage of 1) patients whose asthma is well controlled, 2) patient who are not at increased risk of exacerbations, and 3) patients who have a current written asthma action/management plan. (*MN Community Measurement optimal asthma care composite measure*)

4. Improve the treatment and management of asthma in inpatient care settings. (*Annotation #27*)

Possible measures for accomplishing this aim:

- a. Percentage of hospitalized patients with asthma who are discharged on an inhaled anti-inflammatory medication.
- b. Percentage of discharged patients with asthma who are readmitted to hospital within 30 days.
- c. Percentage of patients with asthma who return to the emergency department for treatment of asthma within 30 days of last visit to the emergency department.
- d. Percentage of patients aged 5 through 50 years with an emergency department visit or inpatient admission for an asthma exacerbation who are discharged from the emergency department OR inpatient setting with an asthma discharge plan. (*National Committee for Quality Assurance/Physician Consortium for Performance Improvement Measure-2009*)

5. Schedule follow-up visits to ensure asthma control is maintained and appropriate therapy is administered following any visit for asthma or medication adjustment. (*Annotations #5, 21, 25, 27, 30*)

Possible measures for accomplishing this aim:

- a. Percentage of patients who are uncontrolled or have a change in medication or clinical status, who are seen by a health care provider within two to six weeks.
- b. Percentage of controlled asthma patients who are seen by a health care provider every one to six months.

## Measurement Specifications

### Possible Success Measurement #1a

Percentage of patients with spirometry or peak flow at the last visit asthma was addressed.

### Population Definition

Patients age five and older diagnosed with asthma.

### Data of Interest

$$\frac{\text{\# of patients with spirometry or peak flow measurement}}{\text{\# of asthma patients age five and older with a visit where asthma was addressed}}$$

### Numerator/Denominator Definitions

**Numerator:** Number of asthma patients age five and older who had spirometry or peak flow measurement at the last visit asthma was addressed.

**Denominator:** Number of asthma patients age five and older with a visit where asthma was addressed. A visit can include any visit with a provider and documentation of one of these ICD-9 diagnosis codes: 493.00, 493.01, 493.10, 493.11, 493.90, 493.91.

### Method/Source of Data Collection

Data may be collected electronically using the claims/encounter database or the enrollment database. Medical groups should identify patients with an asthma ICD-9 diagnosis who are seen at the clinic. Each medical group can then generate a list of all eligible patients with asthma seen during the target month/quarter. A random sample of 20 charts can be chosen from this list. The eligible patients are those who are age five and older who had a visit where asthma was addressed. If a patient had multiple visits during the target month/quarter, select the last visit where asthma was addressed. The patient medical records are reviewed for documentation that spirometry or peak flow meter reading was done.

### Time Frame Pertaining to Data Collection

It is recommended that the data collection be done monthly for groups that want to track process changes in a shorter period. Otherwise, data collection can also be done quarterly.

### Notes

It is important to periodically assess pulmonary function. The main methods are spirometry or PEFR. Spirometry is more precise and yields more information than PEFR. It is helpful to verify the accuracy of the peak flow meter. It is useful when certain physical limitations affect accuracy of PEFR (e.g., very young or elderly, neuromuscular or orthopedic problems). PEFR provides a simple, quantitative and reproducible measure of severity of airflow obstruction. The results are more reliable if the same type of meter, and preferably the patient's own, is used.

This is a process measure, and improvement is associated with a higher score.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #2a**

Percentage of patients with uncontrolled persistent asthma who are on inhaled corticosteroid medication.

**Population Definition**

Patients age five and older with uncontrolled persistent asthma.

**Data of Interest**

$$\frac{\text{\# of patients with at least one prescription for inhaled corticosteroids medications}}{\text{\# of patients age five and older with uncontrolled persistent asthma}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age five and older with at least one prescription for inhaled corticosteroid medication.

Denominator: Number of asthma patients age five and older with uncontrolled persistent asthma. For definition of uncontrolled persistent asthma, refer to the Asthma guideline. Asthma diagnosis ICD-9 diagnosis codes: 493.00, 493.01, 493.10, 493.11, 493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected through a pharmacy database or electronically. If collected electronically, query all patients with asthma diagnosis codes: 493.00, 493.01, 493.10, 493.11, 493.90, 493.91. Select a sample of at least 20 patients and review their medical records for documentation for at least one prescription for inhaled corticosteroid medication.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected quarterly.

