NCC Pediatrics Continuity Clinic Curriculum: **Asthma** ***Faculty Guide***

Pre-Meeting Preparation:

Please read/review the following enclosures:

- Summary of VA/DOD Asthma Clinical Practice Guidelines *(rev: 2012)*
- Sample Asthma Action Plan
- Sample Asthma Symptom Checker
- Sample Inhaler/Spacer Teaching Sheet

Conference Agenda:

- *Review* Asthma Quiz
- Complete Asthma Cases
- Round table: Hands-on demo of different inhalers, disks, masks, and spacers. *Residents should practice "asthma teaching" with each other.*

Post-Conference: *Board Review Q&A*

Extra-Credit:

- National Asthma Education and Prevention Program Expert Panel Report 3: Guidelines for Diagnosis and Management of Asthma *(2007)—74 pgs.*
- Tucson Children's Respiratory Study *(large, prospective cohort study delineating risk factors for asthma)—(2003)*
- The Childhood Asthma Management Program (CAMP) Research Group *(large, multicenter study evaluating long term effects of asthma treatment)—(2000)*
  - Summary & Cases for CAMP Study
- NHLBI Online Asthma Guide *(parent resource- w/videos)*
- Pediatric Asthma in a Nutshell *(PIR, 2014)*
- Indoor Environmental Control Practices and Asthma Management *(AAP Clinical Report, 2016)*

Summary of Asthma Clinical Practice Guidelines

Developed by MAJ Michael McCown (Peds Pulmonologist)

The majority of this summary was pulled directly out of the VA/DOD Asthma Clinical Practice Guideline. The VA/DOD guidelines were based on a combination of the NHLBI and GINA (Global Initiative for Asthma) guidelines. The medication data at the end was pulled from a variety of resources.

Establishing the Diagnosis of Asthma

The diagnosis of asthma primarily rests on obtaining a solid clinical history suggestive of **airway hyper-reactivity** that includes symptoms such as shortness of breath (SOB), cough, wheezing, or chest tightness and objective evidence of **reversible airway obstruction** by either spirometry or broncho-provocation testing. Since many disease processes share similar clinical symptoms, the clinician should not rely solely on symptoms for diagnosing asthma and should always consider alternative diagnoses that mimic asthma. Additional imaging, pulmonary function testing, or biomarkers of inflammation are often required to rule out other causes. It is imperative that the clinician carefully examine the history, spirometric findings, and response to treatment to reach the correct diagnosis and provide proper long-term care.

A. History and Physical Exam:

A complete history and physical exam is the first step in establishing the diagnosis of asthma. Characteristic symptoms of **SOB, wheezing, cough, chest tightness, or nocturnal awakenings** may suggest the diagnosis. The history should emphasize recurrence of symptoms with associated factors such as **exercise, viral infections, or environmental exposures**. Physical exam may demonstrate wheezing or suggest other diagnoses. For children too young to perform spirometry, the diagnosis of asthma is often solely based on the H&P w/o the benefit of objective evidence. Waiting to diagnose asthma until the child is old enough to perform spirometry or other objective measures is inappropriate and unnecessarily delays treatment.

1. A thorough history should be performed to include focus on the following elements:
   - Characterization of symptoms related to **airway obstruction** or **airway hyper-responsiveness** to include cough, wheezing, SOB, chest tightness, & sputum production.
   - In children, **cough** may be the only presenting symptoms, while **wheezing** may not be present in some patients with asthma.
   - The **pattern of symptoms** should be characterized to include onset, duration, frequency, diurnal variation, and seasonality
   - Precipitating and aggravating factors
   - Prior diagnosis, prior symptoms, **prior exacerbations**, and prior therapies
   - Review all current **medications** (include OTC)
   - Family and social history

2. A thorough **birth history** must also be obtained, to include evidence of maternal smoking, prematurity, chronic lung disease, bronchopulmonary dysplasia, and postnatal smoke exposure

3. Careful review of systems for any condition which can **mimic asthma**

4. A thorough PE should be performed emphasizing findings in the following areas:
   - **Upper respiratory tract**: secretions, mucosal swelling, and/or nasal polyps.
   - **Chest**: wheezing during normal breathing or prolonged forced exhalation, hyper-expansion of the thorax, use of accessory muscles, or chest deformity.
   - **Skin**: eczema/dermatitis
   - Absence of the above findings does not exclude the diagnosis of asthma and the examination should include *findings that may support alternative diagnoses*.

B. Chest Radiographs:

The chest X-ray may be an invaluable tool for excluding other diagnose that masquerade or complicate the diagnosis and/or treatment of asthma. Key information provided includes information about: heart size, lung parenchyma, lung vasculature, presence of hyperinflation, and mediastinal structures that are not readily detectable on exam. **Every patient diagnosed with asthma should have at least 1 chest x ray during the initial evaluation to help exclude other conditions**, though it is less useful in the pediatric population vs. adults.

C. Exclude Alternative Diagnoses:

A fundamental tenet of the diagnosis of asthma is a thorough evaluation and exclusion of alternative diagnoses that may masquerade as or co-exist with asthma and complicate the evaluation and treatment. Exclusion/inclusion of alternative diagnoses starts with a thorough H&P from which a differential diagnosis and approach to additional testing can be developed.

1. Alternative diagnoses should be considered in all patients, in particular those over the age of 30 and **under the age of 2** with new symptoms suggestive of asthma

2. **When there is no clear response to initial therapy,** other significant causes of the patient's symptoms and/or airway obstruction must be considered.

D. Pulmonary Function Testing:

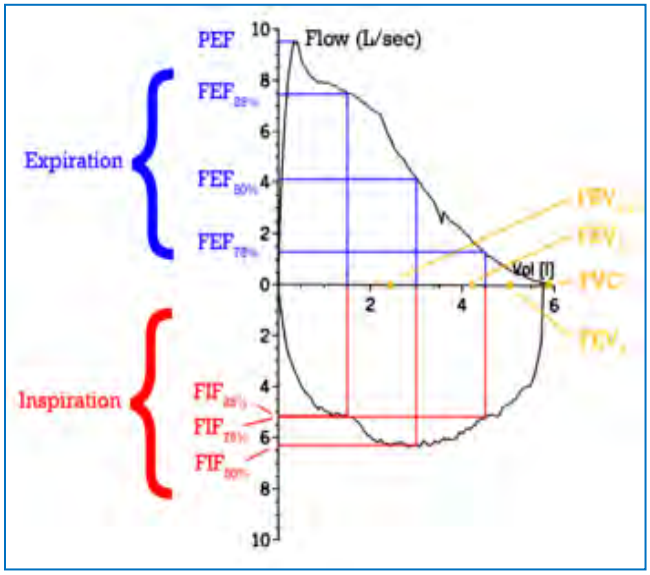
Pulmonary function testing includes spirometry, lung volumes, and measurement of diffusion capacity for carbon monoxide (DLCO). **Children can reliably perform spirometry around by age 6, though some kids can complete the maneuvers as young as age 4.** Since asthma is an obstructive lung disease, spirometry alone is most commonly performed when assessing patients' lung function. *Abnormalities in lung volume and diffusion capacity do not occur from asthma*, and are more commonly found in interstitial lung disease, autoimmune lung disease, or other conditions that are rarely seen in children.

1. Spirometry should be performed in patients suspected to have asthma.

2. If there is obstruction present, **post-bronchodilator testing** should be completed.

3. **Broncho-provocation testing** assesses airway hyperresponsiveness by exposing patients to a known trigger. This may be methacholine, cold air, mannitol, or exercise. These tests are primarily done in adolescents and adults.

4. Consideration of **full pulmonary function testing** should occur on any patient with an atypical course, poor response to therapy, or *symmetric reductions* of FVC and FEV1.

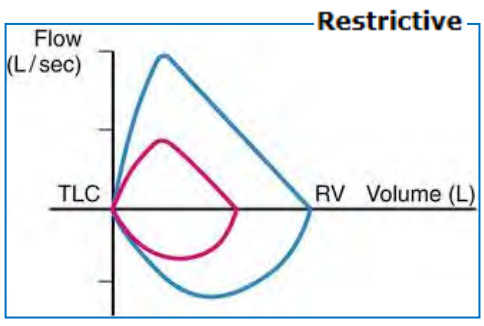


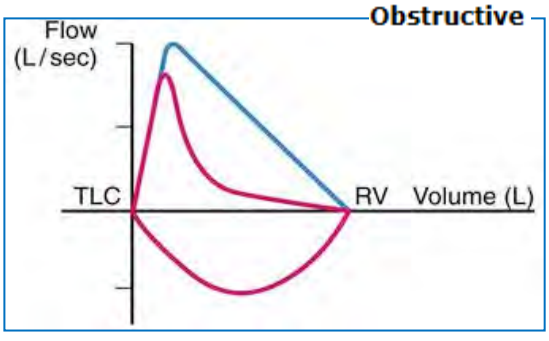
Forced Expiratory Volume in 1 sec (FEV1): Amount of air exhaled with max effort in the first second.

