CHILDHOOD ASTHMA

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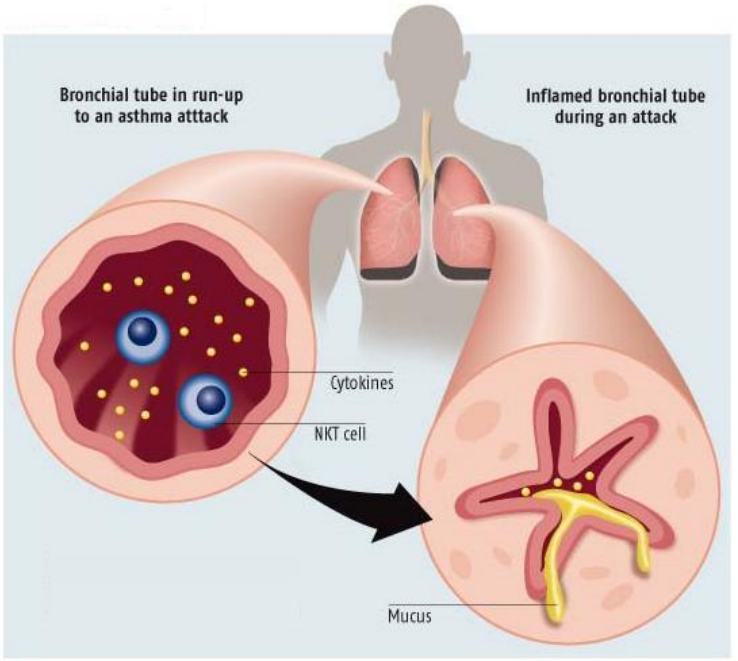
Childhood asthma

- Most common chronic disease of childhood [World prevalence in 2007 -9.6 million children (13%), boys > girls, children in poor families > not poor]
- More prevalent in modern metropolitan locales & more affluent nations
- Prevalence in Sri Lanka - 20 to 30 %
- Leading cause of childhood morbidity

- Most common cause for emergency unit care

Pathophysiology

- Chronic inflammatory disorder of the airways resulting in episodic airflow obstruction



Airway

- Hyper-responsiveness (twitchiness of airway to provocative exposure)
- Inflammation and mucosal oedema

