Lower Airway Diseases

- Lower air way disease often result in air way obstruction. Obstruction below the thoracic inlet manifist mainly as wheezing.
- A **wheeze** is a continuous musical sound that is produced by vibration of airway walls mainly on expiration.
- Intrathoracic pressure is increased relative to atmospheric pressure during exhalation, which tends to collapse the intrathoracic airways and accentuates airway narrowing on expiration. This manifests as expiratory wheeze, prolonged expiratory phase, and increased expiratory work of breathing.

Causes of Wheezing in Childhood:

1- **Reactive airway disease**
   - Asthma
   - Hypersensitivity reactions

2- **Bronchial edema**
   - Infection (e.g., bronchiolitis(
   - Inhalation of irritant gases or particulates

3- **Bronchial hypersecretion**
   - Infection
   - Inhalation of irritant gases or particulates
   - Cholinergic drugs

4- **Aspiration**
   - Foreign body
   - Aspiration of gastric contents

Chronic or recurrent :

1. Reactive airway disease.
2. Hypersensitivity reactions, allergic bronchopulmonary aspergillosis.
3. Dynamic airway collapse.
   - Bronchomalacia/tracheomalacia
   - Vocal cord adduction
4. Airway compression by mass or blood vessel
   - Vascular ring/sling
   - Lymph nodes
5. Aspiration
   - Foreign body
   - Swallowing dysfunction
   - GER

6. Bronchial hypersecretion or failure to clear secretions
    - Bronchitis, bronchiectasis
    - Cystic fibrosis
7. Intrinsic airway lesions
    - Endobronchial tumors
8. Endobronchial tuberculosis
    - Bronchial or tracheal stenosis
    - Bronchiolitis obliterans
9. Congestive heart failure

Asthma ~

Asthma is a chronic inflammatory condition of the lung airways resulting in episodic airflow obstruction. This chronic inflammation heightens the airways hyperresponsiveness (AHR) to provocative exposures.

Epedemiology :-

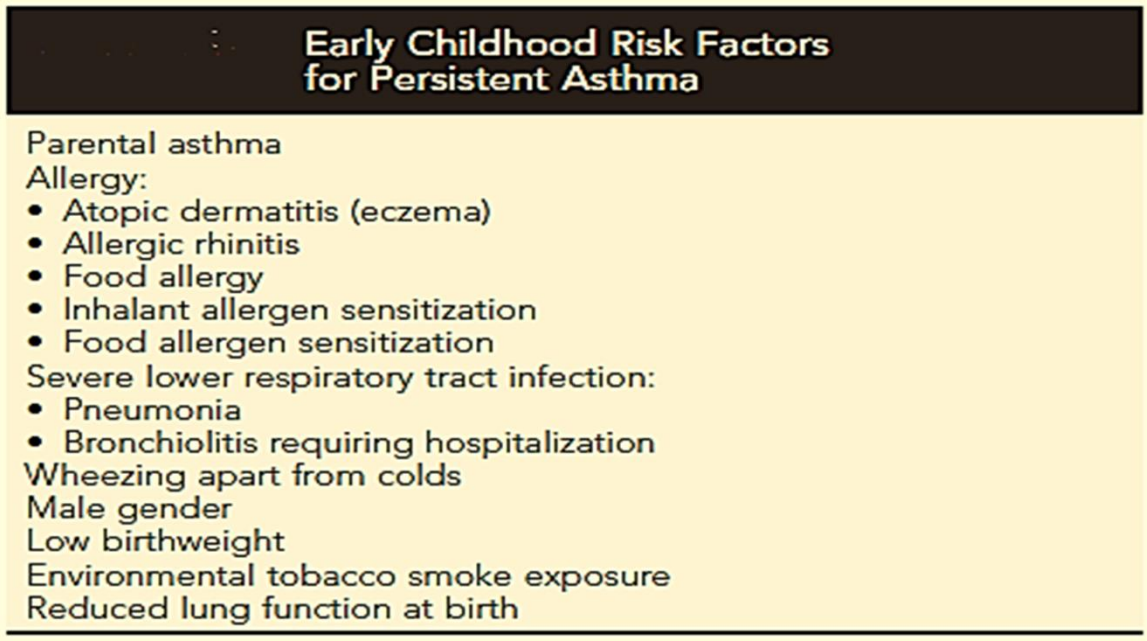
- Asthma is a common chronic disease, causing considerable morbidity.
- Male gender and living in poverty are demographic risk factors for having childhood asthma.
- Childhood asthma is among the most common causes of childhood emergency department visits, hospitalizations, and missed school days .
- Approximately 80% of all asthmatic patients report disease onset prior to 6 yr of age. However, of all young children who experience recurrent wheezing, only a minority go on to have persistent asthma in later childhood.