Forced Vital Capacity (FVC): Total volume of air exhaled with maximal effort.

Forced Expiratory Flow at 25% & 75% of FVC (FEF25-75): The flow rate at the 25% & 75% points of the total volume exhaled. Less dependent on patient effort, and indicative of small airway obstr'n.

Parameter	Pattern	
	Restrictive	Obstructive
Lung volumes		
Total lung capacity (TLC)	↓	Normal or ↑
Vital capacity	↓	Normal or ↓
Residual volume (RV)	Normal or ↓	Normal or ↑
RV/TLC ratio	Normal or ↑	↑
Maximal expiratory flow rates		
FEV1	↓	↓
FEV1:FVC	Normal	↓
FEF 25%-75%	↓	↓
Peak expiratory flow	↓	↓
Flow-volume curve	↓ Volume	↓ Flows
Bronchodilator response	None	↑ Flows





E. Indication for Specialty Consultation:

The majority of patients with asthma should be diagnosed and treated at the primary care level. Some patients with more severe asthma or those whose symptoms present a diagnostic dilemma may benefit from an evaluation by a pulmonologist, allergist, or other specialist.

Findings NOT consistent with typical asthma diagnosis that should prompt referral:

- Poor growth/FTT
- Cyanosis at feeding
- Vomiting at feeding
- Clubbing
- Stridor
- Fixed, persistent wheezing
- Hemoptysis
- Any significant chest x ray abnormality that does not resolve
- Lymphadenopathy (persistent)
- Chronic oxygen requirement
- Recurrent pneumonia
- Unilateral wheezing
- Chronic productive cough or irreversible airway obstruction

Assessment and Determination of Initial Asthma Severity

Asthma severity is classified using standardized, widely accepted terminology. This allows clear communication amongst medical providers and gives a uniform framework for the assessment of asthma. The system for assess severity has been refined from previous guidelines. It now includes the **domains of risk** as well as **current impairment** from asthma.

1. A history of asthma symptoms, nighttime awakenings, need for SABA for relief of symptoms and interference with activities should be used to assess **current impairment**.

2. The frequency and severity of asthma exacerbations should be used in assessing the **domain of risk.** Lung function and psychosocial factors may also help predict risk.

3. **Spirometry** should be used in the initial assessment of all patients who are capable of performing an adequate expiratory maneuver. Lung function is a measure of **impairment,** but may also predict **risk**.

4. Classification of severity of the disease should be based on initial assessment of the patient who is not on long-term control therapy.

Table 5. Initial Assessment of Asthma Severity

SEVERITY (Assess over a period of at least 4-6 weeks)		Classifying Asthma Severity and Initiating Therapy			
		Intermittent	Persistent		
			Mild	Moderate	Severe
Impairment	Symptoms	≤ 2 days/week	> 2 days/week but not daily	Daily	Throughout the day
	Nighttime awakenings	≤ 2 x/month	> 2x/month	> 1x/week but not nightly	Nightly
	Use of quick-relief for symptom control	≤ 2 days/week	> 2 days/week but not daily, and not more than once on any day	Daily	Several times/day
	Interference with normal activity	None	Minor limitation	Some limitation	Extremely limited
Lung Function: Normal FEV1/FVC: ≤ 19 yr - 85% 20-39 yr - 80% 40-59 yr - 75%	FEV1	> 80% predicted Normal between exacerbations	> 80% predicted Normal between exacerbations	60-80% predicted	<60% predicted
	FEV1/FVC	Normal	Normal	Abnormal	Abnormal
Risk	Exacerbations requiring systemic corticosteroids (consider severity and interval since last episode)	0-1 x/year	Age 0-4 years: ≥ 2 exacerbations in 6 months requiring oral or intravenous corticosteroids, OR > 4 wheezing episodes/1 year lasting >1 day AND risk factors for persistent asthma		
			Age ≥5 years and adult: ≥ 2 exacerbations per year requiring oral or intravenous corticosteroids		

Modified from NHLBI 2007 and GINA 2007 guidelines.

Initial Treatment

A. Overall Goals of Therapy:

The goals of therapy are to prevent or reduce the frequency and intensity of symptoms, prevent recurrent exacerbations, prevent decline in lung function, and improve quality of life.

1. Reduce impairment:
   - **Prevent chronic and troublesome symptoms** (e.g. coughing or SOB during the day, at night, or with exertion).
   - Require **infrequent use (<2 days/week) of SABA** for quick relief of symptoms, *not including prevention of exercise-induced bronchospasm (EIB).*
   - Maintain **normal lung function.**
   - Maintain **normal activity levels** (including exercise and other physical activity and attendance at work or school).
   - Meet patient and family expectations of and satisfaction with asthma care.

2. Reduce Risk:
   - Prevent recurrent **exacerbations of asthma** and minimize the need for emergency department visits or hospitalizations.
   - Prevent **progressive loss of lung function**; for children, prevent reduced lung growth.
   - Provide optimal pharmacotherapy with minimal or **no adverse effects.**

B. Medications:

Medications to treat asthma are categorized into **long-term control medications** and **quick relief** medications. The initial medication regimen is based on asthma severity, optimal delivery devices, and safety. *See Pharmacotherapy Section for more detailed information.*

1. Patients diagnosed with **persistent asthma** require treatment with an **inhaled corticosteroid** to reduce inflammation. Additional long-term control medications such as long-acting beta agonists (LABAs) or leukotriene inhibitors may be added based on initial asthma severity and subsequent assessment of control. ***Patients must never be treated solely with LABAs.***

2. **Short-Acting Beta Agonists (SABAs)** should be used for **relief of acute asthma symptoms**. An asthma action plan is needed to guide home use of SABAs. 2-6 puffs of SABA may be used in accordance with the asthma action plan. *Patients who do not experience relief after 3 doses in 1 hour OR who need a dose more frequently than every 4 hours should seek medical care.*

3. To ensure adequate medication delivery, an appropriate inhaler device should be used. **Device selection** must include consideration of the patient's developmental age and ability to perform proper technique.

4. A **large volume spacer** such as the Aerochamber should be used in patients who have difficulty using metered-dose inhalers (This will be all children)

C. Additional Management Factors:

1. Establishing a **patient-provider partnership**. Continuity of care will improve patient communication, education, and comfort with disease management.

2. **Reduce exposure to triggers**. In particular, allergic and environmental triggers should be identified and management. Patients with exercise triggers should NOT be instructed to reduce activities, they should have their treatment adjusted or increased to allow full participation.

3. Manage **co-morbid conditions** such as GERD, rhinitis, sinusitis, obesity, or depression.

Monitoring for Control and Follow-Up

A **stepwise approach** to therapy is recommended, in which medications are increased and decreased based on degree of symptom control. Assess both **impairment** and **risk**. Impairment refers to asthma's effects on quality of life and functional capacity. Risk refers frequency and future likelihood of exacerbations, and reduction of lung growth that occurs in asthma.

A. Assessment of Control:

1. Patients with a **new diagnosis** should be seen frequently enough to ensure they are on an effective regimen and demonstrate sufficient understanding of their disease management.

2. After, patients with **intermittent and mild persistent asthma** should be seen at least every 6 mo. Those with **more labile or persistent** symptoms should have more frequent follow up.

2. Every patient should be taught to recognize their symptoms and a **written asthma action plan** should detail the daily management and how to recognize and handle worsening asthma. The plan is particularly recommended for patients who have moderate or severe asthma, a history of severe exacerbations, or poorly controlled asthma.

3. **Spirometry** should be obtained:
   - At diagnosis
   - After treatment & symptoms stabilize
   - If symptoms worsen
   - If medication change is considered

4. **Peak flow devices** can be considered, especially in patients with moderate-severe asthma, poor perceivers of symptoms, and those with frequent exacerbations.

