

TEXAS CHILDREN'S HOSPITAL
EVIDENCE-BASED OUTCOMES CENTER
Asthma: Chronic Management
Evidence-Based Guideline

Definition: Asthma is the most common chronic disorder of the airways in childhood. It is characterized by variable and recurring symptoms of airflow obstruction, bronchial hyperresponsiveness, and inflammation.

The manifestations of the pathophysiologic features of asthma result in the clinical presentations and severity of asthma and its response to treatment. The clinical presentation can be highly variable among patients and within individuals over time. An individual may have progression or regression of symptoms, including periods of apparent or complete remission or variable degrees of worsening over the course of time.

Acute symptoms of asthma usually arise from bronchospasm and airway inflammation. Bronchospasm typically is partly relieved by bronchodilator therapy. Acute or chronic inflammation can affect not only the airway caliber and airflow but also underlying bronchial hyperresponsiveness, which enhances the severity of episodes of bronchospasm. Airway inflammation in asthma has implications for the diagnosis, management, and potential prevention of the disease.

Airway inflammation contributes to airway hyperresponsiveness, airflow limitation, respiratory symptoms, and disease chronicity. The critical role of inflammation has been further substantiated, but evidence is emerging for considerable variability in the pattern of inflammation, thus indicating phenotypic and endotypic differences that may influence treatment responses.

Distinct but overlapping phenotypic patterns of asthma have been defined that reflect different aspects of the disease, such as intermittent versus persistent or acute versus chronic manifestations.

Debate is ongoing regarding how to best classify infants and young children with recurrent wheezing. In addition to use of the diagnosis asthma, other diagnoses such as reactive airway disease, wheezy bronchitis, asthmatic bronchitis, wheezing-associated respiratory illness, and postinfectious bronchial hyperreactivity have been used as well. Some of these terms actually have the same base ICD code as asthma. Although in the majority of this subgroup of wheezing children where symptoms tend to disappear by five years of age, using a diagnosis of asthma and appropriate evidence-based guidelines to establish monitoring and treatment regimens is still recommended (see more under phenotypes below).

Pathophysiology:

Asthma is a complex process that depends on the interaction of:

- Bronchoconstriction/Airway hyperresponsiveness
- Airway inflammation, resulting in edema and mucus plugging

Epidemiology:

A wide global variation exists in the prevalence of asthma, with higher rates typically seen in higher-income countries. Asthma is the most common chronic disease in childhood in resource-rich countries. In the United States, asthma affects more than 22 million persons. Approximately 7.5 percent of US children had asthma in 2018, which is a decline from the past decade. Approximately one-half of children with asthma present with symptoms before 3 years of age. Hospitalization rates are also

higher among young children 0–4 years of age. Before the onset of puberty, boys have a higher current prevalence of asthma than girls; however, this trend reverses in adolescence. Disparities in prevalence remain, with a higher prevalence seen in poor children and those living in the Southern US and the highest prevalence still seen in Puerto Rican and non-Hispanic Black American children, particularly for those living in urban environments.

The pattern of disease persistence is determined in part by early, recognizable risk factors including atopic disease, recurrent wheezing, and a parental history of asthma. The modified asthma predictive index provides a method for predicting the likelihood for preschool wheezers to develop persistent asthma during school age (Table 2). Although only approximately 30% of children who wheeze before 3 years of age will have persistent asthma by school age, studies suggest that deficits in lung function growth occur more often in children whose asthma symptoms begin during the first 3 years of life as opposed to those with an onset of symptoms after 3 years of age.

Etiology: Asthma is a complex, interactive disease process that depends on the interplay between two major factors—host factors (particularly genetics) and environmental exposures that occur at a crucial time in the development of the immune system. Gene-by-environmental interactions are important to the development and expression of asthma. It is well recognized that asthma has an inheritable component to its expression, but the genetics involved in the eventual development of asthma remain a complex and incomplete picture. A number of other factors continue to be explored asthma risks largely through association studies such as various dietary factors, obesity, and medication use.

Several major environmental factors have emerged as being particularly important in the development, persistence, and possibly severity of asthma: airborne allergens, viral respiratory infections and second hand smoke (SHS)/air pollution.

Allergens and Atopy

Allergen exposure, allergic sensitization, and respiratory infections also may function interactively in the eventual development of asthma. Atopy, the genetic predisposition for the development of an immunoglobulin E (IgE)-mediated response to common aeroallergens, is the strongest identifiable predisposing factor for developing asthma. The "atopic march" usually starts with atopic dermatitis in early life and progresses to the addition of other allergic diseases, including food allergy, asthma, and allergic rhinoconjunctivitis. Early age of onset of atopic dermatitis and allergic sensitization is associated with an increased risk of childhood asthma in several studies.

Infection

Viral respiratory infections are one of the most important causes of asthma exacerbation and may also contribute to the development of asthma. Some infections seem to decrease the risk of developing asthma, whereas viral infections, such as respiratory syncytial virus (RSV), may increase the risk. There is considerable interest in the role of innate and adaptive immune responses associated with both the development and

regulation of inflammation. In particular, research has focused on an imbalance between Th1 and Th2 cytokine profiles and evidence that allergic diseases, and possibly asthma, are characterized by a shift toward a Th2 cytokine-like disease, either as overexpression of Th2 or underexpression of Th1.

Environmental Exposure Risks

Prenatal and postnatal SHS exposures are potentially avoidable and can contribute to the burden of asthma in children. Exposure to SHS is associated with increased prevalence and severity of asthma and wheezing. Pre- and/or postnatal exposure to SHS was associated with an increased risk for asthma. A significant excess of childhood asthma occurs if both parents or the mother smoke. In utero exposures from maternal smoking can adversely affect lung development and function and increase the risk for asthma in early childhood. In addition, smoking during gestation is associated with higher rates of premature delivery, which is another risk factor for asthma.

A dose-response relationship exists between SHS and childhood asthma, and no defined threshold level of exposure is without risk. SHS may increase the frequency of lower respiratory infection in early childhood and promote allergic sensitization. Exposure to SHS also appears to worsen the severity of asthma in children.

Outdoor Air Pollution

A growing body of evidence suggests that early-life exposure to air pollution increases the risk of pediatric asthma including outdoor air pollutants including sulfur dioxide and nitrogen dioxide. Exposure to high ozone levels may worsen asthma control as well. Studies have shown that residence near a major roadway even at relatively low levels of traffic-related pollution increased the risk of early childhood asthma.

Asthma Phenotypes

A number of cohort studies have explored the occurrence and natural history of asthma in children.