Risk factors :-

Early childhood risk factors for persistent asthma have been identified and have been described as:

- Major: (parent asthma, eczema, inhalant allergen sensitization) and
- Minor: (allergic rhinitis, wheezing apart from colds, ≥4% peripheral blood eosinophils, food allergen sensitization .(

Allergy in young children with recurrent cough and/or wheeze is the strongest identifiable factor for the persistence of childhood asthma.



Etiology :-

A combination of environmental exposures and inherent biologic and genetic susceptibilities can trigger airway hyperresponsiveness.

1- **Genetics:**

To date, more than 100 genetic loci have been linked to asthma,although relatively few have consistently been linked to asthma

2- **Environment:**
   - Common viral infections of the respiratory tract
   - Animal dander
   - Indoor allergens (Dust mites , Cockroaches(
   - Seasonal aeroallergens (trees, grasses, weeds(
   - Air pollutants) dust, Wood- or coal-burning smoke(
   - Strong or noxious odors or fumes
   - Cold air, dry air
   - Exercise and psychological factors

Types of childhood asthma :-

There are 2 common types of childhood asthma based on different natural courses :

- Recurrent wheezing in early childhood, primarily triggered by common respiratory viral infections, usually resolves during the preschool/lower school years.
- Chronic asthma associated with allergy that persists into later childhood and often adulthood.

Asthma is also classified by disease severity:

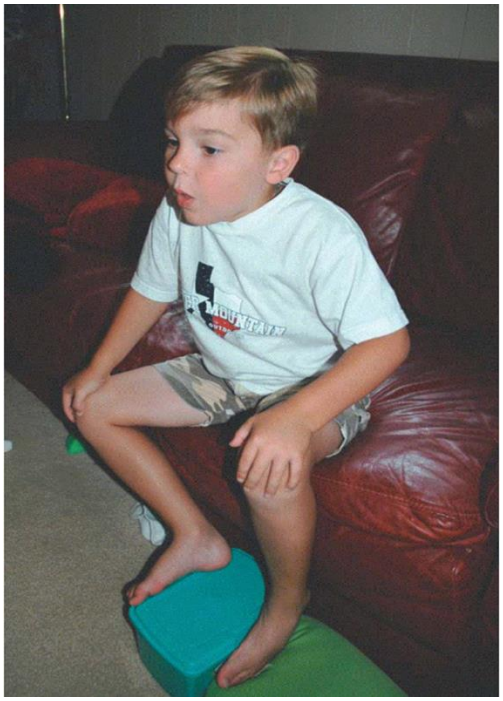
- Intermittent disease :
- Persistent :
  - ✓ Mild
  - ✓ Moderate
  - ✓ Severe

	CLASSIFICATION OF ASTHMA SEVERITY			
		PERSISTENT		
	Intermittent	Mild	Moderate	Severe
COMPONENTS OF SEVERITY				
Impairment				
Daytime symptoms	≤2 days/wk	>2 days/wk but not daily	Daily	Throughout the day
Nighttime awakenings:				
Age 0-4 yr	0	1-2x/mo	3-4x/mo	>1x/wk
Age ≥5 yr	≤2x/mo	3-4x/mo	>1x/wk but not nightly	Often 7x/wk
Short-acting β_2-agonist use for symptoms (not for prevention of exercise-induced bronchospasm)	≤2 days/wk	>2 days/wk but not daily, and not more than 1x on any day	Daily	Several times per day
Interference with normal activity	None	Minor limitation	Some limitation	Extreme limitation
Lung function:				
FEV_1 % predicted, age ≥5 yr	Normal FEV_1 between exacerbations >80% predicted	≥80% predicted	60-80% predicted	<60% predicted