Components of Control		Assessing Asthma Control and Adjusting Therapy All Ages	
		Controlled	**Not Controlled**
Impairment **Normal FEV1/FVC:** ≤19 yr – 85% 20-39 yr – 80% 40-59 yr – 75%	Daytime Symptoms	≤ 2 brief symptomatic episodes per week	> 2 symptomatic episodes per week
	Nighttime awakening	≤ 2 nights/month	> 2 nights/month
	Interference with normal activities	None	Some Limitation
	SABA use for symptom control (not for prevention of EIB)	≤ 2 treatments/week	> 2 treatments/week
	Spirometry (if obtained) * predicted/personal best	FEV1 ≥ 80% AND FEV1/FVC normal	FEV1 ≤ 80% OR abnormal FEV1/FVC
	Asthma Control Test (ACT) Score ages ≥4 years	≥ 20	≤ 19
Risk	Exacerbation requiring oral systemic steroids	0-1 x/year	≥ 2/year
	Progressive loss of lung function	Evaluation requires long-term follow-up and is best assessed by spirometry conducted at regular intervals (at least every 1-2 years)	
	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	
Action for Treatment		Maintain current therapy step Follow up every 1-6 months Consider step down	Step up therapy; Reevaluate in 2-6 weeks - Consider a 5 to 10-day course of oral steroids if acute exacerbation and reevaluate in 1-2 weeks - If persistently uncontrolled or worsening, consider referral to specialist

Modified from the NHLBI (2007) and GINA (2007) guidelines

B. Step-Up or Step-Down Therapy:

1. Patient adherence and inhaler technique should be evaluated at every asthma visit.

2. Adherent patients with poorly controlled asthma or intolerance of medications should be referred to a **specialist**.

3. If asthma is **not controlled** on current regimen, a **"step up"** in therapy is indicated, *after assuring that the patient has good adherence and technique with medication.*

4. If the asthma is **partially controlled**, the provider should consider **"stepping up"** the patient's medication until control is achieved.

5. If the patient is **able to maintain control** of symptoms for at least **3-6 months** on their medication regimen, a **"step down"** or decrease in their control medication may be considered.

Initial Severity	Use of Quick relief [b]	Activity limits	Symptoms		FEV1	Daily Medications [a]		
			Day	Night		Preferred		Alternative
Step 1 Intermittent	< 2 days/week	NONE	< 2 days/week	≤ 2x/month	> 80%	SABA PRN		–
Step 2 Mild	> 2 days/week not daily	Minor limitation	> 2 days/week not daily [c]	> 2x/month	> 80%	Low-dose ICS		–
Step 3 Moderate	Not more than once a day	Minor limitation	> 2 days/week not daily [c]	> 1x/week not nightly	60-80%	Age 0-4:	Medium-dose ICS or Low-dose ICS +LTRA	–
						Age ≥ 5 to Adult:	Low-dose ICS + LABA or Medium-dose ICS	Low-dose ICS + LTRA
Step 4 Severe	Daily	Some limitations	Daily [c]	Nightly	< 60%	Age 0-4:	Medium-dose ICS + LTRA	Consider referral to specialist
						Age ≥ 5 to Adult:	Medium-dose ICS + LABA	Medium-dose ICS + LTRA
Step 5 Severe	Several times a day	Extremely limited	Throughout the day [c]	Nightly	< 60%	Age 0-4:	Medium-dose ICS + LABA + LTRA	Refer to specialist
						Age ≥ 5 to Adult:	High-dose ICS + LABA Consider oral corticosteroids	Medium-dose ICS + LABA + LTRA Consider referral to specialist
Step 6 Severe	Several times a day	Extremely limited	Several times a day [c]	Nightly	< 60%	Age 0-4:	High-dose ICS + LABA + LTRA (Consider 5-10 day course of oral corticosteroids)	Refer to specialist
						Age ≥ 5 to Adult:	High-dose ICS + LABA + oral corticosteroids	High-dose ICS + LABA + LTRA Refer to specialist

[a] Every step: Patient education, environmental control, and management of co-morbidities.
Steps 2-4: Consider subcutaneous allergen immunotherapy for patients who have allergic asthma.
Steps 4-6: Consider referral to specialist for evaluation and/or management.
Steps 5-6: Consider Omalizumab for patients with allergies and elevated IgE.

[b] Quick-relief medications for all patients:
SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20 minute-intervals, as needed. Short course of oral systemic corticosteroids may be needed.

[c] More than 2 exacerbations per year (requiring oral systemic steroids) should prompt step up in therapy

The stepwise approach is meant to assist, not replace, the clinical decision-making required to meet individual patient needs.

Pharmacotherapy

A. Quick Relief (Rescue): Short Acting β2-adrenergic Agonists (SABAs) — e.g. Albuterol

- **Relax smooth muscle** and are the treatment of choice for relief of acute symptoms, exacerbations of asthma, and prevention of EIB.
- SABAs should only be used on an as-needed **(PRN) basis** at the lowest dose and frequency required. Regular, scheduled use is not recommended.
- Increasing use of SABA treatment OR the use of **SABAs > 2 days/week** for symptom relief indicates inadequate asthma control and the need for initiating or increasing anti-inflammatory therapy.
- Efficacy and safety are comparable between racemic and non-racemic agents (e.g. Levalbuterol), therefore use the least costly agent.

B. Long Term (Controller):

1. Inhaled Corticosteroids (ICS): See Table *on next page* for examples.

- Reduce **airway hyper-responsiveness**, inhibit inflammatory cell migration and activation, and **block late-phase reaction** to an allergen.
- Do not appear to alter progression of underlying asthma severity, but do reduce impairment and risk of exacerbations.
- Currently, ICS are the **most effective anti-inflammatory medications** for long-term control of persistent asthma across all age groups and in all therapy care steps.
- ICS should be used as **first-line therapy to control persistent asthma.** Initial dosing should be based on severity.
- Treatment should be monitored for adverse effects, and the patient should be counseled regarding management and risk of adverse effects.
- ICS delivery via nebulization should be administered correctly

Estimated comparative daily doses for inhaled glucocorticoids in adolescents and adults

Drug	Low dose	Medium dose	High dose
Beclomethasone HFA	80-240 mcg	240-480 mcg	>480 mcg
40 mcg/dose	(2-6 puffs)		
80 mcg/dose	(1-3 puffs)	(3-6 puffs)	(>6 puffs)
Budesonide DPI (Flexhaler®)	180-600 mcg	600-1200 mcg	>1200 mcg
90 mcg/dose	(2-6 inhalations)		
180 mcg/dose	(1-3 inhalations)	(4-6 inhalations)	(>6 inhalations)
Budesonide DPI (Turbuhaler®)*	200-600 mcg	600-1200 mcg	>1200 mcg
100 mcg/dose	(2-6 inhalations)		
200 mcg/dose	(1-3 inhalations)	(3-6 inhalations)	(>6 inhalations)
400 mcg/dose	(1 inhalation)	(2-3 inhalations)	(>3 inhalations)
Ciclesonide HFA	80-320 mcg	320-640 mcg	>640 mcg
80 mcg/puff	(1-4 puffs)	(4-8 puffs)	(>8 puffs)
160 mcg/puff	(1-2 puffs)	(2-4 puffs)	(>4 puffs)
Flunisolide HFA*	320 mcg	320-640 mcg	>640 mcg
80 mcg/puff	(4 puffs)	(4-8 puffs)	(>8 puffs)
Fluticasone HFA	88-264 mcg	264-440 mcg	>440 mcg
44 mcg/puff	(2-6 puffs)		
110 mcg/puff	(2 puffs)	(3-4 puffs)	(>4 puffs)
220 mcg/puff			(>2 puffs)
Fluticasone DPI	100-300 mcg	300-500 mcg	>500 mcg
50 mcg/dose	(2-6 inhalations)		
100 mcg/dose		(3-5 inhalations)	(>5 inhalations)
250 mcg/dose			(>2 inhalations)
Mometasone DPI	220 mcg	440 mcg	>440 mcg
110 mcg/dose	(2 inhalations)		
220 mcg/dose	(1 inhalation)	(2 inhalations)	(>2 inhalations)

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 effects.
Some doses may be outside package labeling.
The conventions for expressing doses from metered dose inhalers (MDIs) and dry powder inhalers (DPIs) vary from one country to another. In the United States, MDI doses are expressed as the actuator dose (the amount of drug leaving the actuator and delivered to the patient, eg, fluticasone 44, 110 or 220 mcg per spray). This is different from the dose expressed as the valve dose (the amount of drug leaving the valve, not all of which is available to the patient), which is used in many European countries and in some of the scientific literature (eg, fluticasone 50, 125 or 250 mcg per spray). In the United States, DPI doses may be expressed as the amount of drug in the inhaler chamber following priming (eg, mometasone DPI 110 mcg or 220 mcg per dose). In other countries, DPI doses may be expressed as the amount of drug delivered from the mouthpiece (eg, mometasone DPI 100 mcg or 200 mcg per dose).
HFA: hydrofluoroalkane propellant metered dose inhaler; CFC: chlorofluorocarbon propellant metered dose inhaler.
* Not available in the United States.

2. Long Acting β2-Agonists (LABA) + ICS (*only available in US as combo therapy):*
   e.g. **Advair** (Fluticasone + Salmeterol MDI + DPI); Symbicort (Budesonide + Formoterol DPI); Dulera (Mometasone + Formoterol MDI)—See Table for dose combinations.