The Tucson Children's Respiratory Study prospective longitudinal study of a cohort of 1246 newborns based upon the presence of wheezing symptoms during the first three years of life and again at six years. Subsequent analyses of data from this cohort led to a revised definition of three groups of wheezers:

- Transient wheeze in infancy – Begins in infancy (the first year of life) and resolves by the preschool years; associated with decreased lung function, narrower intrapulmonary airways, maternal tobacco use during pregnancy, having siblings, and daycare attendance.
- Nonatopic persistent wheezing phenotype – Begins in infancy and resolves in mid-childhood; associated with lack of both allergic sensitization and methacholine hyperresponsiveness.
- Immunoglobulin E (IgE)-associated/atopic persistent wheezing phenotype – Can begin in infancy but increases in prevalence with age; associated with personal and family history of atopy, methacholine hyperresponsiveness, and poor growth of lung function. This phenotype may represent a classic allergic asthma phenotype, but it is unknown if children with this phenotype will have symptoms that persist into adulthood.

Asthma Endotypes

Greater understanding of the heterogeneity associated with pathophysiology of asthma has led to the identification of distinct asthma endotypes. Two distinct endotypes have been

identified based on identifiable triggers, the inflammatory cell milieu, and the presence or absence of clinical features such as atopy, nasal polyposis and clinical response to steroids.

Th2 high, or atopic asthma is characterized by the presence of inflammatory markers associated with Th2 cells, including IL-4, IL-5, and IL-13, and predominantly eosinophilic inflammation. Patients typically have allergic sensitization and are most often steroid responsive. Th2 low or non-atopic asthma is characterized by the absence of Th2 markers of activation and predominantly neutrophilic or paucigranulocytic inflammation. In contrast to atopic asthma, patients may be less responsive to steroid treatments. Identifying these endotypes becomes important in optimizing treatment whereby patients with Th2 high asthma are more likely to respond to corticosteroid therapy and may be candidates for emerging biologic therapies targeting specific inflammatory pathways (see below).

Inclusion Criteria for guideline application

- Children with symptoms of recurrent episodes of airflow obstruction (at least partially reversible) or airway hyperresponsiveness not related to alternative diagnoses ⁽¹³⁾

Exclusion Criteria for guideline application

- Other chronic lung disease, bronchiolitis, bacterial pneumonia, neurological disorders, immunodeficiency diseases, and cardiac patients

Remark: Asthma can coexist with other chronic illnesses.

Differential Diagnosis

Chronic or recurrent bronchitis
 Recurrent Pneumonia
 Recurrent Upper Respiratory Infection
 Environmental allergies and allergic rhinitis
 Gastroesophageal reflux
 Sinus disease
 Atelectasis and right middle lobe syndrome
 Bronchiolitis
 Foreign body
 ILO- inducible laryngeal obstruction and eILO-exercise induced inducible laryngeal obstruction (VCD, PVFM, VFD).
 Laryngo- or tracheomalacia
 Immune deficiency, including HIV
 External airway compression (vascular ring, mass lesion, enlarged lymph nodes as seen with tuberculosis or tumor)
 Internal airway obstruction (web, cyst, hemangioma, stenosis)
 Congenital heart disease
 Bronchopulmonary dysplasia
 Primary ciliary dyskinesia
 Bronchiolitis obliterans
 Bronchopulmonary aspergillosis

Diagnostic Evaluation

Establishing a diagnosis of asthma involves a careful process of history taking, physical examination, and diagnostic studies. The differential diagnosis of wheezing must be carefully considered, particularly in infants and very young children, for whom testing for reversible airflow obstruction is not done routinely.

History- Assess for: ⁽¹³⁾

- Symptoms: cough, wheezing, shortness of breath, chest tightness, chest pain
- Pattern of symptoms
- Precipitating and/or aggravating factors

- Development of disease and treatment
- Family history of asthma and/or atopy
- Social history
- History of exacerbations
- Impact of asthma on patient and family
- Assessment of patient's and family's perceptions of disease
- Seasonal variation
- Response to asthma medications (in particular, + bronchodilator response defined as improvement in symptoms or lung function parameters after correct use of 2-4 puffs of SABA)

- Chest
 - Sounds of wheezing during normal breathing or prolonged phase of forced exhalation
 - Accessory muscle use
 - Hunched shoulder appearance
 - +Hyperexpansion of the thorax
 - +Chest deformity (eg: pectus excavatum)
 - +Expiratory/Inspiratory stridor
- Skin/Extremities
 - Atopic dermatitis/Eczema
 - +Clubbing

Physical Examination

*Absence of the below findings does not rule out asthma. Signs/symptoms may be absent between episodes. ⁽¹³⁾

+May lead you to consider other differential diagnoses

- General
 - +Failure to Thrive
- Upper respiratory tract
 - Increased nasal secretions
 - Mucosal swelling
 - +Nasal polyps
 - +Inspiratory Stridor

Diagnostic Tests

*Asthma is a clinical diagnosis and testing does not confirm or rule out a diagnosis of asthma.

- Chest X-ray
- Spirometry (age ≥5 years) ± fractional exhaled nitric oxide (FeNO) (age ≥5 years)
- Clinical symptoms may indicate additional testing such as (not in order of frequency):
 - Sweat test
 - Upper GI study
 - Sinus imaging
 - Allergy evaluation for endotyping asthma
 - CBC with differential
 - Eosinophils

Section I: Initial Asthma Screening, Evaluation, and Diagnosis

Indications for Asthma Screening and Trial of Short Acting Bronchodilator

- **Wheezing**- 2 or more episodes or persistent wheezing
- **Cough**- After evaluation of other causes of acute cough especially if characterized by *any* of the following:
 - 2 or more episodes in a year lasting more than 3 weeks or not improving in 2 weeks
 - Poor response to treatment with antibiotics, decongestants, or antihistamines
 - Nocturnal episodes
 - Interferes with sleeping, eating, exercise, school, or other activities
 - Recurrent "croupy" cough
 - Causes vomiting (usually post-tussive)
 - Concerns raised by parent, teacher, school nurse, or other healthcare providers
- **Shortness of breath**
- **Chest tightness or pain**
- **Recurrent lower respiratory infections**- such as bronchitis, pneumonia, or bronchiolitis (especially if 2 or more episodes have occurred)
- **An emergency center or urgent care visit or hospitalization**- for difficulty breathing associated with coughing and wheezing
- **Respiratory symptoms that respond to bronchodilators and/or corticosteroids**
- **Symptoms occur or are worse in the presence of:** ⁽¹³⁾
 - Exercise
 - Viral infection
 - Inhalant allergens (animals with fur or hair, house dust mites, mold, pollen)
 - Irritants (tobacco or wood smoke, airborne chemicals)
 - Changes in weather
 - Thunderstorms
 - Strong emotional expression (laughing or crying hard)
 - Stress
 - Menstrual cycles

Assessing Initial Asthma Severity

- The presence of *at least one* feature in a component of severity is sufficient to place a patient in that severity classification (see Table 1).
- Patients should be assigned to the *most severe classification* in which any feature occurs.
- A child's classification will change over time. Severity, control and risk should be *reassessed at every visit* (see Table 1). Symptoms necessitating medications for control do not downgrade severity.
- Patients at any level of severity can have mild, moderate, or severe exacerbations. Even patients with intermittent asthma can experience life-threatening exacerbations separated by long asymptomatic periods. This may be especially common with exacerbations provoked by respiratory infections.