Clinical manifestation :-

- The history should elicit the frequency, severity, and factors that worsen the child's symptoms. Exacerbating factors include viral infections, exposure to allergens and irritants. Rhinosinusitis, gastroesophageal reflux, and sensitivity to NSAID(especially aspirin) can aggravate asthma. Obtaining a family history of allergy and asthma is useful .
- Children with asthma have symptoms of coughing, wheezing, shortness of breath or rapid breathing, and chest tightness. Nighttime symptoms are common.
- Physical examination: tachypnea, tachycardia, cough, wheezing, and a prolonged expiratory phase & the finding may be subtle. Physical examination may show evidence of other atopic diseases such as eczema or allergic rhinitis .
- In severe attack: cyanosis, diminished air movement, retractions, agitation, inability to speak, tripod sitting position, diaphoresis, and pulsus paradoxus (decrease in blood pressure with inspiration of >15 mm Hg) may be observed.

Tripod position



Investigations :-

1- **Lung Function:**

Spirometry: children older than 5 years of age can perform spirometry maneuvers .

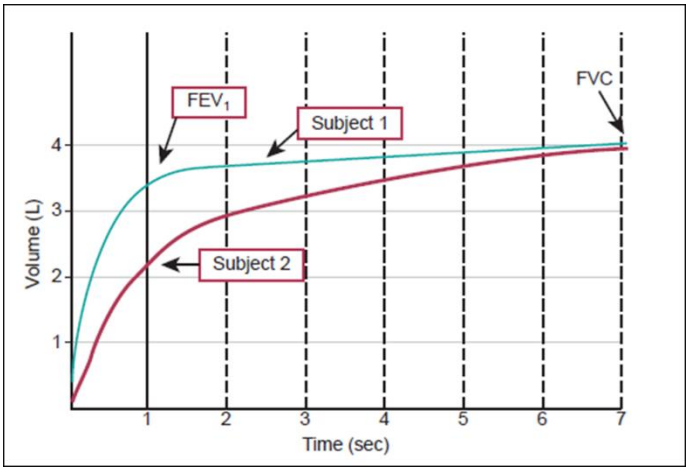
- Low FEV1
- FEV1/FVC ratio <0.80
- Bronchodilator response (to inhaled β-agonist) , Improvement in FEV1 ≥12% or ≥200 mL
- Exercise challenge ---- worsening in FEV1 ≥15%
- Daily peak flow or FEV 1 monitoring: day to day and/or AM-to-PM variation ≥20%

2- **Allergy skin testing**

3- **Radiology:**

- CXR in children with asthma often appear to be normal, aside from subtle and nonspecific findings of hyperinflation (flattening of the diaphragms) and peribronchial thickening.
- Indicated in 1st episode, in recurrent episode with fever(suggesting pneumonia) or localized findings on physical examination & recurrent episode of cough or wheeze to exclude anatomic abnormalities .
- Two novel forms of monitoring asthma and airway inflammation directly include exhaled nitric oxide analysis and quantitative analysis of expectorated sputum for eosinophilia .

Spirometry



Subject 1: A non-asthmatic child
FEV_1 = 3.4 (100% of predicted)
FVC = 3.8 (100% of predicted)
FEV_1/FVC = 0.86

Subject 2: An asthmatic child
FEV_1 = 2.1 (62% of predicted)
FVC = 3.7 (97% of predicted)
FEV_1/FVC = 0.57

Treatment

Optimal goal: Well-controlled asthma

- *Reduce impairment*
  - Prevent chronic symptoms
  - Prevent sleep disturbance
  - Infrequent SABA need
  - Maintain (near) normal lung function
  - Maintain normal activity
- *Reduce risk*
  - Prevent exacerbations
  - Minimize ER visits/hospitalizations
  - Prevent reduced lung growth
  - No (minimal) adverse effects of therapy

Management

- *Assessment and monitoring* ↓
  - Assess severity
  - Monitor control
  - Med adverse effects
- *Education* ↓
  - Key elements
- *Contol environmental factors and co-morbid conditions* ↓
  - Environmental controls
  - Co-morbidities
- *Medications* ↓
  - Long-term controllers
  - Quick relievers
- *Exacerbations* ↓
  - Management
  - High-risk features
  - Home action plan

The key elements to optimal asthma management:

1- **Assessment and monitoring:**
   - Assessing asthma severity as intermittent & persistent (mild, moderate, severe (
   - Monitoring control with medications & SE of therapy

2. ***Education***
   - Specify goals of asthma management
   - Explain basic facts about asthma:
     - Contrast normal vs asthmatic airways
     - Long-term-control and quick-relief medications
     - Potential adverse effects of asthma pharmacotherapy
   - Teach, demonstrate, and have patient show proper technique for:
     - Inhaled medication use (spacer use with metered-dose inhaler)
     - Peak flow measures
   - Investigate and manage factors that contribute to asthma severity:
     - Environmental exposures
     - Comorbid conditions as rhinitis, sinusitis & GERD
   - Create written 2-part asthma management plan:
     - Daily management
     - Action plan for asthma exacerbations
   - Regular follow-up visits:
     - Twice yearly (more often if asthma not well-controlled)
     - Monitor lung function annually

3. **Control environmental factors and co-morbid conditions**

ELIMINATE OR REDUCE PROBLEMATIC ENVIRONMENTAL EXPOSURES:

Environmental tobacco smoke elimination or reduction in home and automobiles

Allergen exposure elimination or reduction in sensitized asthmatic patients:

- Animal danders: pets (cats, dogs, rodents, birds)
- Pests (mice, rats)
- Dust mites
- Cockroaches
- Molds

Other airway irritants:

- Wood- or coal-burning smoke
- Strong chemical odors and perfumes (e.g., household cleaners)
- Dusts

TREAT COMORBID CONDITIONS:

- Rhinitis
- Sinusitis
- Gastroesophageal reflux

4. Medications: Long-term controllers & quick relievers.

A. Long-Term Control Medications:

- Inhaled Corticosteroids :
  - the most effective anti-inflammatory medications for the treatment of chronic, persistent asthma and are the preferred therapy when initiating long-term control therapy.
  - given by inhaler or nebulizer .
  - rinsing the mouth after inhalation lessen the local adverse effects of dysphonia and candidiasis and decrease systemic absorption from the gastrointestinal tract.

- ***Leukotriene Modifiers:***
  - Leukotriene are potent mediators of inflammation and smooth muscle bronchoconstriction.
  - Two classes of leukotriene modifiers include
    - leukotriene receptor antagonists (zafirlukast and montelukast)
    - leukotriene synthesis inhibitors (zileuton).
  - *Zafirlukast* is approved for children older than 5 years of age and is given twice daily.
  - *Montelukast* is dosed once daily at night
    - as 4-mg (6 months to 5 years)
    - 5-mg (6 to 14 years)
    - 10-mg tablets for adolescents 15 years of age or older.

- ***Long-Acting β2-Agonists :***

Long-acting β_2-agonists, formoterol and salmeterol, have twice-daily dosing and relax airway smooth muscle for 12 hours, but they do not have any significant anti-inflammatory effects.

- ***Theophylline :***

It is mildly to moderately effective as a bronchodilator.

Adverse effects associated with elevated theophylline levels include nausea, headaches, and seizures.

- ***Omalizumab (Xolair) :***

a humanized anti-IgE monoclonal antibody that prevents binding of IgE to high-affinity receptors on basophils and mast cells. It is approved for moderate to severe allergic asthma in children 12 years of age and older.

B. Quick-Relief Medications :

- ***Short-Acting β2-Agonists :***
    - Such as *albuterol*, *levalbuterol*, and *pirbuterol*, are effective bronchodilators that exert their effect by relaxing bronchial smooth muscle within 5 to 10 minutes of administration. They last for 4 to 6 hours.
    - Generally, a short-acting β_2-agonist is prescribed for acute symptoms and as prophylaxis before allergen exposure and exercise.
    - The inhaled route is preferred because adverse effects-tremor, prolonged tachycardia, and irritability-are fewer.
    - **Overuse:** use of more than one metered dose inhaler canister per month or more than eight puffs per day suggests poor control.
- ***Anticholinergic Agent :***

Ipratropium bromide is an anticholinergic bronchodilator that relieves bronchoconstriction, decreases mucus hypersecretion, and counteracts cough-receptor irritability.