- Long-acting bronchodilators that have no anti-inflammatory effect. They are used **always in combination with ICS** for maintenance therapy. LABA dosing varies with the formulation.

- All preparations have a **"black box" warning regarding elevated risk of sudden death**. You should always counsel families about this at time of prescribing.
    - Initial studies evaluating **LABA alone** for asthma control found several deaths of unclear etiology. Potential reasons include down regulation of beta receptors, confusion over rescue vs. chronic medication, or other unknown effect. Deaths occurred in primarily in African-American patients.
    - *No increase in adverse events when used in combination with ICS.*
- Integration into **Step-Up Therapy**:
    - Patients on low-dose ICS: increase dose of ICS or add LABA
    - Patients on moderate to high-dose ICS: add LABA
    - Combining LABA to ICS is preferred to adding Leukotriene Inhibitor (see below)
- *Rarely/never used as initial therapy (i.e. should always be used as a "step-up).*

Usual doses of combination inhaled glucocorticoids and long-acting beta-agonists for the treatment of asthma in adolescents age 12 and older and adults

Medication	Low dose	Medium dose	High dose
Budesonide/formoterol HFA			
80 mcg-4.5 mcg	2 puffs twice a day		
160 mcg-4.5 mcg		2 puffs twice a day	
Fluticasone/salmeterol DPI			
100 mcg-50 mcg	1 inhalation twice a day		
250 mcg-50 mcg		1 inhalation twice a day	
500 mcg-50 mcg			1 inhalation twice a day
Fluticasone/salmeterol HFA			
45 mcg-21 mcg	2 puffs twice a day		
115 mcg-21 mcg		2 puffs twice a day	
230 mcg-21 mcg			2 puffs twice a day
Mometasone/formoterol HFA			
100 mcg-5 mcg		2 puffs twice a day	
200 mcg-5 mcg			2 puffs twice a day

By convention, doses from metered dose inhalers are expressed as puffs, and doses from dry powder inhalers are expressed as inhalations. Do not exceed the maximum number of inhalations/puffs per day listed in the table due to the risk of toxicity from an excess dose of salmeterol or formoterol. Dose per puff or per inhalation of commercially available fixed dose combinations are according to US licensed product information.
HFA: metered dose inhaler with hydrofluoroalkane propellant; DPI: dry powder inhaler.

3. Leukotriene Modifiers: Singulair (Montelukast= leukotriene receptor antagonist = LTRA)

- **Interfere with pathway of leukotriene mediators** released from mast cells, eosinophis, and basophils. Small, variable bronchodilator effect and reduce airway inflammation.
- Monotherapy for well-controlled asthma can be considered, but is not preferred for mild-persistent asthma.
- Can be added as a "step-up" in place of adding a LABA, but not preferred

4. Other Agents: *Use in conjunction with specialist-evaluation*

- Cromolyn: Mast-cell stabilizer with a weak anti-inflammatory effect. Shown to be less effective as compared to ICS. No longer available as metered-dose inhaler.
- Theophyline: Methylxanthine, relaxes bronchial sm. muscle. Narrow therapeutic index.
- Xolair: Monoclonal anti-IgE (injections). Requires Allergy-Immunology consult.
- Chronic Prednisone: *Short courses (3-5 d) can be used for exacerbations.*

Comparison of Inhaler Devices

Device	Advantages	Disadvantages
Metered Dose Inhaler (MDI) Beta2–Agonists Corticosteroids Cromolyn Sodium Anticholinergics	• Portable – compact • Little or no preparation time • Short treatment time • High dose-to-dose reproducibility • No content contamination	• Requires significant breath and actuation coordination • Physical dexterity for actuation required • Not all inhaled medications available in this form • Few with dose counters
Metered Dose Inhaler (MDI) with Valved Holding Chamber (VHC) See above	• Portable • Little or no preparation time • Short treatment time • High dose-to-dose reproducibility • Less pharyngeal deposition vs. MDI • Reduced coordination vs. MDI • No content contamination	• Less compact vs. MDI only • Physical dexterity for actuation required • Not all inhaled medications available in this form • Few with dose counters
Dry Powder Inhaler (DPI) Beta2–Agonists Corticosteroids Anticholinergics	• Portable – compact • Little or no preparation time • Short treatment time • Breath actuated • Less patient coordination • Propellant not required • Most have dose counters	• Requires 30-60 lpm inspiratory flow for optimal delivery • Some units require loading with each dose • Not all medications available in this form
Small Volume Jet Nebulizer Beta2–Agonists Corticosteroids Cromolyn Sodium Anticholinergics	• Patient coordination minimal • Effective with tidal breathing • Can be used with supplemental oxygen	• Lengthy treatment time • Contamination possible • Device cleaning required • Pressurized gas source required • Limited portability • Not all medications available in this form • Device preparation required • Performance variability

Adapted from Dolovich et al., 2005

Asthma Action Plan

AMERICAN LUNG ASSOCIATION®

General Information:

■ Name _____

■ Emergency contact _____ Phone numbers _____

■ Physician/Health Care Provider _____ Phone numbers _____

■ Physician Signature _____ Date _____

Severity Classification

❍ Mild Intermittent ❍ Moderate Persistent
❍ Mild Persistent ❍ Severe Persistent

Triggers

❍ Colds ❍ Smoke ❍ Weather
❍ Exercise ❍ Dust ❍ Air pollution
❍ Animals ❍ Food
❍ Other _____

Exercise

1. Pre-medication (how much and when) _____
_____
2. Exercise modifications _____
_____

Green Zone: Doing Well

Peak Flow Meter Personal Best =

Symptoms

- Breathing is good
- No cough or wheeze
- Can work and play
- Sleeps all night

Peak Flow Meter

More than 80% of personal best or _____

Control Medications

Medicine	How Much to Take	When To Take It

Yellow Zone: Getting Worse

Contact Physician if using quick relief more than 2 times per week.

Symptoms

- Some problems breathing
- Cough, wheeze or chest tight
- Problems working or playing
- Wake at night

Peak Flow Meter

Between 50 to 80% of personal best or
_____ to _____

Continue control medicines and add:

Medicine	How Much to Take	When To Take It

IF your symptoms (and peak flow, if used) return to Green Zone after one hour of the quick relief treatment, THEN

❍ Take quick-relief medication every 4 hours for 1 to 2 days

❍ Change your long-term control medicines by
_____

❍ Contact your physician for follow-up care

IF your symptoms (and peak flow, if used) DO NOT return to the GREEN ZONE after 1 hour of the quick relief treatment, THEN

❍ Take quick-relief treatment again

❍ Change your long-term control medicines by
_____

❍ Call your physician/Health Care Provider within _____ hours of modifying your medication routine

Red Zone: Medical Alert

Ambulance/Emergency Phone Number:

Symptoms

- Lots of problems breathing
- Cannot work or play
- Getting worse instead of better
- Medicine is not helping

Peak Flow Meter

Between 0 to 50% of personal best or
_____ to _____

Continue control medicines and add:

Medicine	How Much to Take	When To Take It

Go to the hospital or call for an ambulance if

❍ Still in the red zone after 15 minutes

❍ If you have not been able to reach your physician/health care provider for help

❍ _____

Call an ambulance immediately if the following danger signs are present

❍ Trouble walking/talking due to shortness of breath

❍ Lips or fingernails are blue

Patient's Name:_____ Today's Date:_____

Childhood Asthma Control Test for children 4 to 11 years.

How to take the Childhood Asthma Control Test

- **Step 1** Let your child respond to **the first four questions (1 to 4)**. If your child needs help reading or understanding the question, you may help, but let your child select the response. Complete the remaining **three questions (5 to 7)** on your own and without letting your child's response influence your answers. There are no right or wrong answers.
- **Step 2** Write the number of each answer in the score box provided.
- **Step 3** Add up each score box for the total.
- **Step 4** Take the test to the doctor to talk about your child's total score.

19 or less

If your child's score is 19 or less, it may be a sign that your child's asthma is not controlled as well as it could be. Bring this test to your doctor to talk about your results.

Have your child complete these questions.

1. How is your asthma today?

0	1	2	3	SCORE
Very bad	Bad	Good	Very good	

2. How much of a problem is your asthma when you run, exercise or play sports?

0	1	2	3	
It's a big problem, I can't do what I want to do.	It's a problem and I don't like it.	It's a little problem but it's okay.	It's not a problem.	

3. Do you cough because of your asthma?

0	1	2	3	
Yes, all of the time.	Yes, most of the time.	Yes, some of the time.	No, none of the time.	

4. Do you wake up during the night because of your asthma?

0	1	2	3	
Yes, all of the time.	Yes, most of the time.	Yes, some of the time.	No, none of the time.	

Please complete the following questions on your own.