- Any exacerbation requiring systemic corticosteroids (IV or oral) should lead one to strongly consider raising the level of severity at least one step for 1-6 months accompanied by an increase in stepwise therapy. Patients can then be reassessed and stepped down if appropriate.
 - Remarks:** For patients with a history of intermittent or mild persistent asthma there may be several appropriate approaches based on their pattern of illness. Management decisions may be best made in collaboration with an Asthma Specialist.

The table below is the standard of care. No new evidence or professional external guidelines have led to an update of the NAEPP EPR-3 2007 classification of initial asthma severity. Reaffirmed with NAEPP EPR-4 2020 update.

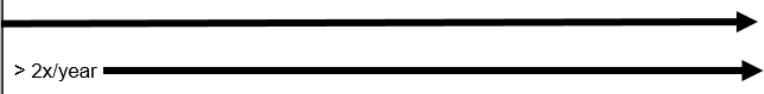
Guidelines for Classifying Asthma Severity and Initiation of Treatment by age													
Components of Severity		Intermittent			Persistent								
					Mild			moderate			severe		
Age in years		0-4	5-11	>12	0-4	5-11	>12	0-4	5-11	>12	0-4	5-11	>12
Impairment	Symptoms	≤ 2 days/week			≥ 2 days/week but not daily			daily			throughout the day		
	Nocturnal symptoms	0	≤ 2x/month		1-2x/mo	3-4x/month		3-4x/month	≥ 1x/week		≥ 2x/week	Often 7x/week	
	SABA use	≤ 2 days/week			≥ 2 days/week			daily			several times/day		
	Interferes with normal activity	none			minor			some			extremely		
	PFT	FEV ₁	n/a	> 80%		n/a	> 80%		n/a	60-80%		n/a	< 60%
	FEV ₁ /FVC	n/a	> 85%	Normal ratio	n/a	> 80%	Normal ratio	n/a	75-80%	Reduced by 5%	n/a	< 75%	Reduced by >5%
Risk	Exacerbations requiring systemic corticosteroids	0-1x/year			≥ 2x/6 months OR > 4x/year + risk factors								
Recommended Step for Initiating Treatment		Step 1			Step 2			Step 3			step 3		Step 4 or Step 5

Table 1: Guidelines for classifying asthma severity and initiation of stepwise treatment by age. This table is adapted from the NAEPP EPR-3 2007 guidelines with no changes made to the classification schema in the NAEPP EPR-4 2020 update. Severity is classified by symptoms in two domains: (1) the impairment domain, defined by the frequency and severity of symptoms including daytime or nocturnal cough, wheezing, shortness of breath, chest pain or tightness, as well as functional impairment measured by pulmonary function testing and exercise intolerance, and (2) the risk domain, defined by the number of exacerbations requiring systemic steroids. It is important to note that spirometry results do not necessarily reflect symptom severity; spirometry is often normal despite significant symptoms particularly in children, and clinical correlation is recommended. Refer to Figure 1 for details on step therapy. FEV₁=forced expiratory volume in 1 second, FEV₁/FVC=forced expiratory volume/forced vital capacity, PFTs=pulmonary function tests, SABA=short-acting beta-agonist. Table created by MR Gupta MD.

Critical Points of Evidence

TCH Evidence-Based Recommendations

Evidence Supports

- For children ≥4 years of age, administer at least 1 Asthma Control Test (ACT) per year for those with intermittent asthma and at least 2 ACTs per year for those with persistent asthma (at least 4 months apart) to track changes in the patient's level of asthma control. We value the greater sensitivity of detection of seasonal variation and changes over time that may be missed if only 1 ACT is administered each year. (8-10, 17-20) – Strong recommendation, low quality evidence

Evidence Lacking/Inconclusive

- Routine monitoring of peak expiratory flow is not recommended for management of asthma in most patients. It has shown no superiority to symptom monitoring in previous studies. It is an effort dependent test likely to be more variable than spirometry. – Consensus recommendation
- Home pulse oximetry is not routinely recommended for monitoring asthma in most patients. – Consensus recommendation

Recommendations Adopted/Adapted from National Guidelines

- “Use severity classification chart, assessing both domains of impairment and risk, to determine initial treatment.” (13)
- “Use multiple measures of impairment and risk: different measures assess different manifestations of asthma; they may not correlate with each other; and they may respond differently to therapy.” (13)
- Spirometry should be obtained when asthma is first diagnosed, in children 5 years and older who are able to complete the test, then every one to two years or more often for not-well-controlled asthma. (13)

- In individuals **ages 5 years and older** for whom the **diagnosis of asthma is uncertain** using history, clinical findings, clinical course, and spirometry, including bronchodilator responsiveness testing, or in whom spirometry cannot be performed, the addition of fractional exhaled nitric oxide (FeNO) measurement as an adjunct to the evaluation process is conditionally recommended. ⁽¹⁴⁾
 - **Remarks:** FeNO <20 does not rule out a diagnosis of asthma. FeNO results should be considered in conjunction with a patient's history, physical exam, symptoms, and discussion with a specialist.
- In individuals ages 5 years and older with persistent **allergic** asthma, for whom there is uncertainty in choosing, monitoring, or adjusting anti-inflammatory therapies based on history, clinical findings, and spirometry, the addition of FeNO measurement as part of an ongoing asthma monitoring and management strategy that includes frequent assessments is conditionally recommended. ⁽¹⁴⁾
- In individuals ages 5 years and older with asthma, FeNO measurements should **not** be used **in isolation** to assess asthma control, predict future exacerbations, or assess exacerbation severity. If used, it should be as part of an **ongoing monitoring and management** strategy. ⁽¹⁴⁾
 - **Remarks:** If a patient is not able to do spirometry then FeNO may be an option. A single FeNO measurement is not useful. A careful review of a patient's history, physical, and symptoms is required.
- In children ages 0–4 years with recurrent wheezing, FeNO measurement should **not** be used to predict the future development of asthma. ⁽¹⁴⁾
 - **Remarks:** The modified asthma predictive index is a clinical predictor of future development of asthma in children ≤ 5 years of age (Chang et al., 2013).
- "Asthma is highly variable over time, and periodic monitoring is essential. consider scheduling patients at:
 - 2- to 6-week intervals while gaining control
 - 1–6 month intervals, depending on step of care required or duration of control, to monitor if sufficient control is maintained;
 - 3-month intervals if a step up or step down in therapy is anticipated. ⁽¹³⁾