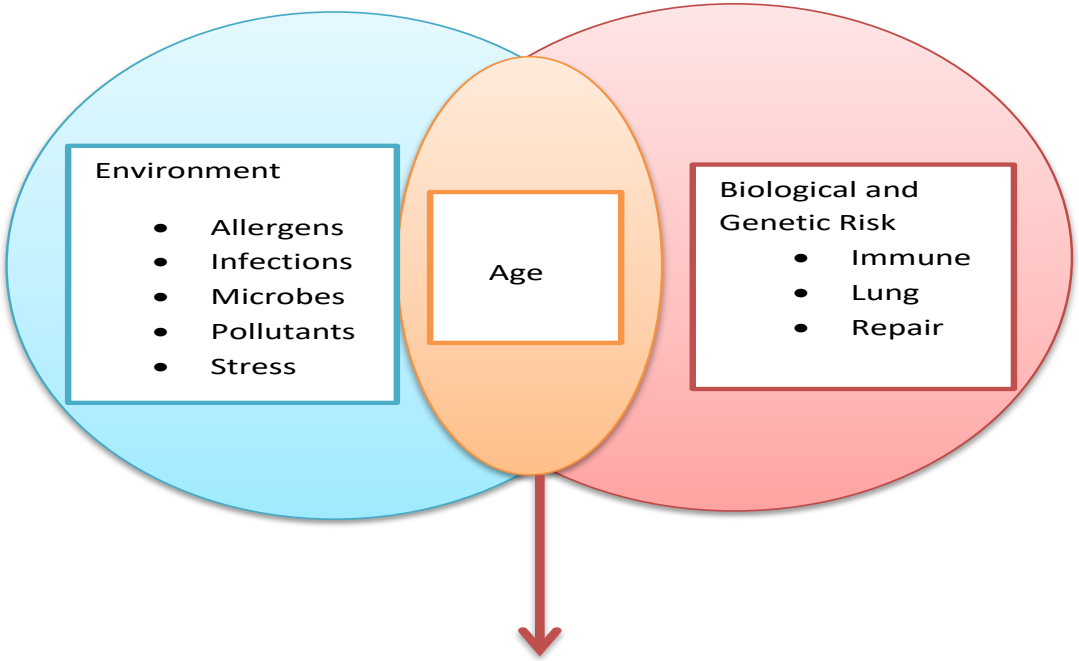
- Exacerbated by triggers

Early childhood risk factors for persistent asthma

- Parental asthma or atopy
- Personal allergy:

  (allergic rhinitis/rhinosinusitis/conjunctivitis, eczema , dermographism, food/inhalant allergen sensitization)
- Severe LRTI: Bronchiolitis and pneumonia
- Male sex
- LBW
- Wheezing apart from colds
- Environmental tobacco smoke exposure
- Possible use of paracetamol
- > 4% eosinophils in FBC

Aetiology and pathogenesis of asthma



Innate and Adaptive Immune Development

(Atopy)

Respiratory viral Infections

Aeroallergens

ETS
Pollutants /toxicants

- Persistent inflammation
- AHR
- Remodeling
- Airways growth and differentiation

Asthma

Asthma triggers

- Respiratory infections(mostly viral)
- Aero-allergens in sensitized asthmatics(indoor allergens, house dust mite, animal dander, cockroaches, molds)
- Seasonal aero-allergens (pollens –trees, grasses, weeds)
- Environmental tobacco smoke and biomass fuels
- Air pollutants –ozone, sulfur dioxide, particulate matter, wood or coal burning smoke, endotoxin, mycotoxin, dust
- Strong or noxious odors or fumes – perfumes, hairsprays, cleaning agents
- Drugs (aspirin , beta blockers), foods and additives
- Cold air, dry air
- Strong odors
- Exercise – crying, laughter, hyperventilation
- Emotional stress

Co morbidities

- GORD
- Rhinitis
- Sinusitis

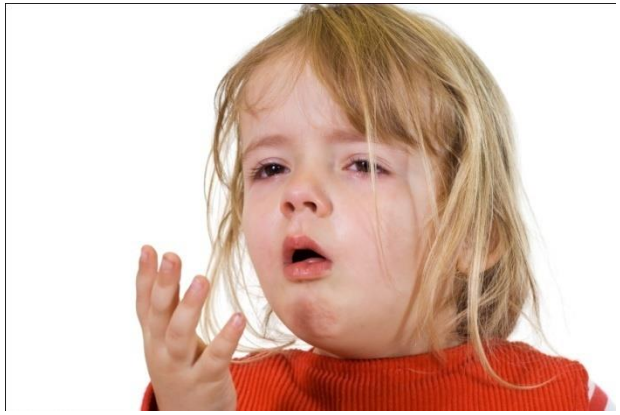
Diagnosis

- Clinical diagnosis

Clinical features - symptoms

- Cough – diurnal variation (early morning and night)
- Wheezing
- Breathlessness
- Chest tightness
- Post-tussive vomiting
- Exercise induced symptoms (cough or wheeze)

- Atopy in the child or in family



Consider asthma if any of the following is present

- Frequent episodes of wheeze > once a month
- Activity-induced cough or wheeze
- Cough particularly at night during periods without viral infections
- Absence of seasonal variation in wheeze
- Symptoms that persist after age 3
- Symptoms occur or worsen in the presence of aeroallergens, RTI, exercise, pollen, strong emotional expression & tobacco smoke.
- Colds repeatedly go to the chest
- Take more than 10 days to clear up
- Wheezing with rapid response to inhaled β_2 agonists and systemic steroids