**Notes**

Since asthma is a chronic inflammatory disorder of the airways with recurrent exacerbations, therapy for uncontrolled asthma emphasizes efforts to suppress inflammation over the long term and prevent exacerbations.

This is a process measure, and improvement is associated with a higher score.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #3a**

Percentage of patients whose asthma is 1) well controlled, 2) patients who are not at increased risk of exacerbations and 3) patients who have a current written asthma action/management plan (*MN Community Measurement optimal asthma care composite measure*)

**Notes**

This is an outcome composite measure on optimal asthma care by MN Community Measurement. Full specifications for this measure can be obtained through MN Community Measurement. (<http://www.mncm.org/site/>)

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #4a**

Percentage of hospitalized patients with asthma who are discharged on an inhaled anti-inflammatory medication.

**Population Definition**

Patients age five and older with hospitalization related to asthma.

**Data of Interest**

$$\frac{\text{\# of patients discharged on an inhaled anti-inflammatory medication}}{\text{\# of patients age five and older with asthma hospitalization}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age five and older who are discharged on an inhaled anti-inflammatory medication

Denominator: Number of asthma patients age five and older with asthma hospitalization. Asthma includes ICD-9 diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected electronically. If collected electronically, query all patients with asthma diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91. Select a sample of at least 20 patients and review their medical records for documentation that patients were discharged on an inhaled anti-inflammatory medication.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected monthly for those that want to be able to track process changes over a shorter period. Otherwise, data can also be collected quarterly.

**Notes**

This is a process measure, and improvement is associated with a higher score.

This measure is primarily for inpatient care settings.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #4b**

Percentage of discharged patients with asthma who are readmitted to hospital within 30 days of discharge.

**Population Definition**

Patients age five and older with hospitalization related to asthma.

**Data of Interest**

$$\frac{\text{\# of patients readmitted to the hospital within 30 days of discharge}}{\text{\# of asthma patients age five and older who were discharged from an asthma-related hospitalization}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age five and older who are readmitted to the hospital within 30 days of discharge that is asthma-related.

Denominator: Number of asthma patients age five and older who were discharged from an asthma-related hospitalization. Asthma includes ICD-9 diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected electronically. If collected electronically, query all patients with asthma diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91 who were discharged. Select a sample of at least 20 patients and review their medical records for documentation of re-admission within 30 days of discharge.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected monthly for those that want to be able to track process changes over a shorter period. Otherwise, data can also be collected quarterly.

**Notes**

This is a process measure, and improvement is associated with a lower score.

This measure is primarily for inpatient care settings.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #4c**

Percentage of patients with asthma who return to the emergency department (ED) for treatment of asthma within 30 days of last visit to the emergency department.

**Population Definition**

Patients age five and older with ED visit related to asthma.

**Data of Interest**

$$\frac{\text{\# of patients who return to the ED within 30 days of the last visit to the ED}}{\text{\# of asthma patients age five and older who were seen in ED for asthma treatment}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age 5 and older who return to the ED for treatment of asthma within 30 days of the last visit to the ED.

Denominator: Number of asthma patients age 5 and older who were seen in ED for asthma treatment. Asthma includes ICD-9 diagnosis codes 493.00, 493.01,493.10,493.11,493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected electronically. If collected electronically, query all patients with Asthma diagnosis codes 493.00, 493.01,493.10,493.11,493.90, 493.91 who were seen in ED for asthma treatment. Select a sample of at least 20 patients and review their medical records for documentation of return to the ED within 30 days of the last visit for asthma treatment.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected monthly for those that want to be able to track process changes over a shorter period. Otherwise, data can also be collected quarterly.

**Notes**

This is a process measure, and improvement is associated with a lower score. Specifically, this measure looks at overuse of ED for treatment of asthma.

This measure is primarily for inpatient care settings with ED.

### **Possible Success Measurement #4d**

Percentage of patients aged 5 through 50 years with an ED visit or inpatient admission for an asthma exacerbation who are discharged from the ED OR inpatient setting with an asthma discharge plan. (*National Committee for Quality Assurance/Physician Consortium for Performance Improvement Measure-2009*)

### **Notes**

This is a process measure by National Committee for Quality Assurance/Physician Consortium for Performance Improvement (NCQA/PCPI).