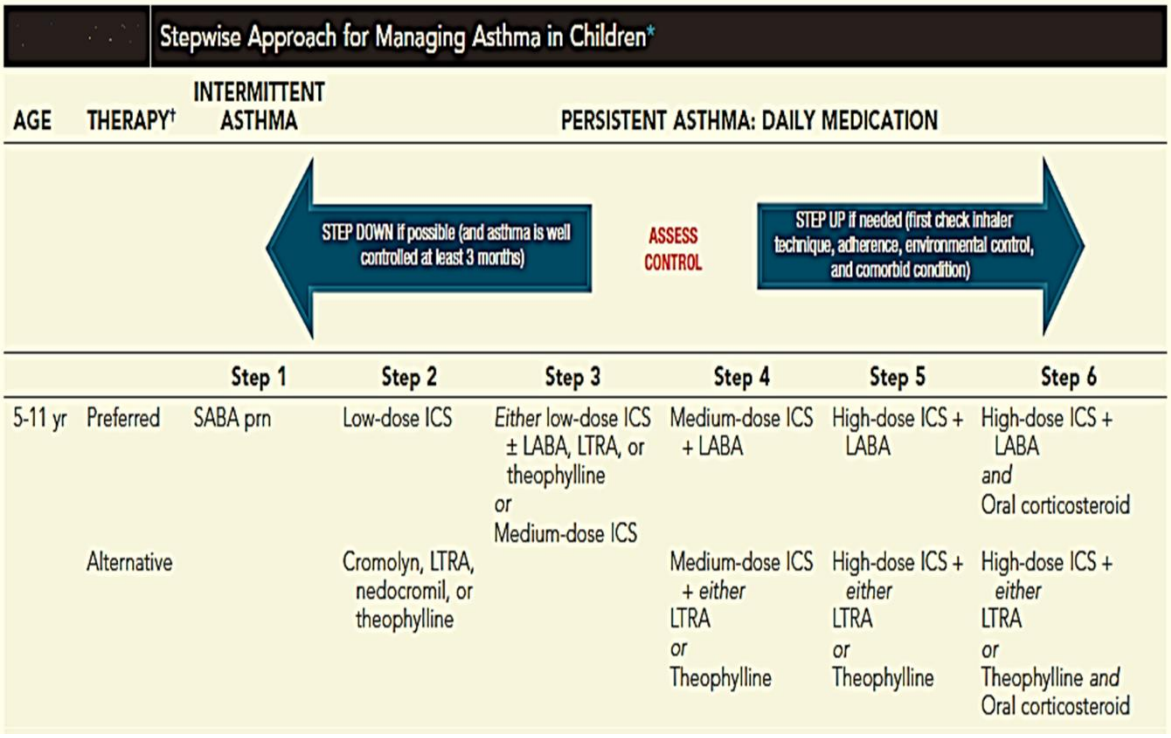
- ***Oral Corticosteroids :***

Short bursts of oral corticosteroids (3 to 10 days) are administered to children with acute exacerbations.

Prolonged use of oral corticosteroids can result in systemic adverse effects such as: hypothalamic-pituitary-adrenal suppression, cushingoid features, weight gain, hypertension, diabetes, cataracts, glaucoma, osteoporosis, and growth suppression.

Approach to Therapy

- A stepwise approach is used for management.
- Medication type, amount, and scheduling are determined by the level of asthma severity or asthma control.
- Therapy is then increased (stepped up) as necessary and decreased (stepped down) when possible .
- A short-acting bronchodilator should be available for all children with asthma .
- the rule of two is helpful: daytime symptoms occurring ≥2 / week or nighttime awakening ≥2 / month implies a need for daily anti-inflammatory medication.



QUICK-RELIEF MEDICATION FOR ALL PATIENTS

- SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-min intervals as needed. Short course of oral systemic corticosteroids may be needed.
- Caution: Use of SABA >2 days/wk for symptom relief (not prevention of exercise-induced bronchospasm) generally indicates inadequate control and the need to step up treatment.
- For ages 0-4 yr: With viral respiratory infection: SABA q4-6h up to 24 hr (longer with physician consult). Consider short course of systemic corticosteroids if exacerbation is severe or patient has history of previous severe exacerbations.