Modified Asthma Predictive Index (mAPI)

≥ 4 wheezing episodes in 1 year + at least 1 major **OR** 2 minor criteria required

Major Criteria

- Physician-diagnosed parental history of asthma
- Physician-diagnosed atopic dermatitis
- Allergic sensitization to ≥ 1 aeroallergen

Minor Criteria

- Allergic sensitization to milk, eggs, or peanuts
- Wheezing unrelated to colds
- Eosinophilia ($\geq 4\%$)

Table 2: Modified Asthma Predictive Index (mAPI). The mAPI can be used in children ≤ 5 years of age with early episodes of wheezing to help determine the risk for developing persistent asthma in school age children. A positive mAPI increases the probability of future asthma. *Adapted from Chang et al 2013.* ⁽⁴⁾

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

Section II: Stepwise Approach for Managing Asthma

Stepwise Approach ⁽¹³⁾

The stepwise approach for achieving and maintaining asthma control incorporates four components of care:

- Assessing and monitoring asthma severity and asthma control
 - Assess severity to initiate therapy.
 - Assess control and risk to adjust therapy.
 - Once optimal asthma control is achieved and maintained, a patient's overall asthma severity is the lowest level of treatment required to maintain control.
- Medications
 - The prescribed medication regimen is determined by the level of asthma severity and/or control/risk.
 - Therapy is increased as necessary and decreased when possible.
 - Counsel families about and monitor for potential side effects.
 - Medication regimen is determined by the level of asthma severity and/or control/risk.
 - Medication administration technique particularly for inhaled medications should be taught and reviewed regularly.
 - Medication adherence should be reviewed regularly.
- Control of environmental factors and comorbid conditions that affect asthma
 - Evaluate the potential role of allergens and irritants.
 - Advise patients who have asthma to reduce exposure to allergens, pollutants, and irritants that they are sensitive to.
 - Identify and treat comorbid conditions that may interfere with appropriate asthma management (i.e. reflux, allergic rhinitis, chronic sinusitis, obesity, cardiovascular disease, and other chronic lung diseases)
- Education for a partnership in care
 - All patients (and/or caregivers) should have a written asthma action plan, in their preferred language, that includes instructions for both daily management and actions to manage worsening asthma.
 - All patients should be taught how to monitor asthma control and recognize inadequate control.

- Self-management education improves patient outcomes.
- Educate to all patients (and/or caregivers) about the role of each medication and how they are delivered.
 - Label and color code the patient's medications to avoid confusion.
 - The importance of and process for priming inhalers should be reviewed.
- Assist family in working with school and/or daycare in the education of asthma management.

The stepwise approach is to assist, not replace, clinical decision making required to meet individual patient's needs.

Referral to an asthma specialist is recommended for the following reasons ⁽¹³⁾:

- Asthma control cannot be achieved or maintained
- Patient requires >2 bursts of oral systemic corticosteroids in 1 year or has an exacerbation requiring hospitalization
- Step 3 care or higher is required for children 0-4 years of age
- Consider referral if Step 3 care is required in older children (or children 5 years and older)
- Referral is recommended if Step 4 care is required
- If immunotherapy and/or biologic therapy is considered
- Additional testing is indicated

Biologic Agents Used in Asthma

There are a growing number of humanized monoclonal antibody therapies, otherwise known as “biologics”, targeting specific inflammatory pathways available for the treatment of moderate to severe persistent asthma. They vary in their mechanism of action, route of delivery (subcutaneous injection vs. intravenous infusion), dosing frequency, and lower age limit for FDA approved use. Many of these agents are also used to treat other atopic conditions such as atopic dermatitis, nasal polyposis, hypereosinophilic syndrome, and chronic idiopathic urticaria. These agents are generally considered in Steps 5 and 6 of therapy (table 3) for inadequately controlled asthma to reduce symptom severity, reduce asthma exacerbation rates, increase FEV1, reduce inhaled and oral corticosteroid dosing, and improve quality of life. Patients are typically referred to an asthma specialist to evaluate the risks/benefits of these therapies and monitor response.

Available agents:

6 years and older:

- Omalizumab (brand Xolair)- Antibody that binds circulating IgE at the binding site for the high affinity IgE receptor (FcεRI), preventing circulating IgE from binding on mast cells, basophils and other antigen presenting cells to inhibit Th2 cytokine production and mediator release in response to allergen exposure and downregulate expression of the high-affinity IgE receptor on cells.
- Mepolizumab (brand Nucala)- Antibody that binds directly to interleukin-5 (IL-5), preventing activation of the IL-5 receptor on eosinophils and basophils, which blocks eosinophil differentiation and survival, resulting in a drop in blood and sputum eosinophil count.
- Dupilumab (brand Dupixent)- An antibody that binds to the common interleukin-4 receptor alpha subunit (IL-4Rα) to inhibit signaling through both the IL-4 and IL-13 receptors inhibiting production of Th2 cytokines necessary to promote allergic inflammation

12 years and older:

- Benralizumab (brand Fasenra)- Antibody that binds to the IL-5 alpha receptor expressed on eosinophils and basophils which blocks IL-5 signaling and induces apoptosis of eosinophils and basophils through antibody-dependent cell mediated cytotoxicity resulting in eosinopenia.
- Tezepelumab (brand Tezspire)- Antibody that binds thymic stromal lymphopoietin (TSLP), a cytokine produced by epithelial cells in response to inhaled insults such as allergens, infectious organisms, pollutants, or irritants, and inhibits activation of both Th2 and non-Th2 mediated inflammatory pathways. Tezepelumab is the only biologic FDA approved for use in both Th2-high and Th2-low asthma.

18 years and older:

- Reslizumab (brand Cinqair)- Antibody that binds directly to interleukin-5 (IL-5), preventing activation of the IL-5 receptor on eosinophils and basophils, which blocks eosinophil differentiation and survival, resulting in a drop in blood and sputum eosinophil count. This is the only biologic that is delivered via intravenous infusion.

		Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
		Intermittent Asthma	Persistent Asthma: Daily Medications				
0-4 years of age	Preferred	high-dose ICS x 7-10 days at start of URI	low-dose ICS	low-dose ICS + LABA or LTRA OR medium-dose ICS	medium-dose ICS + LABA	high-dose ICS + LABA	high-dose ICS + LABA + OCS
	Alternative		LTRA		medium-dose ICS + LTRA	high-dose ICS + LTRA	high-dose ICS + LTRA + OCS
5-11 years of age	Preferred	SABA as required	low-dose ICS	low-dose ICS/formoterol daily and prn	medium-dose ICS/formoterol daily and prn	high-dose ICS + LABA	high-dose ICS + LABA + OCS
	Alternative		LTRA	medium-dose ICS OR low-dose ICS + LABA or LTRA	medium-dose ICS + LABA or LTRA	high-dose ICS + LTRA	high-dose ICS + LTRA + OCS
≥12 years of age	Preferred	SABA as required	low-dose ICS OR low-dose ICS prn	low-dose ICS/formoterol daily and prn	medium-dose ICS/formoterol daily and prn	medium to high-dose ICS + LABA + LAMA	high-dose ICS + LABA + LAMA + OCS
	Alternative		LTRA	medium-dose ICS OR low dose ICS + LABA or LAMA or LTRA	medium-dose ICS + LABA or LAMA or LTRA	medium to high-dose ICS + LABA OR high-dose ICS + LTRA	
For all ages at each step: PRN SABA							
For All Ages at each step: Patient Education, Environmental Control, Management of Co-morbidities							
For all ages at Step 3 or 4: consider specialist referral							
Consider Biologics at Step 5 and 6: 6-11 yo: omalizumab (Xolair), mepolizumab (Nucala), dupilumab (Dupixent); ≥12 yo: + benralizumab (Fasenra), tezepelumab (Tezspire); ≥18 yo: + reslizumab (Cinqair)							
For ≥5 years old : Consider subcutaneous immunotherapy for patients with persistent allergic asthma							

Table 3: NAEPP EPR-4 2020 recommendations for step-wise therapy by age. Boxes highlight major changes as compared to NAEPP EPR-3 2007 guidelines. For low, medium, high dose ranges of ICS please see Table 6. Only ICS/formoterol is indicated for use as SMART (single maintenance and reliever therapy) therapy; ICS/salmeterol is to be used as maintenance therapy alone. Even with SMART, a SABA should be prescribed for emergency use. ICS=inhaled corticosteroid, LABA=long-acting beta-agonist, LAMA=long-active muscarinic antagonist, LTRA=leukotriene receptor antagonist, SABA=short-acting beta-agonist, OCS=oral corticosteroid. Table by MR Gupta, MD.

SMART Protocol

In the stepwise treatment guideline Steps 3 and 4 (Table 3) for selected patients 5 years and older a new option for therapy has been added with the NAEPP EPR-4 2020 guideline update. SMART stands for single maintenance and reliever therapy. This protocol has the patient use a single inhaler that contains a combination of an inhaled corticosteroid (ICS) and formoterol, a specific long-acting beta-agonist (LABA) bronchodilator for both maintenance (daily controller) and quick relief therapy. It is important to note that this protocol cannot be done with the LABA salmeterol as it does not have as rapid onset as formoterol. There are dosing limits with maximum of 8 puffs/24 hours for 5-11 years and 12 puffs/24 hours for 12 years and older. A short-acting beta-agonist (SABA) back-up inhaler should always be available.

Clinical trials suggest this approach can be successful to reduce the risk for severe asthma exacerbations, improve long-term asthma control, and reduce potential for over-reliance on SABAs. Of note, some trials were done with different formulations than those available in the United States. Use of this approach requires careful explanation to the family with a customized asthma action plan. The family needs to clearly know which inhaler to use and skill checks for inhaler technique are important.

The cost to patients and the management of prescriptions needs to be considered. You have to assure that when the inhaler use is increased with symptoms the patient does not run out and have difficulty getting a refill. A provider may need to supply 2 inhalers to allow for a back-up. This may not be approved by all insurers or require special notation to pharmacies as currently this is not approved by the FDA so is off-label use. Mouth rinsing is advised after maintenance dosing of inhalers containing ICS. It is not considered necessary after as-needed dosing.

In all patients, assessment of asthma control including risk of exacerbations, low lung function and symptom perception should be considered with dosing. While this approach has strong evidence from clinical trials, it does require good clinical management, patient training and monitoring.

Guidelines for Assessing Asthma Control and Adjusting Therapy by Age										
Components of Control		Well Controlled			Not Well Controlled			Poorly Controlled		
Age in years		0-4	5-11	>12	0-4	5-11	>12	0-4	5-11	>12
Impairment	Symptoms	≤ 2 days/week but not daily			≥ 2 days/week OR multiple times per day on ≤ 2 days/week			Throughout the day		
	Nocturnal Symptoms	≤ 1x/mo	< 2x/mo		>1x/mo	≥ 2x/mo	1-3x/week	> 1x/week	≥ 2x /week	4x /week
	SABA use	≤ 2 days/week			≥ 2days/week			several times/day		
	Limitations in Activity	none			some			extremely		
	ACT	> 20			16-19			≤15		
	PFTs	FEV ₁	n/a	> 80%		n/a	60-80%	n/a	< 60%	
	FEV ₁ /FVC		> 80%	n/a		75-80%	n/a	< 75%	n/a	
Risk	Exacerbations requiring systemic steroids	0-1x/year			2-3x/yr	> 2x/year		> 3x/year	> 2x/year	
	Reduction in lung growth	n/a	Long Term Follow up		n/a	Long Term Follow up		n/a	Long Term Follow up	
	Side effects of Treatment	Side effects can vary. Consider in assessment of risk.								
Recommended Action for Treatment		Maintain Step down if control at least 3 months			Step up 1 step			Systemic corticosteroids Step up 1-2 steps		

Table 4: Guidelines for assessing asthma control and adjusting therapy by age. Table is adapted from the NAEPP EPR-3 2007 guidelines with no changes made to the schema in the NAEPP EPR-4 2020 update. Asthma control should be assessed at every visit in both the impairment and risk domains. Validated asthma questionnaires such as the ACT may be used. It is important to note that spirometry results do not necessarily reflect symptom severity; spirometry is often normal despite significant symptoms, particularly in children. If asthma is not well controlled or poorly controlled in either domain, a step up in therapy is indicated. If asthma control has been maintained for at least 3 months, a step down in treatment may be indicated. Refer to Figure 1 for details on step therapy. ACT= asthma control test, FEV₁=forced expiratory volume in 1 second, FEV₁/FVC- forced expiratory volume/forced vital capacity, PFTs=pulmonary function tests, SABA-short-acting beta-agonists. Table created by MR Gupta MD.