Full specifications for this measure can be obtained from NCQA at <http://www.ncqa.org>.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #5a**

Percentage of patients who are uncontrolled or have a change in medication or clinical status, who are seen by a health care provider within two to six weeks.

**Population Definition**

Patients age five and older with asthma diagnosis.

**Data of Interest**

$$\frac{\text{\# of patients who are seen by a provider within two to six weeks of change in medication or clinical status}}{\text{\# of asthma patients age five and older who are uncontrolled or have a change in medication or clinical status}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age five and older who are seen by a provider within two to six weeks of change in medication or clinical status.

Denominator: Number of asthma patients age five and older who are uncontrolled or have a change in medication or clinical status. For definition of uncontrolled asthma, see the guideline. Asthma includes ICD-9 diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected electronically. If collected electronically, query all patients with asthma diagnosis codes 493.00, 493.01, 493.10, 493.11, 493.90, 493.91 who were seen in the clinic and at the time of visit, their asthma was uncontrolled or there was a change in medication or clinical status. Select a sample of at least 20 patients and review their medical records for documentation that a provider saw them within two to six weeks of change in medication or clinical status.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected monthly for those that want to be able to track process changes over a shorter period. Otherwise, data can also be collected quarterly.

**Notes**

This is a process measure, and improvement is associated with a higher score.

**Priority Aims and Suggested Measures**

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**Possible Success Measurement #5b**

Percentage of controlled asthma patients who are seen by a health care provider every one to six months.

**Population Definition**

Patients age five and older with asthma diagnosis.

**Data of Interest**

$$\frac{\text{\# of patients who are seen by a provider every one to six months}}{\text{\# of asthma patients age five and older who are controlled}}$$

**Numerator/Denominator Definitions**

Numerator: Number of asthma patients age five and older who are seen by a provider every one to six months.

Denominator: Number of asthma patients age five and older who are controlled. For definition of controlled asthma, see the guideline. Asthma includes ICD-9 diagnosis codes 493.00,493.01,493.10, 493.11,493.90, 493.91.

**Method/Source of Data Collection**

Data for this measure can be collected electronically. If collected electronically, query all patients with Asthma diagnosis codes 493.00, 493.01,493.10,493.11,493.90, 493.91 who are controlled. Select a sample of at least 20 patients and review their medical records for documentation that a provider saw them every between 1 to 6 months of the last visit.

**Time Frame Pertaining to Data Collection**

It is suggested that data are collected monthly for those that want to be able to track process changes over a shorter period. Otherwise, data can also be collected quarterly.

**Notes**

This is a process measure, and improvement is associated with a higher score.

## Key Implementation Recommendations

The following system changes were identified by the guideline work group as key strategies for health care systems to incorporate in support of the implementation of this guideline.

1. Facilitate timely and accurate diagnosis of asthma and asthma severity and control.
2. Educate providers in the use of spirometry as a diagnostic tool.
3. Educate providers and patients in the importance of developing and maintaining an asthma action plan and assessing adherence.

## Knowledge Resources

### Criteria for Selecting Resources

The following resources were selected by the Diagnosis and Management of Asthma guideline work group as additional resources for providers and/or patients. The following criteria were considered in selecting these resources.

- The site contains information specific to the topic of the guideline.
- The content is supported by evidence-based research.
- The content includes the source/author and contact information.
- The content clearly states revision dates or the date the information was published.
- The content is clear about potential biases, noting conflict of interest and/or disclaimers as appropriate.

### Resources Available to ICSI Members Only

ICSI has a wide variety of knowledge resources that are *only* available to ICSI members (these are indicated with an asterisk in far left-hand column of the Resources Available table). In addition to the resources listed in the table, ICSI members have access to a broad range of materials including tool kits on CQI processes and Rapid Cycling that can be helpful. To obtain copies of these or other Knowledge Resources, go to [http://www.icsi.org/improvement\\_resources](http://www.icsi.org/improvement_resources). To access these materials on the Web site, you must be logged in as an ICSI member.

The resources in the table on the next page that are not reserved for ICSI members are available to the public free-of-charge.