5. Exacerbations (Status Asthmaticus)

A. Management

RISK ASSESSMENT ON ADMISSION	
Focused history	• Onset of current exacerbation • Frequency and severity of daytime and nighttime symptoms and activity limitation • Frequency of rescue bronchodilator use • Current medications and allergies • Potential triggers • History of systemic steroid courses, emergency department visits, hospitalization, intubation, or life-threatening episodes
Clinical assessment	• Physical examination findings: vital signs, breathlessness, air movement, use of accessory muscles, retractions, anxiety level, alteration in mental status • Pulse oximetry • Lung function (defer in patients with moderate to severe distress or history of labile disease)
Risk factors for asthma morbidity and death	
TREATMENT	

Risk Factors for Asthma Morbidity and Mortality

BIOLOGIC
- Previous severe asthma exacerbation (intensive care unit admission, intubation for asthma)
- Sudden asphyxia episodes (respiratory failure, arrest)
- Two or more hospitalizations for asthma in past year
- Three or more emergency department visits for asthma in past year
- Increasing and large diurnal variation in peak flows
- Use of >2 canisters of short-acting β-agonists per month
- Poor response to systemic corticosteroid therapy
- Male gender
- Low birthweight
- Nonwhite (especially black) ethnicity
- Sensitivity to *Alternaria*

ENVIRONMENTAL
- Allergen exposure
- Environmental tobacco smoke exposure
- Air pollution exposure
- Urban environment

ECONOMIC AND PSYCHOSOCIAL
- Poverty
- Crowding
- Mother <20 yr old
- Mother with less than high school education
- Inadequate medical care:
  - Inaccessible
  - Unaffordable
  - No regular medical care (only emergency)
  - Lack of written asthma action plan
  - No care sought for chronic asthma symptoms
  - Delay in care of asthma exacerbations
  - Inadequate hospital care for asthma exacerbation
- Psychopathology in the parent or child
- Poor perception of asthma symptoms or severity
- Alcohol or substance abuse

Emergency Department Management of Asthma Exacerbations.

- The primary goals of asthma management include correction of hypoxemia, rapid improvement of airflow obstruction, and prevention of progression or recurrence of symptoms.
- Indications of a severe exacerbation include:
  - SOB, retractions, accessory muscle use, tachypnea,
  - Cyanosis.
  - Mental status changes.
  - silent chest with poor air exchange.
  - PEF or FEV1 value <50%

- Initial treatment includes:
    - O2
    - Hydration
    - Inhaled SABA every 20 min for 1 hr
    - Systemic CS either orally or intravenously
    - Inhaled ipratropium may be added to the β-agonist treatment if no significant response.
    - IM or SC adrenaline for impending respiratory failure or other adjunct therapy.
- **Discharged to home if there is:**
    - Sustained improvement in symptoms.
    - Normal physical findings.
    - PEF >70%
    - O2 saturation >92% while the patient is breathing room air for 4 hr.
    - Discharge medications:
    - Include administration of an inhaled β-agonist up to every 3-4 hr .
    - 3-7 day course of an oral corticosteroid.
    - Consider initiation of ICS for those not on long- term control therapy.