Critical Points of Evidence*

TCH Evidence-Based Recommendations

Evidence Supports

- Do not routinely provide home visits for environmental assessments and remediation for children with persistent asthma; these home visits may be appropriate and beneficial for children with life-threatening or poorly controlled asthma. An environmental history should always be taken to identify potential asthma triggers. (1-3, 5, 7, 15, 16) – Strong recommendation, moderate quality evidence

Remarks: The benefits of home visits do not outweigh the associated costs for most children with persistent asthma.

Additionally, caregivers may misinterpret these in-home visits and remediation efforts as a cure for asthma, which they are not. Selective home visits may be indicated for patients with difficult to control asthma and/or parental concerns about their home environment.

Recommendations Adopted/Adapted from National Guidelines

- “Use asthma control chart, assessing both domains of impairment and risk, to determine if therapy should be maintained or adjusted (step up if necessary, step down if possible).” (13)

- “Assess asthma control, medication technique, written asthma action plan, patient adherence and concerns at every visit.” ⁽¹³⁾
Remarks: ICE- Inhaler technique, Compliance, Environment
- “In individuals with asthma who do not have sensitization to specific indoor allergens or who do not have symptoms related to exposure to specific indoor allergens, allergen mitigation interventions should not be a part of routine asthma management.” ⁽¹⁴⁾
- “In individuals with asthma who have symptoms related to exposure to identified indoor allergens, confirmed by history taking or allergy testing, a multicomponent allergen-specific mitigation intervention is recommended”. ⁽¹⁴⁾
- “In individuals with asthma who have sensitization or symptoms related to exposure to pests (cockroach and rodent), integrated pest management is recommended alone or as part of a multicomponent allergen-specific mitigation intervention.” ⁽¹⁴⁾
- In individuals with asthma who have sensitization or symptoms related to exposure to dust mites, impermeable pillow/mattress covers are recommended as part of a multicomponent allergen mitigation intervention, not as a single-component intervention. ⁽¹⁴⁾
Remarks: A multicomponent allergen intervention is the use of two or more of the below single-component interventions simultaneously, to target one or more allergens that the patient is both **sensitized and exposed** to. A particular combination of strategies cannot be identified or recommended as optimal at this time. ⁽¹⁴⁾

Allergen Mitigation Interventions ⁽¹⁴⁾						
Single-Component Interventions	Allergens				Evidence on use as a single-component strategy	Evidence on use as a multicomponent strategy
	Animal dander	Dust mites	Cockroaches	Mold		
Acaricide		++			Evidence insufficient	Intervention makes no difference (moderate certainty of evidence)
Air filtration systems and air purifiers	++	+	+	++	Intervention makes no difference (low certainty of evidence)	Intervention makes no difference (moderate certainty of evidence)
Carpet removal	++	++		+	Evidence insufficient	Intervention makes no difference (low certainty of evidence)
Cleaning products				++	Evidence insufficient	Evidence insufficient
HEPA vacuum cleaners	++	+	+	++	Evidence insufficient	Evidence favors intervention (among children only; moderate certainty of evidence)
Impermeable pillow and mattress covers		++			Intervention makes no difference (moderate certainty of evidence)	Evidence favors intervention (moderate certainty of evidence)
Integrated pest management	+*		++		Evidence favors intervention (low certainty of evidence)	Evidence favors intervention (low certainty of evidence)
Mold mitigation				++	Evidence insufficient	Evidence favors intervention (low certainty of evidence)
Pet removal	++				Evidence insufficient	Evidence insufficient

Table 5: Allergen Mitigation Interventions. Table is adapted from the NAEPP EPR-4 2020 guidelines. ⁽¹⁴⁾ ++ Primary target allergen(s) for the intervention. + Secondary target allergen(s) for the intervention. * Dander from rodents.

[^]See patient goals in Epic for additional Lifestyle Management for allergy triggers for the following allergens/irritants: animal dander, dust/dust mites,

Recurrent Wheezing **0-4 Years of Age**

- In children ages 0–4 years with recurrent wheezing (3 or more episodes in a lifetime or 2 of more episodes in a year) triggered by respiratory tract infections and no wheezing between infections, start a short course of high dose ICS (see Table 6) daily for 7-10 days at first sign of cold/cough or the onset of a respiratory tract infection with as-needed SABA for quick-relief therapy compared to as-needed SABA for quick-relief therapy only. ⁽¹⁴⁾

Low, Medium, High Daily Dose Ranges for Inhaled Corticosteroids (ICS) by Age									
Steroid dose	Low-dose ICS			Medium-dose ICS			High-dose ICS		
	Age in years	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11
Beclomethasone Dipropionate HFA (Qvar Redihaler 40 or 80 mcg)	NR	80-160 mcg	80-240 mcg	NR	>160-320 mcg	>240-480 mcg	NR	>320 mcg	>480 mcg
Budesonide Nebulized (Pulmicort 0.25, 0.5, 1 mg)	0.25-0.5 mg	0.5 mg	NR	0.5-1 mg	1 mg	NR	1 mg	2 mg	NR
DPI (Pulmicort Flexihaler 90, 180 mcg)	NR	180-360 mcg	180-540 mcg	NR	>360-720 mcg	>540-1080 mcg	NR	>720 mcg	>1080 mcg
HFA (Symbicort 80/4.5, 160/4.5 mcg)	160 mcg	160 mcg	160 mcg	160-320 mcg	320 mcg	320 mcg	>320 mcg	640 mcg	640 mcg
Fluticasone Propionate HFA (Flovent 44, 110, 220 mcg or Advair 45/21, 115/21, 230/21 mcg)	176 mcg	88-176 mcg	88-264 mcg	176-352 mcg	176-352 mcg	264-440 mcg	>352 mcg	>352 mcg	>440 mcg
DPI (Flovent diskus 50, 100, 250 mcg or Advair diskus 100/50, 250/50, 500/50 mcg or ArmonAir Digihaler 113 mcg or AirDuo Digihaler 113/14 mcg)	NR	100-200 mcg	100-300 mcg	NR	>200-400 mcg	>300-500 mcg	NR	>400 mcg	>500 mcg
Mometasone Furoate DPI (Asmanex twisthaler 110, 220 mcg)	NR	110 mcg	110-220 mcg	NR	>220-440 mcg	>220-440 mcg	NR	>440 mcg	>440 mcg
HFA (Asmanex 50, 100, 200 mcg or Dulera 50/5, 100/5, 200/5 mcg)	100 mcg	100-200 mcg	100-200 mcg	>100-200 mcg	>200-400 mcg	>200-400 mcg	>200 mcg	>400 mcg	>400 mcg
Ciclesonide HFA (Alvesco 80, 160 mcg)	80 mcg	80 mcg	80-160 mcg	80-160 mcg	80-160 mcg	160-320 mcg	>160 mcg	>160 mcg	320 mcg
Fluticasone Furoate DPI (Arnuity Ellipta 50, 100, 200 mcg)	NR	50 mcg	50 mcg	NR	100 mcg	100 mcg	NR	200 mcg	200 mcg