- 80% of all asthmatics report the onset prior to 6 yrs
- However, a minority of young recurrent wheezers will go on to have persistent asthma in later childhood

Asthma predictive index

- A child with 4 or more episodes of wheeze per year

together with

- one major risk factor i.e. parent asthma, personal:eczema, inhalant allergen sensitization

or

- 2 of 3 minor risk factors (personal) i.e. ≥4% eosinophilia, wheezing apart from colds, allergic rhinitis, food allergen sensitization

↓

Predict asthma in later childhood

Physical signs

- Variable degree of respiratory distress
- Increased AP diameter , barrel chest , Harrison sulcus
- Prolonged expiration
- Polyphonic expiratory wheeze , rhonchi
- Crepitations (due to excess mucous production and inflammatory exudates)
- In extreme cases with severe airflow limitation will not have rhonchi
- Reversibility of airflow limitation with nebulised β_2 agonists is characteristic

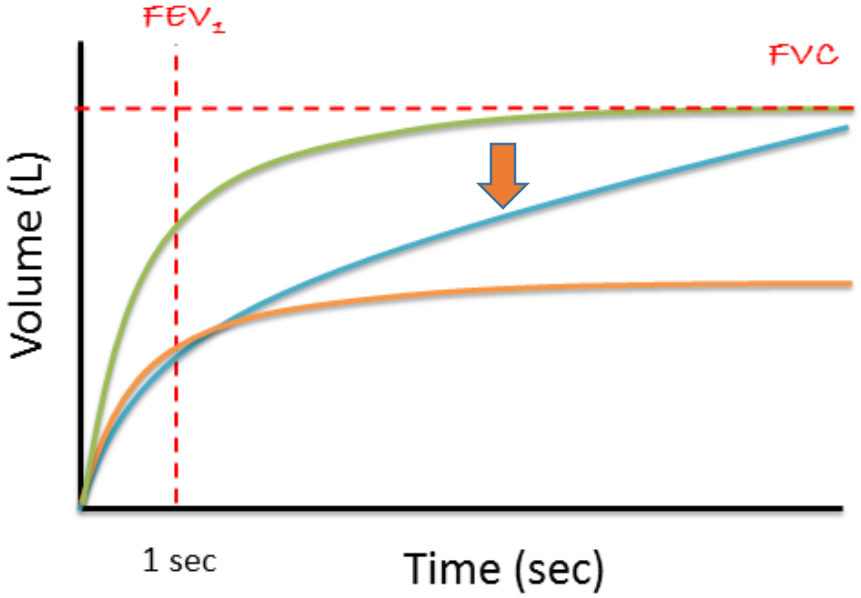
Therapeutic trial

- When the diagnosis is doubtful and when β_2 agonist therapy needs to be repeated more frequently than 6-8 weeks

  a diagnostic trial of regular controller therapy (inhaled steroids) for 3 months is an option to confirm whether symptoms are due to asthma.

  Marked improvement during treatment and deterioration when the drug is discontinued supports the diagnosis of asthma.

Lung function tests - Spirometry



Not routinely performed

Normal
Obstruction
Restriction

Spirometry &Peak Expiratory Flow Rate – 6 yrs and above

- Reversibility > 12 % or 200 ml with bronchodilator
- Worsening with exercise > 15%
- Diurnal variation > 20%

support the diagnosis of asthma

Investigations

CXR – not necessary to diagnose asthma, may be supportive

Eg: hyperinflation (flattening of diaphragm, elongated mediastinum)

Mainly to exclude other DD for persistent wheezing which can mimic asthma

Eg: Structural leisions of the lung, tuberculosis

Management - Goals

- Avoid troublesome symptoms during day and night
- Use little or no reliever medication
- Have productive and physically active lives (satisfactory growth)
- Avoid serious attacks

(GINA)

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

The key elements of optimal asthma management

Recurrent/chronic cough,wheeze,dyspnoea

Diagnosis

symptoms
exacerbations
Risk factors
Triggers
Lungs functions
Differential dx.