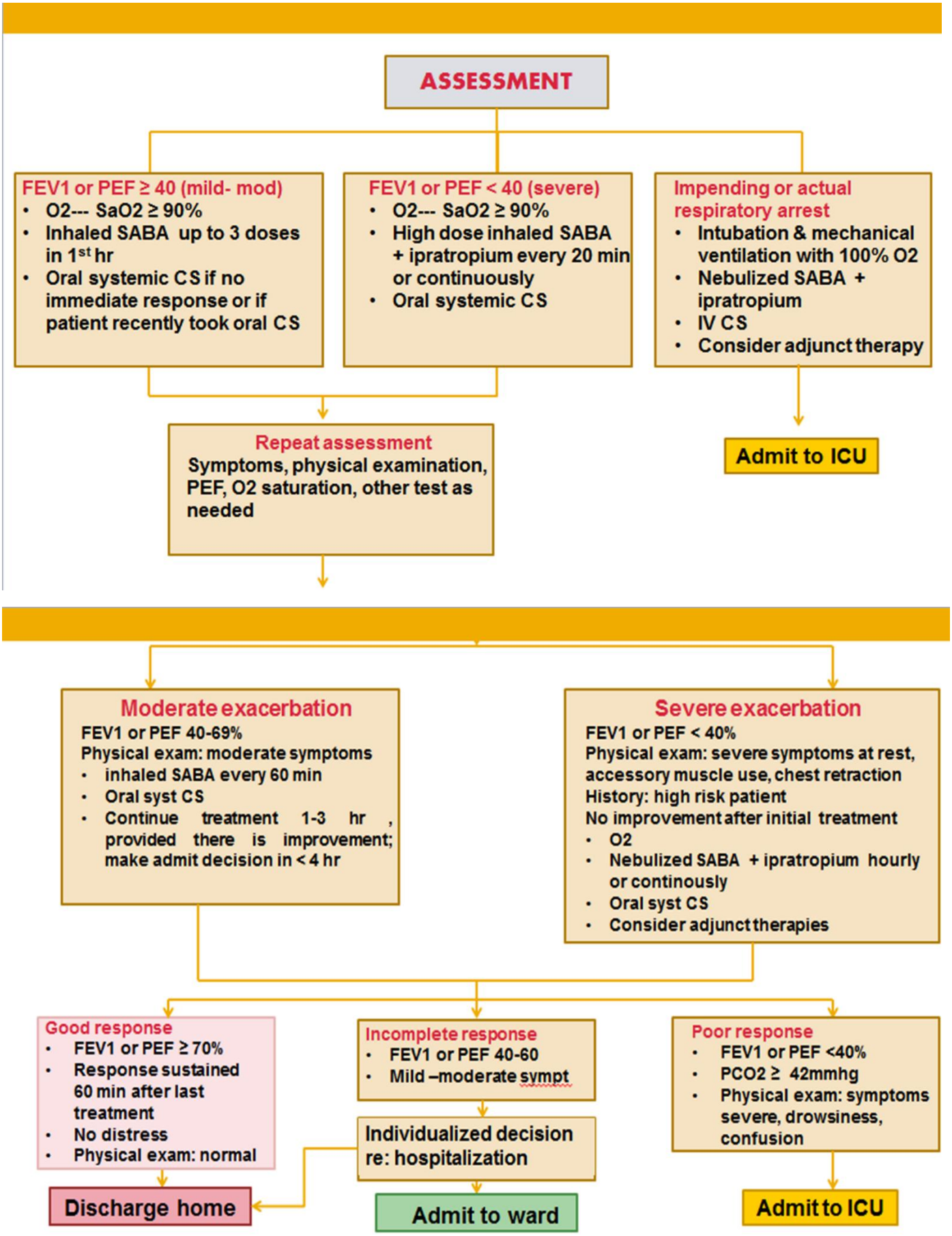
Hospital Management of Asthma Exacerbations