5. During the last 4 weeks, how many days did your child have any daytime asthma symptoms?

5	4	3	2	1	0	
Not at all	1-3 days	4-10 days	11-18 days	19-24 days	Everyday	

6. During the last 4 weeks, how many days did your child wheeze during the day because of asthma?

5	4	3	2	1	0	
Not at all	1-3 days	4-10 days	11-18 days	19-24 days	Everyday	

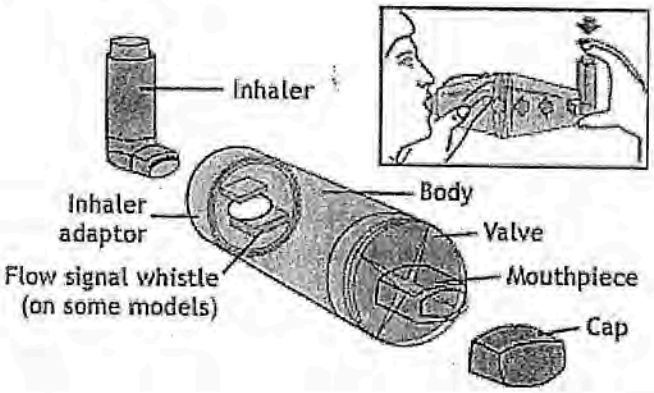
7. During the last 4 weeks, how many days did your child wake up during the night because of asthma?

5	4	3	2	1	0	
Not at all	1-3 days	4-10 days	11-18 days	19-24 days	Everyday	

TOTAL

GlaxoSmithKline

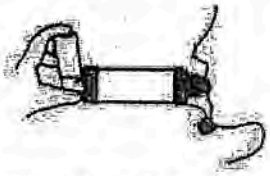
SPACER USE



Spacers should ALWAYS be used with MDIs (Metered-dose inhaler). A spacer is not just for children; it is for people of all ages:)

Taking an Inhaled Treatment (WITHOUT MASK):

1. Shake the inhaler: This mixes the medication properly.
2. Gently breathe out as far as you can without force, away from the spacer.
3. Put the mouthpiece in your mouth between your teeth and close your lips around it.



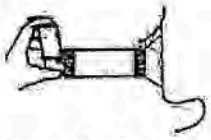
4. Press the inhaler ONCE. Never do two puffs at the same time.
5. Breathe in slowly and deeply over 3 - 5 seconds. Slow your breath down if you hear it whistle. If you hear the whistle don't count that puff and try again.
6. Hold your breath for 10 seconds. This allows the medication time to deposit in the airways.
7. WAIT ONE MINUTE.
8. Repeat steps 1 - 6 when more than one puff is prescribed.

Remember to rinse your mouth after corticosteroid inhalers. (Flovent, Adviar)

Taking an Inhaled Treatment (WITH A MASK)

1. Child should be standing or held in an upright position and as calm as possible. Crying will prevent the medicine from making it to the lungs
2. Shake inhaler before each puff
3. Hold the mask to the face so that both the nose and mouth are covered. It is important to create a good seal between the face and mask so that all medication

will be delivered to the airways.

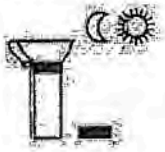


4. Press the inhaler once.
5. Breathe in and out 10 times.
6. Remove the mask from the face. WAIT ONE MINUTE.
7. Repeat steps 1-4 when more than one puff is prescribed.
8. **Remember to rinse mouth after corticosteroid inhaler. (Flovent, Advair)**

Cleaning and Care for the Spacer.

1. Clean the Spacer twice a month or sooner if needed.
2. Remove the back rubber piece for the spacer.
3. Soak both parts for 15 minutes in luke warm water with liquid detergent. Move gently in the water. The spacer is not dishwasher safe. Do not use a brush or anything else inside of the spacer.

4. Rinse - LEAVE RESIDUE OF DISH SOAP IN THE SPACER!!! – The dish soap coats the inside of the spacer instead of the medicine coating the inside. So, the medicine goes to the lungs☺
5. Shake off excess water but do not rub anything in the spacer. Air dry in vertical position.



6. IF YOU PHYSICALLY CANNOT HOLD YOUR BREATH DUE TO AN ACUTE EVENT, FOLLOW THE INSTRUCTIONS FOR TAKING THE MDI WITH A MASK. HOWEVER IN THIS CASE YOU SHOULD TAKE 6 PUFFS AND BE ON YOUR WAY TO A LOCAL HOSPITAL. (A mask is not needed to perform these instructions. Place Spacer in mouth)

Asthma Quiz

1. A great pulmonologist once said, "All that wheezes is not asthma". So what else is it?

Common
Allergies
Asthma or reactive airway disease
Gastroesophageal reflux disease
Infections
Bronchiolitis
Bronchitis
Pneumonia
Upper respiratory infection
Obstructive sleep apnea

"The Diagnosis of Wheezing in Children" *Am Fam Physician.* 2008 Apr 15;77(8):1109-1114.

Uncommon
Bronchopulmonary dysplasia
Foreign body aspiration

Rare
Bronchiolitis obliterans
Congenital vascular abnormalities
Congestive heart failure
Cystic fibrosis
Immunodeficiency diseases
Mediastinal masses
Primary ciliary dyskinesia
Tracheo-bronchial anomalies
Tumor or malignancy
Vocal cord dysfunction

2. At what age should you obtain a **chest X-ray** when considering a diagnosis of asthma? "All ages", especially if first-time wheezer *(this is debatable).* At what age should you obtain **spirometry** when considering a diagnosis of asthma? Age 6; some children can perform at age 4.

3. Please complete the following **asthma severity** table:

	Symptoms/Day	Symptoms/Night	FEV1
Intermittent	≤ 2 days per week	≤ 2 times per month	≥ 80%
Mild Persistent	> 2 days per week	> 2 times per month	≥ 80%
Moderate Persistent	Daily	>1 time per week	60-80%
Severe Persistent	Continuous	Nightly	< 60%

4. Please complete the following **step-wise approach to asthma management, by age range** *(include preferred options only)*:

Step 1 SABA PRN

Step 2 Low-dose ICS

Step 3
0-4y: Medium-dose ICS
5-11y: *Above or* Low dose ICS + LABA, LTRA

Step 4
0-4y: Medium-dose ICS + LTRA
5-11y: Medium-dose ICS + LABA

Step 5
0-4y: Medium- or high-dose* ICS + LABA or LTRA
5-11y: High-dose ICS + LABA

* GINA vs. NHLBI

Step 6
0-4y: High-dose ICS + LABA or LTRA + Oral corticosteroids
5-11y: High-dose ICS + LABA + Oral corticosteroids

Asthma *Mega*-Case

Initial Presentation:

Wheezy Knight is a 7 y.o. female who presents with a chief complaint of "`PICU follow-up`". Wheezy was admitted from Malcolm Grow 3 days ago with respiratory distress and wheezing. She was treated with 3 "stacked nebs" in the ED and 1 dose of PO steroids with minimal improvement. In the PICU, Wheezy was started on IV Solumedrol and continuous Albuterol, and was weaned by HD3 to q4h Nebs. She was discharged home on HD4 to complete a 5-day course of PO steroids and a tapering course of Albuterol.

Wheezy's mother reports that she's doing well, now 2 days post-discharge, but asks, "The nurses gave me some sheet of paper—which we lost—with stop-lights, and they said something about my Wheezy having asthma. Do you think she has asthma?"

How will you address Mrs. Knight's question? What else do you want to know?

- Characteristic Symptoms: SOB, wheezing, cough, chest tightness, nocturnal awakenings.
- Characteristic Triggers: exercise, viral infections, environmental exposures
- PMHx: Birth history (CLD, BPD); prior diagnosis of asthma or RAD; prior use of bronchodilators for "viral infections" or "cough"; diagnosis of other atopic disease
- SocHx: pre- and post-natal smoke exposure; allergen exposures
- FamHx: of asthma or other atopic disease
- ROS: r/o mimics (e.g. pertussis, CF, GERD, post-nasal drip, tracheomalacia, CHF)

Mrs. Knight reports that Wheezy "coughs all the time". When you probe further, you learn that she wakes up coughing at least 2-3 nights per week "ever since we PCS'd 1 year ago . . . because of the air quality". She also usually has 1-2 "coughing spells" each day, often on her walk to the bus-stop or when playing Dance Dance Revolution with her step-brother. She has been prescribed "breathing treatments" in the past for colds, but more recently, her mother has been giving cough syrup at night.

Wheezy was a term infant, with no other PMHx. She lives with her mother and step-father. Her mother has no history of atopy, and she is unsure about Wheezy's bio-father, but adds "his skin is kind of dry, now that you mention it". Her step-father smokes, but "only outside". They have 2 cats, and they live in an apartment in D.C. that "may have had a cockroach issue".