Table 6: Low, medium, high daily dose ranges of commonly prescribed ICS by age. Data based off GINA and NAEPP published guidelines, and expert panel recommendations. Advair, Dulera, and Symbicort contain ICS/LABA and are recommended to be given as 2 puffs per dose. Combination MDIs containing formoterol as the LABA (Symbicort, Dulera) may be used as rescue and controller therapy (SMART therapy), not to exceed 8 puffs a day for patients 5-11 years old, and 12 puffs a day for patients ≥12 years old. Inhalers containing salmeterol (Advair) should not be used as rescue therapy with maximum dosing at 2 puffs twice daily. Fluticasone Furoate is a dosed at one puff daily. All HFA inhalers should be used with spacer device for optimal dose delivery. *DPI=dry powder inhaler, HFA=hydrofluoroalkane propellant used in metered dose inhalers, NR=not recommended.* Table by MR Gupta MD.

Mild to Moderate Persistent Asthma

4 Years and Older

- In individuals ages 4 years and older with **mild to moderate persistent asthma** who **are likely to be adherent** to daily ICS treatment, a short-term increase in the ICS dose for increased symptoms or decreased peak flow is **not** recommended-conditional. ⁽¹⁴⁾

Remarks: However, a short-term increase (tripling-quadrupling) in the ICS dose may be considered for patients that are not adherent to daily therapy, despite counseling. In randomized control trials (RCT) temporarily quintupling the ICS dose in response to worsening symptoms did not significantly reduce the risk of exacerbations, improve quality of life, or decrease the rate of exacerbations requiring treatment with systemic corticosteroids, but did have a non-statistically significant trend towards decrease in linear growth. ^(6, 11) However, in a real-world study, McKeever et al did show a statistically significant reduction in time to severe exacerbation and the rate of use of systemic steroids when quadrupling the dose of ICS at the onset of an acute exacerbation. ⁽¹²⁾ Although the reasons for the differences in findings are not clear, in the McKeever study, the adherence to daily ICS regimens were found to be low (between 42-50%) as compared to adherence rates in the RCT (>80%). Thus, the recommendation against short-term increases in ICS dose applies most specifically to individuals who are likely to adhere to their daily ICS regimen. In patients where adherence is not well known, intermittent increases in ICS dose to high-dose daily ranges may be considered in all ages to help reduce the severity and duration of exacerbations and mitigate the need for systemic steroids. Increases in daily ICS or ICS/LABA treatment should be communicated to pharmacy to ensure continued adequate supply.

12 Years and Older

- In individuals ages 12 years and older with **mild persistent asthma**, either daily low-dose ICS and as-needed SABA for quick-relief therapy or as-needed ICS to achieve high daily dose ranges and SABA (e.g. Albuterol) used concomitantly is recommended. ⁽¹⁴⁾

Moderate to Severe Persistent Asthma

4 Years and Older

- In individuals ages 4 years and older with **moderate to severe (step 3 and 4) persistent asthma**, ICS-formoterol in a single inhaler used as both daily controller and reliever therapy compared to either: Higher-dose ICS as daily controller therapy and SABA for quick-relief therapy, or same-dose ICS-LABA as daily controller therapy and SABA for quick-relief therapy is recommended. ⁽¹⁴⁾

Remarks: Ensure that the patient has an adequate prescription refill.

12 Years and Older

- In individuals ages 12 years and older with **moderate to severe (step 3 and 4) persistent asthma**, ICS-formoterol in a single inhaler used as both daily controller and reliever therapy compared to higher-dose ICS-LABA as daily controller therapy and SABA for quick-relief therapy is recommended. ⁽¹⁴⁾

Remarks: Refer to the SMART protocol for specific dosing recommendations.

- "In individuals ages 12 years and older with **uncontrolled persistent asthma**, the Expert Panel conditionally recommends against adding LAMA to ICS compared to adding LABA to ICS." ⁽¹⁴⁾
- "If LABA is not used, in individuals ages 12 years and older with **uncontrolled persistent asthma**, the Expert Panel conditionally recommends adding LAMA to ICS controller therapy compared to continuing the same dose of ICS alone." ⁽¹⁴⁾

Remarks: Refer to an Asthma specialist if patient meets this criteria.

- In individuals ages 12 and older with **uncontrolled persistent asthma**, despite consistent use of controller therapy, the Expert Panel conditionally recommends adding LAMA to ICS-LABA compared to continuing the same dose of ICS-LABA. ⁽¹⁴⁾

Remarks: Refer to an Asthma specialist if patient meets this criteria.

Use of Immunotherapy in Allergic Asthma

- "In individuals ages 5 years and older with **mild to moderate allergic asthma**, the Expert Panel conditionally recommends the use of subcutaneous immunotherapy as an adjunct treatment to standard pharmacotherapy in those individuals whose asthma is controlled at the initiation, build up, and maintenance phases of immunotherapy." ⁽¹⁴⁾
- "In individuals with persistent allergic asthma, the Expert Panel conditionally recommends against the use of sublingual immunotherapy in asthma treatment." ⁽¹⁴⁾

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

For recommendations on acute asthma please refer to the [Acute Asthma Exacerbations/Recurrent Wheezing Clinical Guideline](#)

Condition-Specific Elements of Clinical Management

General: The child's age, severity of illness, and environmental exposures are important factors to consider in diagnosing and managing chronic asthma. Other health conditions and atopy are also factors to consider.

Treatment Recommendations:

- Patients should have regular assessments at least every 6 months.
- Assess asthma control, medication technique, inhaler and spacer cleaning, patient adherence and concerns at every visit.
- Each patient should have a written asthma action plan that is reviewed and updated each visit.
- Consider impairment and risk when deciding whether a patient should initiate or adjust treatment.
- Patients that require yellow-zone interventions (for more than 24-48 hours) or any red-zone interventions should be reported to the patient's PCP and/or Asthma specialist.
- Patients needing to be seen at the hospital, ED, or urgent care for asthma symptoms should be seen by their PCP or Asthma Specialist within 30 days to update and adjust the patient's asthma action plan.
- Assess environmental exposures that may trigger or contribute to asthma symptoms
- Refer to Step wise figure above (see figure 1)
- SMART protocol may be considered in select patients
- Use an asthma control test for all patients >4 years of age at each visit.

- Spirometry should be strongly considered every one to two years (or more often for not-well-controlled asthma) to monitor disease in children >5 years of age who are able to complete the test.
- Exhaled FeNO may be helpful in selected cases but should not be used alone for diagnosis (exhaled FeNO can be used for serial monitoring).