## Resources Available

*	Author/Organization	Title/Description	Audience	Web Sites/Order Information
	Allergy and Asthma Network/Mothers of Asthmatics	A national non-profit network of families whose desire is to overcome allergies and asthma through knowledge. This Web site produces accurate, timely, practical and livable alternatives to suffering.	Patients and Families; Health Care Providers	<a href="http://www.aanma.org">http://www.aanma.org</a> 1-800-878-4403
	American Academy of Allergy, Asthma and Immunology	The largest professional medical organization in the United States devoted to the allergy/immunology specialty. The AAAAI is devoted to the advancement of the knowledge and practice of allergy, asthma and immunology for optimal patient care.	Patients and Families; Health Care Providers	<a href="http://www.aaaai.org">http://www.aaaai.org</a> 1-414-272-6071
	American College of Allergy, Asthma and Immunology (ACAAI)	Provides both patient- and professional-oriented information on asthma diagnosis and management.	Patients and Families; Health Care Providers	<a href="http://www.acaaai.org">http://www.acaaai.org</a>
	American Lung Association (ALA)	Offers comprehensive information for patients and practitioners on asthma care and reduction of exacerbations and asthma triggers.	Patients and Families; Health Care Providers	<a href="http://www.lungusa.org/">http://www.lungusa.org/</a> 1-800-548-4872
	Association of Asthma Educators (AAE)	Promotes asthma education as an integral comprehensive asthma program, to raise the competence of health care professionals who educate individuals and families affected by asthma, and to raise the standard of care and quality of asthma education delivered.	Health Care Providers	<a href="http://www.asthmaeducators.org/">http://www.asthmaeducators.org/</a> 1-888-988-7747
	Asthma and Allergy Foundation of America (AAFA)	Focus is on improving the quality of life for people with asthma and allergies and their caregivers, through education, advocacy and research. Provides practical information, community-based services, support and referrals through a national network of chapters and educational groups.	Patients and Families; Health Care Providers	<a href="http://www.aafa.org">http://www.aafa.org</a> 1-800-727-8462
	Centers for Disease Control and Prevention	CDC.gov is CDC's primary online communication channel. It provides users with credible, reliable health information on topics ranging from data and dtatistics to fiseases and conditions and more.	Patients and Families; Health Care Providers	<a href="http://www.cdc.gov">http://www.cdc.gov</a> 1-800-232-4636

\* Available to ICSI members only.

**Resources Available**

*	Author/Organization	Title/Description	Audience	Web Sites/Order Information
*	Institute for Clinical Systems Improvement	Emergency and Inpatient Management of Asthma Focus Group Video	Health Care Providers	<a href="http://www.icsi.org/">http://www.icsi.org/</a>
*	Institute for Clinical Systems Improvement	Improvement Case Report on Asthma: Family Health Services Minnesota PA, Process Improvement Report #19	Health Care Providers	<a href="http://www.icsi.org/">http://www.icsi.org/</a>
	Minnesota Department of Health	Offers information for health care professionals, schools and patients about asthma. An asthma action plan is also included in English and Spanish.	Patients and Families; Health Care Providers	<a href="http://www.health.state.mn.us">http://www.health.state.mn.us</a> (651) 201-5000 1-888-345-0823
	National Heart, Lung, and Blood Institute (NHLBI)	Provides asthma health education resources for patients, school/day care providers and health professionals. Materials written in Spanish are available.	Patients and Families; Health Care Providers	<a href="http://www.nhlbi.nih.gov">http://www.nhlbi.nih.gov</a> 1-800-490-9198
	National Jewish Medical and Research Center (Lung Line)	At the forefront of research and medicine for more than 110 years. Integrates the latest scientific discoveries with coordinated care for pulmonary, cardiac, immune and related conditions.	Patients and Families; Health Care Providers	<a href="http://www.njc.org">http://www.njc.org</a> 1-800-222-5864
	U.S. Environmental Protection Agency (EPA)	Offers asthma education that incorporates an awareness of indoor environmental asthma triggers (e.g., secondhand smoke, dust mites, mold, pet dander and cockroaches) and actions that can be taken to reduce children's exposure to them in homes, schools and child care settings.	Patients and Families; Health Care Providers	<a href="http://www.epa.gov/iaq">http://www.epa.gov/iaq</a> 1-800-490-9198
	Wisconsin Asthma Coalition (WAC)	WAC mission is to develop and implement a sustainable statewide action plan to expand and improve the quality of asthma education, management and services in the state. Materials and resources available include clinical care education public policy, disparities and surveillance.	Patients and Families; Health Care Providers	<a href="http://dhs.wi.gov/eh/Asthma/WAC.htm">http://dhs.wi.gov/eh/Asthma/WAC.htm</a>

\* Available to ICSI members only.