***Now,* how will you address Mrs. Knight's question about whether or not Wheezy has asthma? If you have enough information, how would you classify her asthma?**

- Impairment: Likely has **moderate-persistent** asthma—daily coughing (triggered by exercise or "colds"), nighttime sxs >1 night/week, limits normal activities (e.g. dancing, walking to bus-stop). *No info at this time about PFTs or need to use rescue-med.*
- Risk: Only **1 major exacerbation** (recent PICU stay) in her lifetime suggests lower risk. However, her exposure to potential triggers (e.g. cockroaches, cat dander) may place her at risk for future exacerbations, unless they are addressed.

Wheezy's PE is significant for intermittent end-expiratory wheezing, a dry cough, and clear rhinorrhea. There is no eczema. Her CXR from the ER was read as "No infiltrate; no airway abnormalities. Diffuse peribronchial cuffing, clinical correlation required". You tell Mrs. Knight that Wheezy appears to have asthma. She looks at you quizzically and asks if there is a "better test you can do for asthma".

You decide to proceed with PFTs today, realizing that Wheezy is just 2 days s/p discharge. **Where and how are PFTs done in the WR-B clinic? What information will you need?**

- PFTs are done in the **Sub-Specialty Clinic** by the RT (Ms. Shannon Coles) or one of the Sub-Specialty Nurses. *You can often walk your patient over for a same-day PFT.*
- Normal values for PFTs are based on **age, height, ethnicity**, and **sex**—be sure to provide this information prior to your patient's PFT and be sure to check the results for accuracy.

Wheezy's PFT results are at the end of this case. **What is your interpretation? Do these PFT results support your prior diagnosis?** Results suggest **reversible obstructive disease:**

- Decreased FEV1 *(55%)*, decreased FEV1: FVC *(55%)*, decreased FEF 25-75 *(29%)*
  - ***Based on example PFTs, patient is technically in severe persistent zone (FEV1 <60% predicted).*** *This may impact treatment plan (i.e. start with Step 4 vs. 3).*
- Improvement pre- vs. post-bronchodilator [**>12%Δ is significant**; criteria may vary]
  - Change in FEV1= *47%*; Change in FEF 25-75 = *123%*
- "Scooped-out" appearance of flow-volume loop

You present these results to Mrs. Knight, who admits that she's been worried about asthma all along. As you prepare to conclude the visit, she asks again about Wheezy's missing Asthma Action Plan. **Write an Asthma Action Plan, using your preferred template. Discuss the rationale for each of the medications you choose. When do you want to follow up?**

➡ **See Asthma-Action Plan at the end of this case:* Step 3 Recommendations*

- Quick-relief/Rescue-Med: **Albuterol**—relaxes bronchial smooth muscle
- Maintenance/Controller-Med: **Flovent**— decrease airway inflammation/late-phase rxn.
  - "Preferred" is **medium-dose ICS** (e.g. Flovent 110 mcg; 3-4 puffs/day) or **low-dose ICS + LABA** (e.g. Advair 45/21 mcg; 2 puffs/day).
  - "Alternative" is **low-dose ICS** (e.g. Flovent 44mcg) + **LTRA** (e.g. Singulair).
- ***Be sure to order appropriate-sized mask & spacer, in addition to ordering inhalers.***
- Since this is a new diagnosis, in a patient with persistent and labile symptoms, she should probably be **seen in 1-2 weeks** with phone follow-up within the next several days.

Wheezy and her mother thank you for your evaluation. Several minutes into your next patient, you are interrupted by the pharmacist who asks, "Mrs. Knight wants to know why she can't do nebulizer treatments, since that was what got her better in the PICU". **How do you respond?**

- In mild-to-moderate exacerbations, **MDI+VHC is as effective as nebulized therapy** with appropriate administration technique and coaching by trained personnel.
- In general, MDI +VHC (spacer) can be used for almost all children **≥ 4yrs**, and with a mask can be used for many children < 4yrs.

If Wheezy were younger and could not use inhalers, how would you order a nebulizer?

- Contact one of the Tricare Network Home Health Agencies:
  - *America's Health Care (1-800-545-6026)*
- Provide patient's name, age, reason for nebulizer request, home phone # and address.
- Enter **CON order in CHCS for "DME & Medical Supplies Net BE"**. In the comments section, put the name of the agency and the pertinent patient information, above.
- Print out CON order from CHCS and fax to Health Agency:
  - *America's Health Care (1-800-545-6071)*

Follow-up Visit:

Wheezy and her mother return in 2 weeks for a follow-up. **What do you want to ask Wheezy and her mother to assess her degree of control?** *See Asthma Control Test:*

- Ensure **compliance** with controller medication regimen; review Asthma Action Plan.
- Ask about daytime symptoms (>2/wk), nighttime awakenings (>2/mo), interference with daily activities, SABA use for sx control (>2/wk)

Wheezy proudly reports that she has taken the "pink and orange" (Flovent) inhaler every day for the last 2 weeks. Mrs. Knight concurs and states that the coughing spells have decreased to 2x last week, which is about how many times they used Albuterol. There have been no nighttime awakenings and no interference with daily activities. Wheezy's PE today is unremarkable.

Is her asthma controlled? What else do you want to at this visit? What is your next step?

- Consider **repeating spirometry**, if you suspect that treatment/sxs have stabilized.
- Wheezy meets criteria for "Controlled" asthma. Recommendation is to consider step-down therapy if control is maintained for **3-6 months**. Follow-up monthly or bi-monthly.
- Step-down therapy would be (Step 2)—**low-dose ICS** (e.g. Flovent 110mcg; 2 puffs/day; Flovent 44mcg; 2-6 puffs/day)

What if Mrs. Knight reported daytime symptoms >2x/ week, nighttime awakening >2 nights/month, SABA use >2x/ week. **Under this scenario, what is your next step?**

- Wheezy would then meet criteria for "Not Controlled" Asthma.
- First, double-check compliance and technique with elements of Asthma Action Plan.
- Step-up therapy would be (Step 4)—"Preferred" is **Medium-dose ICS + LABA** (e.g. Advair 115/21 mcg; 2 puffs BID); "Alternative" is **Medium-dose ICS + LTRA.**
- **Follow-up** q2-6 weeks, until control is obtained.

When would you make a referral and to whom? *(From Expert Panel Report)*

Referral to an asthma specialist for consultation or co-management is recommended:

- If there are symptoms not-consistent with asthma *(see list in reading)*
- If there are difficulties achieving or maintaining control of asthma
- If the patient required >2 bursts of oral systemic corticosteriods in 1 year
- If the patient has an exacerbation requiring hospitalization
- If step 4 care or higher is required (step 3 care or higher for children 0–4 years of age)
- If immunotherapy or omalizumab is considered
- If additional testing is indicated (e.g. full spirometry, allergy testing)

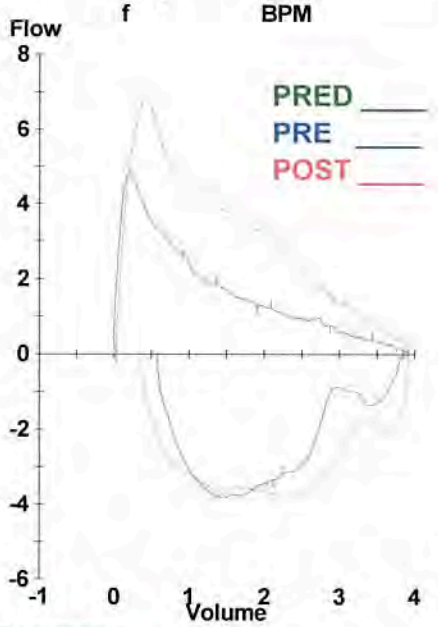
WRAMC Peds Pulmonary
Washington DC

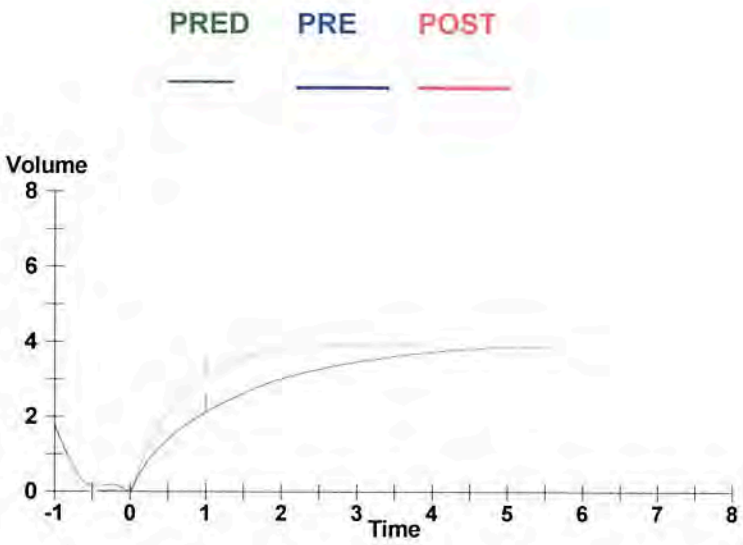
Name Wheezy Knight
Gender: Female
Age: 7 Race: Caucasian
Height(in): Weight(lb):
Any Info:

Id:
Date:
Temp: 22 PBar: 756
Physician: Lipton
Technician: Smith

Spirometry

	(BTPS)	PRED	PRE-RX BEST	%PRED	POST-RX BEST	%PRED	% CHG
FVC	Liters	4.40	3.87	88	3.93	89	2
FEV1	Liters	3.82	2.12	55	3.10	81	47
FEV1/FVC	%	87	55		79		
FEF25-75%	L/sec	4.29	1.24	29	2.76	64	123
IsoFEF25-75	L/sec		1.24		2.93		136
FEF75-85%	L/sec		0.53		1.22		130
PEF	L/sec	7.90	4.83	61	7.17	91	49
FET100%	Sec		5.62		3.84		-32
FIVC	Liters		3.28		3.58		9
FEV1	Liters	3.82	2.12	55	3.10	81	47
FIV1	Liters		1.54		2.99		94
FEF/FIF50			0.40		0.89		122
Vol Extrap	Liters		0.01		0.07		340
FVL ECode			100011		000011		
MVV	L/min	120					
f	BPM						





Comments:

Interpretation:

By signing this interpretation the physician is acknowledging that he/she has reviewed the computer interpretation and, in his/her professional opinion, this is a true and accurate reflection of the patient's current clinical condition.

CALIBRATION: Pred Volume: 3.00 Expire Avg: 3.00 Inspire Avg: 3.00 Flow Cal Date: 05/19/11

( ) = OUTSIDE 95% CONFIDENCE INTERVAL PF Reference: NHANES III - Version: IVS-0101-21-1

Asthma Action Plan

AMERICAN LUNG ASSOCIATION®

General Information:

- Name: Wheezy Knight
- Emergency contact: Mrs. Knight (a.k.a. Mom) — Phone numbers: _____
- Physician/Health Care Provider: Dr. Breathe Goode — Phone numbers: Call "Mommy Pager"
- Physician Signature: _____ Date: _____

Severity Classification

- ❍ Mild Intermittent
- ☒ Moderate Persistent
- ❍ Mild Persistent
- ❍ Severe Persistent

Triggers

- ☒ Colds
- ☒ Smoke
- ☒ Weather
- ☒ Exercise
- ☒ Dust
- ☒ Air pollution
- ❍ Animals
- ❍ Food
- ❍ Other _____

Exercise

1. Pre-medication (how much and when): Albuterol 2 puffs 15min prior
2. Exercise modifications: none

Green Zone: Doing Well

Peak Flow Meter Personal Best =

Symptoms

- ■ Breathing is good
- ■ No cough or wheeze
- ■ Can work and play
- ■ Sleeps all night

Can include allergy meds or alternative controllers.

Peak Flow Meter

More than 80% of personal best or _____

Control Medications

Medicine	How Much to Take	When To Take It
Flovent 110 mcg	2 puffs	2x/ day (AM & PM)

Yellow Zone: Getting Worse

Contact Physician if using quick relief more than 2 times per week.

Symptoms

- ■ Some problems breathing
- ■ Cough, wheeze or chest tight
- ■ Problems working or playing
- ■ Wake at night

Peak Flow Meter

Between 50 to 80% of personal best or _____ to _____

- Some providers may double ICS dose.
- Not all providers (or pts) are comfortable with home initiation of PO steroids.

Continue control medicines and add:

Medicine	How Much to Take	When To Take It
Albuterol	2 puffs	Every 4-6hr for sxs
Start oral corticosteroid (5 day course)		

IF your symptoms (and peak flow, if used) return to Green Zone after one hour of the quick relief treatment, THEN

- ☒ Take quick-relief medication every 4 hours for 1 to 2 days
- ❍ Change your long-term control medicines by _____
- ☒ Contact your physician for follow-up care

IF your symptoms (and peak flow, if used) DO NOT return to the GREEN ZONE after 1 hour of the quick relief treatment, THEN

- ☒ Take quick-relief treatment again
- ❍ Change your long-term control medicines by _____
- ❍ Call your physician/Health Care Provider within 2-4 hours of modifying your medication routine

Red Zone: Medical Alert

Ambulance/Emergency Phone Number:

Symptoms

- ■ Lots of problems breathing
- ■ Cannot work or play
- ■ Getting worse instead of better
- ■ Medicine is not helping

Peak Flow Meter

Between 0 to 50% of personal best or _____

Not all providers are comfortable with home initiation of PO steroids.

Continue control medicines and add:

Medicine	How Much to Take	When To Take It
Albuterol	4-6 puffs	Every 20min x 3
Start oral corticosteroid (5 day course)		

Go to the hospital or call for an ambulance if

- ☒ Still in the red zone after 15 minutes
- ☒ If you have not been able to reach your physician/health care provider for help
- ❍ _____

Call an ambulance immediately if the following danger signs are present

- ☒ Trouble walking/talking due to shortness of breath
- ☒ Lips or fingernails are blue

Asthma Board Review

1. A mother brings her 9-year-old boy to your clinic because he has been complaining of being tired in physical education class at school for the past few months. When you ask him about his symptoms, he reports having trouble catching his breath after he runs. Past medical history is negative, and a review of systems reveals only a cough that occurs primarily at night several times a month. He has grown well, and findings on physical examination are normal.

Of the following, the MOST likely reason for his exercise intolerance is
A. cystic fibrosis
B. exercise-induced asthma
C. iron deficiency anemia
D. vocal cord dysfunction
E. Wolff-Parkinson-White syndrome

Exercise intolerance is the failure to tolerate physical exercise at a level that would be expected for a person's age and condition, such as described for the boy in the vignette. For the child, it is important to determine whether exercise intolerance is due to a primary pulmonary or extra-pulmonary cause. Pulmonary causes include asthma, cystic fibrosis, and acute and chronic infections of the lung. Among the extra-pulmonary causes of exercise intolerance are cardiac disorders such as congestive heart failure, neuromuscular disorders such as muscular dystrophy, anemia, and deconditioning.

Exercise intolerance is measured primarily by the maximal oxygen consumption test, and examining the components of maximal oxygen consumption can be useful in understanding the reasons for exercise intolerance associated with various disease states. The Fick equation for maximal oxygen consumption is:
$VO_2max = SVmax \times HRmax \times (CaO_2 — CvO_2)max$

> where VO_2 = oxygen consumption, SV=stroke volume, HR=heart rate,
> CaO_2=oxygen content of arterial blood, and CvO_2=oxygen content of mixed venous blood.

A sedentary lifestyle and certain cardiac diseases such as congestive heart failure and cyanotic heart disease can cause a decrease in stroke volume. Diseases such as asthma, cystic fibrosis, anemia, and vocal cord dysfunction lower the oxygen content of arterial blood. States causing muscle weakness, such as muscular dystrophy or general deconditioning, can result in decreased oxygen use by the tissues. Alterations in any of these components can lead to decreased maximal oxygen consumption and exercise intolerance.

The shortness of breath after running and a nighttime cough described for the boy in the vignette make exercise-induced bronchoconstriction (EIB), also called exercise-induced asthma, the most likely diagnosis. Children who have EIB generally experience shortness of breath, chest tightness, and cough approximately 10 to 15 minutes after beginning exercise.

Administration of a short-acting beta2 agonist or inhaled cromolyn sodium prior to exercising can help to prevent the symptoms. For patients who have poorly controlled asthma and experience EIB, the most appropriate management is the use of inhaled corticosteroids and possibly other maintenance medications to control overall asthma symptoms. If a child who has presumed EIB fails to respond to pretreatment with beta2 agonists or inhaled cromolyn sodium, other diagnoses such as vocal cord dysfunction should be considered.

Vocal cord dysfunction is the paradoxic adduction of the vocal cords during inspiration, causing airway obstruction during exercise. Inspiratory wheezing and throat tightness are common symptoms, but cough

at night is not. Cystic fibrosis is unlikely in any child who is growing well and has no extrapulmonary symptoms. Iron deficiency anemia can cause exercise-induced dyspnea, but the boy's history is not suggestive of this condition. Wolff-Parkinson-White syndrome causes re-entrant tachycardia; syncope rather than exercise intolerance is the usual clinical manifestation.