Consults/Referrals

- Consider referral to an Asthma Specialist if Step 3 care is required.
- Referral to an Asthma Specialist is recommended if Step 4 care is required.

Measures Structure

- Epic optimizations specific to asthma population

Process

- Proportion of patients who received an Asthma Action Plan
- Proportion of patients filling controller medications
- Percentage of asthma patients with follow up within 6 months

Outcome

- Hospital, ED, and Urgent Care visits
- Percentage of asthma patients with an ACT score of 20 or greater


Appendix A

Asthma Action Plan


@NAME@'s ASTHMA ACTION PLAN

Know your triggers: Avoid irritants like smoke, infections, and things that you are allergic to.
Remember: WASH MY HANDS and get a FLU SHOT EVERY YEAR in the fall to help avoid infections.
Always use a SPACER with inhalers and rinse your mouth out after using any controller inhaler.
Asthma visits: Even if feeling healthy, I should follow-up at least every six months with my provider.



Green Zone – Medications I should take EVERY DAY to stay healthy:

	<p>Symptoms No cough No wheeze No chest tightness</p>	<p>{Green Zone Meds:24665}</p> <p>Call my provider if having regular symptoms or need quick relief medicine more frequently.</p>
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Yellow Zone – Take QUICK Relief Medications:

	<p>Symptoms Slight cough or wheeze Starting a cold Chest tightness Difficulty breathing</p>	<p>Inhaler: albuterol (ProAir/Ventolin/Proventil) or levalbuterol (Xopenex) inhaler with a spacer 4 puffs every 4 hours</p> <p>Continue taking my controller medication(s). CALL MY PROVIDER if I don't get to the GREEN ZONE after 24 hours.</p>
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Red Zone – Take QUICK Relief Medications NOW:

	<p>Symptoms Increasing cough Continued wheezing Worsening wheezing Fast breathing</p>	<p>Inhaler: albuterol (ProAir/Ventolin/Proventil) or levalbuterol (Xopenex) inhaler with a spacer 6 puffs every 2-3 hours as needed for 9-12 hours</p> <p>Oral steroid (if prescribed). Continue taking my controller medication(s). CALL MY PROVIDER NOW OR GO TO THE HOSPITAL.</p>
	<p>Symptoms Breathing very hard/fast Breathing so hard I can't walk or talk Lips or fingertips are blue</p>	<p>DANGER ZONE – I NEED IMMEDIATE HELP! QUICK RELIEF medications are not working. CALL 911 or go to nearest Emergency Room. Continue my QUICK RELIEF medicine in the RED ZONE.</p>

My primary care provider is: @PCP@. **Phone number:** @PCPPH@.

Completed by: @ME@.

The Asthma Action Plan is available via Epic in English and Spanish and can be found in Patient Goals, under Clinical Tools (or with the filter through Snapshot). It is accessible by parents and caregivers in MyChart and should be reviewed and refreshed each visit, even if there are no changes to update.

Appendix B

Green Zone SmartList

Symptoms	
(Green Zone Meds:24665)	
No controller medications needed at this time. Call if having regular symptoms or need for quick relief medicine.	
Beclomethasone (Qvar redihaler) {conc:24696} {dosing:23503}; rinse mouth after using.	
Fluticasone (Flovent HFA) {conc:24691} {dosing:23503} with a spacer; rinse mouth after using.	
Ciclesonide (Alvesco) {conc:19415} {dosing:23503} with a spacer; rinse mouth after using.	
Mometasone (Asmanex) {conc freq:25596}	
Fluticasone/salmeterol (Advair) {conc freq:304050758}	
Budesonide/formoterol (Symbicort) {conc:24697} {dosing:23503} with a spacer; rinse mouth after using.	
Mometasone/formoterol (Dulera) {conc:19416} {dosing:23503} with a spacer; rinse mouth after using.	
Budesonide (Pulmicort) {conc:25331} {dosing:23503}; rinse mouth after using.	
Budesonide (Pulmicort) respules {Pulmicort conc:24692} with Pari neb {1 - 4 times/day:24694}; rinse mouth after administering.	
Montelukast (Singulair) {Singulair conc:304050776} by mouth once daily.	

BEFORE EXERCISE/SPORTS/PLAY:	Albuterol (ProAir/Ventolin/Proventil) HFA {dosing:25332} with spacer {pre-treat min:23506} before activity/sports.
BEFORE EXERCISE/SPORTS/PLAY:	Albuterol 2.5 mg/vial with nebulizer {pre-treat min:23506} before activity/sports.
BEFORE EXERCISE/SPORTS/PLAY:	Levalbuterol (Xopenex) HFA {dosing:25332} with spacer {pre-treat min:23506} before activity/sports.
BEFORE EXERCISE/SPORTS/PLAY:	Levalbuterol (Xopenex) {Xopenex dosing:21157} with nebulizer {pre-treat min:23506} before activity/sports.
BEFORE EXERCISE/SPORTS/PLAY:	Ipratropium (Atrovent) HFA {dosing:25332} with spacer {pre-treat min:23506} before activity/sports.

For additional asthma management goals for patients and families search "asthma" in patient goals in Epic.

Appendix C

Asthma Control Test (ACT)

An Asthma Control Test (ACT) is a validated tool to assess asthma control over the prior 4 weeks. A score of 20 or better indicates symptom control and a score of 19 or less denotes poor control of asthma symptoms. Assess asthma control with an ACT at least every 6 months in patients 4 years and older. There are two versions of the ACT, one for patients 4-11 years of age and one for patients 12 years and older. The patient responds to some of the items together with the caregiver. The ACT is available in English and Spanish and can be completed electronically via Epic's MyChart or in person during the patient's visit.

See <https://www.asthmacontroltest.com/welcome/> for additional information.

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Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

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No relevant financial or intellectual conflicts to report.

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
 - Evidence search confirmed with content experts
2. Review of Existing External Guidelines
 - National Asthma Education and Prevention Program 2020 Focused Updates
 - National Asthma Education and Prevention Program Expert Panel Report 3
3. Literature Review of Relevant Evidence
4. Critically Analyze the Evidence
5. Summarize the Evidence
 - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in an Asthma: Chronic Management evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.

This clinical standard specifically summarizes the evidence *in support of* or *against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions. **"Evidence Supports"** provides evidence to support an intervention. **"Evidence Against"** provides evidence against an intervention. **"Evidence Lacking/Inconclusive"** indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence*.

The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus

weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	Type of Evidence
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the diagnosis/management of Chronic Asthma in children. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children's Hospital. Content Expert Teams are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner should use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient's family, to make the ultimate judgment regarding care.

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Version History

Date	Comments
Apr 2022	Completed