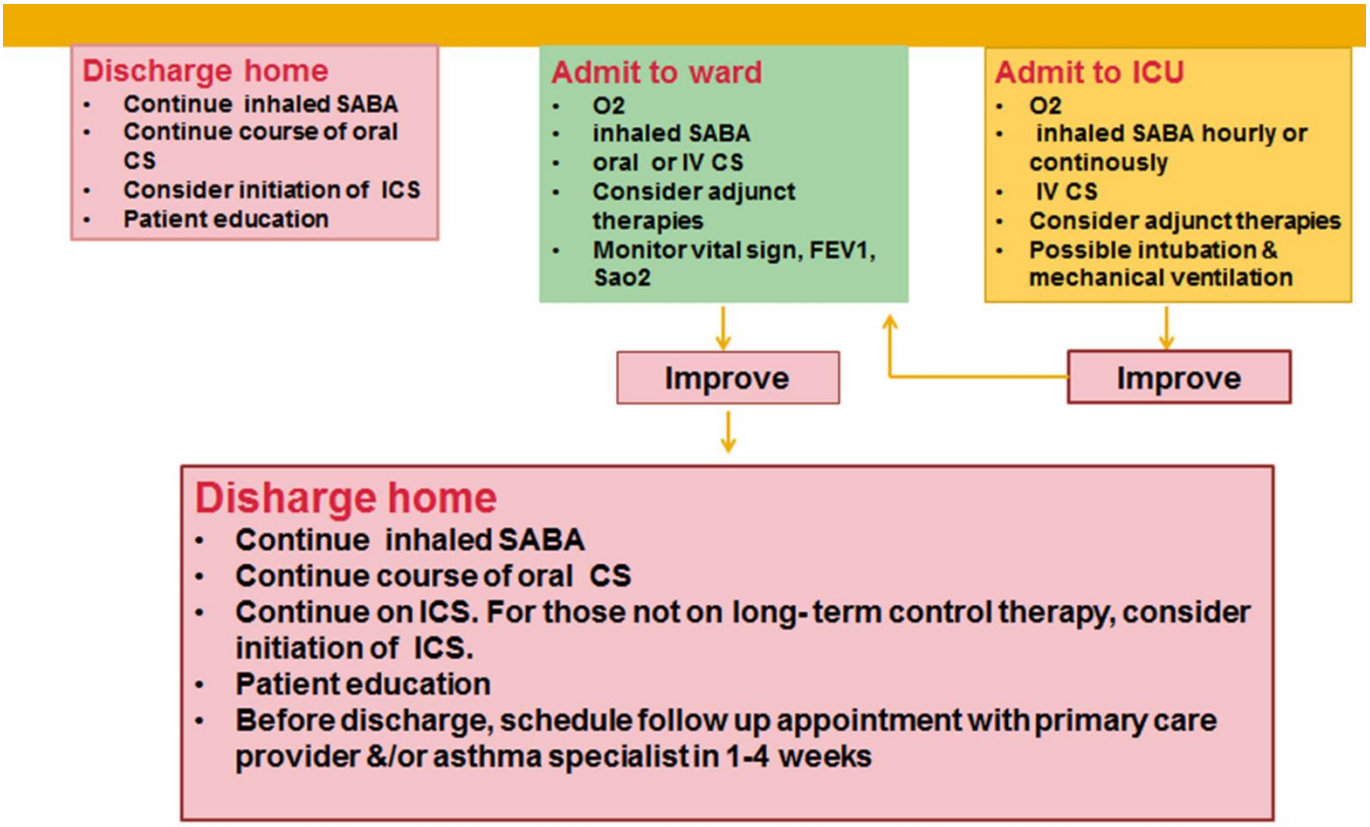
- **Admission to ward:**
    - Patients with moderate to severe exacerbations that do not adequately improve within 1-2 hr of intensive treatment.
    - FEV1 or PEF 40-69%
    - If there is high-risk features for asthma morbidity or death.

Continue treatment with monitoring & may need other adjunct therapy as magnesium or inhaled heliox (helium and oxygen mixture) .

- **Admission to ICU:**
    - Patients with severe respiratory distress.
    - Poor response to therapy.
    - Potential respiratory failure & arrest.
    - FEV1 <40%
    - PCO2 ≥ 42 mmHg

Continue treatment & monitoring with possible intubation & mechanical ventilation.





B. Home action plan

- Families of all children with asthma should have a **written action plan**
- to guide their recognition and management of exacerbations, along
- with the necessary medications and tools to manage them.
- A written home action plan can reduce the risk of asthma death by 70%.
- **The NIH guidelines recommend:**

a. **immediate inhaled SABA,** up to 3 treatments in 1 hr. (A good response is characterized by resolution of symptoms within 1 hr, no further symptoms over the next 4 hr, and improvement in PEF value to at least 80% of personal best.)

b. If the child has an incomplete response (persistent symptoms and/or a PEF value <80% of personal best), **oral CS** should be instituted.

c. **Immediate medical attention** if lack of expected response or high-risk factors for asthma morbidity or mortality.

d. For patients with severe asthma and/or a history of life-threatening episodes, especially if abrupt-onset in nature, providing an **epinephrine autoinjector** and, possibly**, portable oxygen** at home should be considered & call for emergency support.

Prognosis :-

- Children with *moderate to severe asthma* and with lower lung function measures are likely to have persistent asthma as adults.
- Children with *milder asthma* and normal lung function are likely to improve over time, with some becoming periodically asthmatic.

Prevention :-

- ***Education*** plays an important role in helping patients and their families adhere to the prescribed therapy and needs to begin at the time of diagnosis.
- ***Peak flow monitoring*** is a self-assessment tool that is helpful for children older than 5 years of age. It is advisable for:
    - children who have moderate to severe asthma.
    - have a history of severe exacerbations.
    - Peak flow monitoring also can be useful in children who are still learning to recognize asthma symptoms.