2. An 18-month-old girl has been having an intermittent nonproductive cough for the past 6 months. Her parents state that the cough awakens the toddler at night a few times a month and occurs when playing vigorously. During a recent upper respiratory tract illness, her cough worsened and occurred daily for 3 weeks. On physical examination, there is no nasal discharge, and the toddler appears healthy.

Of the following, the MOST likely diagnosis is
A. asthma
B. atypical pneumonia
C. gastroesophageal reflux
D. sinusitis
E. upper airway cough syndrome

The chronic cough that is exacerbated during the night, with activity, and during an upper respiratory tract infection described for the child in the vignette most likely represents asthma. Chronic cough typically is defined as one that persists for more than 8 weeks. When the patient's chest radiograph appears normal, three causes account for 95% of chronic coughs: asthma, gastroesophageal reflux (GER), and upper airway cough syndrome (UACS) (previously termed postnasal drip syndrome).

Asthma usually develops in early childhood, with 80% of patients reporting symptoms prior to age 6 years. Symptoms may include cough, wheezing, shortness of breath, and chest tightness. The most common trigger for infants and toddlers is a viral upper respiratory tract infection (URI). Fortunately, URI-induced wheezing resolves in most infants by age 6 years (so-called "transient wheezers"). Those who continue to have asthma symptoms after age 6 are at greater risk for persistent asthma.

UACS encompasses allergic rhinitis, nonallergic rhinitis, and sinusitis. Allergic rhinitis typically occurs in children older than 3 years of age and is associated with other ocular and nasal symptoms, such as pruritus, sneezing, and rhinorrhea. Sinusitis also is characterized by rhinorrhea and postnasal symptoms. Atypical pneumonia caused by *Mycoplasma pneumoniae* and *Chlamydophila pneumonia* (previously termed *Chlamydia pneumoniae*) may present at any age, although it is unusual prior to age 3 years. Characteristic constitutional symptoms include fever, malaise, and headache. Cough can represent the sole manifestation of GER, but GER usually becomes symptomatic during the first few postnatal months, improving by 12 months of age. GER may worsen at night during supine positioning, but exercise and URIs are uncommon precipitating factors for GER symptoms.

3. An 8-year-old girl presents with multiple episodes of "bronchitis." For the past 2 years, she has had problems with coughing, wheezing, and difficulty catching her breath during vigorous exercise. Treatment with a metered dose beta2 agonist inhaler has improved her symptoms. In your office, you discuss the different tests to assess lung function.

Of the following, the BEST test to measure lung function for this girl is
A. arterial blood gas
B. exhaled breath condensate
C. exhaled nitric oxide
D. pulse oximetry
E. spirometry

Spirometry, also referred to as a pulmonary function test (PFT), measures inspiratory and expiratory respiratory effort. Established pretest norms are based on the patient's height and ethnicity. Measurements of lung function that can be obtained with spirometry include the forced vital capacity (FVC), volume of air exhaled during the first second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF), and airflow during the middle half of the effort (forced expiratory flow) (FEF25-75). Because ideal test conditions require a patient to exhale for 6 seconds, children younger than 6 to 7 years of age often are unable to complete the test. Also, spirometry does not measure total lung capacity (TLC) or residual volume (RV).

An arterial blood gas is a gas diffusion measurement that provides insight into oxygenation (PO2) and ventilation (PCO2), but it does not measure lung function. Pulse oximetry is a simple, noninvasive method to measure oxygenation, but it also does not measure ventilation or lung function.

Exhaled nitric oxide (eNO) measurement was approved by the United States Food and Drug Administration in 2003 for children ages 4 years and older. Although not a measure of lung function, eNO is a useful noninvasive tool to measure nitric oxide, a marker of airway inflammation.

Exhaled breath condensate is a noninvasive method to measure the pH of the airway, another marker of inflammation. Similar to eNO, exhaled breath condensate does not measure lung function but is being developed as another tool to assess airway inflammation and assist with asthma management.

4. A 16-year-old girl who has moderate persistent asthma presents to the emergency department with coughing, wheezing, and increasing dyspnea. She states that she was feeling fine until she was exposed to cologne that one of her classmates was wearing. An ambulance was called after her symptoms did not improve following administration of two puffs of her beta2 agonist inhaler. On physical examination, the teenager has a respiratory rate of 30 breaths/min, heart rate of 90 beats/min, and pulse oximetry of 98% on room air. She has difficulty completing a sentence and points to her neck, saying it is "hard to get air in." Her lungs are clear to auscultation, and rhinolaryngoscopy demonstrates adduction of one of the vocal cords during inspiration. Pulmonary function testing shows a blunted inspiratory loop.

Of the following, the MOST likely cause for this patient's symptoms is
A. allergic rhinitis
B. asthma exacerbation
C. habit cough
D. sinusitis
E. vocal cord dysfunction

The teenager described in the vignette has signs and symptoms consistent with vocal cord dysfunction (VCD), a condition that can mimic or coexist with asthma. In contrast to an asthma exacerbation, the key features of VCD exhibited by this girl include a normal room air pulse oximetry reading, failure to improve with her beta2 agonist inhaler, clear lungs, and difficulty with inspiration instead of expiration. A blunted inspiratory loop on spirometry also is supportive of VCD, although affected patients usually have normal spirometry readings when not experiencing symptoms. Triggers for VCD can include viral upper respiratory tract infections, chemicals, fumes, pollution, emotional changes, laughing, exercise, gastroesophageal reflux (GER), and cold air.

GER can cause cough and be a trigger for asthma. It may worsen during exercise, eating, or when supine. Although GER is a cause of chronic cough, the patient in the vignette does not admit to GER symptoms, making this diagnosis unlikely.

Postnasal drip syndrome, now termed upper airway cough syndrome, can result in coughing due to allergic rhinitis, nonallergic rhinitis, or sinusitis. The lack of nasal congestion, rhinorrhea, or postnasal drip for this girl makes this an unlikely cause of her acute symptoms.

Psychogenic cough, also called habit cough syndrome, is a well-described chronic cough that may begin after a viral upper respiratory tract infection. The cough usually is nonproductive and does not occur during sleep. Teenagers who have asthma may use coughing as a method to avoid school (factitious or malingering), but the girl in the vignette is not having symptoms during a specific class or time of day.

5. You are asked to consult on a 9-month-old boy who has been hospitalized five times for wheezing. His history reveals occasional coughing with feedings, but results of a pH probe performed during his last admission were normal. His weight and height are at the 50th percentile. Except for scattered wheezes with good aeration bilaterally, results of his physical examination are normal.

Of the following, the test that is MOST likely to reveal the cause of his recurrent wheezing is
A. chest computed tomography scan
B. immunoglobulin panel
C. inspiratory and expiratory chest radiographs
D. pulmonary function testing
E. videofluoroscopic swallow study

Recurrent wheezing can be caused by many diseases, including reactive airway disease, cystic fibrosis, extrinsic airway compression, and aspiration with and without gastroesophageal reflux. The history of coughing with feedings described for the boy in the vignette should alert the clinician to the possibility of swallowing dysfunction, with aspiration as the cause of his recurrent symptoms. Accordingly, a video-fluoroscopic swallow study is the best diagnostic procedure to reveal the cause of his wheezing.

Gastroesophageal reflux is a common cause of recurrent aspiration, but swallowing dysfunction without gastroesophageal reflux also can occur and cause significant recurrent respiratory symptoms. Several types of swallowing dysfunction are seen in infants.

Laryngeal penetration without aspiration describes the entry of food particles into the airway down to the level of the vocal cords. Aspiration is defined as the entry of food below the level of the vocal cords, and nasopharyngeal backflow or reflux is the entry of food posterior or superior to the soft palate. One study of infants referred for swallowing study due to recurrent respiratory difficulty showed that all had some degree of swallowing dysfunction and silent aspiration. The dysfunction resolved in all of the infants by age 9 months. Another study showed that of infants who had swallow studies, 50% showed laryngeal penetration, aspiration, or nasopharyngeal regurgitation. Most of these infants did not cough to clear their airway, which should remind the clinician that absence of cough with feedings does not eliminate the possibility of silent aspiration. If a fluoroscopic swallow study reveals swallowing dysfunction, thickening formula or human milk and feeding in the upright position may improve symptoms. In some cases, cessation of oral feedings and placement of a nasojejunal or gastrostomy tube may be indicated for a period of time.

Chest computed tomography scan may be indicated to rule out a structural anomaly if an infant has recurrent localized wheezing, but it probably would not be helpful for assessing recurrent diffuse wheezing. An immunoglobulin panel can aid in ruling out immunodeficiency, but in an infant who has no recurrent infections and is growing well, immunodeficiency is not likely. Inspiratory and expiratory chest radiographs and pulmonary function testing are technically difficult in infants and would not be of benefit in the evaluation of this child.