Asthma

Management

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

Components in the management

1. Regular assessments and monitoring of disease activity
2. Provision of education to enhance knowledge & skills for self management
3. Identification and management of triggers and co-morbidities
4. Appropriate selection of medications to address the patient’s needs

Component 1:Regular assessment and monitoring

Regular assessment

Assessment

Assessing Asthma and initiating treatment for those who are not taking long-term control medications

		CLASSIFICATION OF ASTHMA SEVERITY		
	Intermittent	**Persistent Mild**	**Persistent Moderate**	**Persistent Severe**
Daytime symptoms	≤2 days/wk	>2 days/wk but not daily	Daily	Throughout the day
Nighttime awakenings:				
Age 0-4 yr	0	1-2/mo	3-4/mo	>1/wk
Age ≥5 yr	≤2/mo	3-4/mo	>1/wk	often 7 /wk
Short-acting β2 agonist (SABA) use for symptoms	≤2 day/wks	>2 days/wk but daily, and not more than 1 on any day	Daily	Several times per day
Interference with normal activity	None	Minor limitation	Some limitation	Extreme limitation
Lung function:				
FEV1% predicted, ≥age 5yr	Normal FEV1,between exacerbations >80% predicted	≥80%	60-80%	<60%
Exacerbations requiring systemic corticosteroids:		≥2 exacerbations in 6 mo requiring systemic steroids or ≥4 wheezing episodes/yr lasting >1 day and risk factors for persistent asthma		
Age 0-4 yr	0-1/yr			
Age ≥5 yr	0-1/yr	≥2/yr	≥2/ yr	≥2/ yr

Consider severity and interval since last exacerbation.
Frequency and severity may fluctuate over time for patients in any severity category.
Relative annul risk of exacerbations may be related to FEV1

Assessment

Assessing Asthma control in those who are already on preventers

	Classification of Asthma control		
	Well controlled	**Not well controlled**	**Very poorly controlled**
Components of control Impairment			
Symptoms	≤ 2 days/wk, but not > one time on each day	>2 days/wk or multiple times on <2 days/wk	Throughout the day
Nighttime awakening:			
Age 0-4 yr	≤1/mo	>1/mo	>1/wk
Age 5-11 yr	≤1/mo	≥2 mo	≥/wk
Age ≥12 yr	≤2/mo	1-3/wk	≥4/wk
SABA use for symptoms	≤2 days/wk	>2 days/wk	Several time per day
Interference with normal activity	None	Some limitation	Extremely limited
Lung function:			
FEV1 /PFR	>80% Predicted	60-80 % predicted	< 60% Predicted
Exacerbations requiring systemic corticosteroids:			
Age 0-4 yr	0-1 /yr	2-3/ yr	>3/ yr
Age ≥5 yr	0-1 /yr	≥2/yr	
Consider severity and interval since last exacerbation			

Monitoring

Regular clinic visits

- Every 2-6 weeks until good asthma control is achieved

Based on - Symptoms

- LFT in older children

- QoL in older children

- Thereafter 2-4 asthma checks up/year

Component 2:Patient education

Patient education

- Specify goals of asthma management

  Explain basic facts about asthma:

    contrast normal vs asthmatic airway

    Link airways inflammation,”twitchiness”,and bronchoconstriction

  Long-term-control and quick-relief medications

- Address concerns about potential adverse effects of asthma pharmacotherapy

Patient education- done at clinic visit

- Teach & demonstrate proper technique for inhaled medication use, peak flow measurements
- Investigate and manage factors that contribute to asthma severity:
  - Environmental exposures
  - Co-morbid conditions
- Written two-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

Adherence to medications

- to a daily regimen is often suboptimal
- ICS s

  are under-utilised in 60% of the time

- Adherence (compliance) is poor when

✓ medications need to use more frequent

✓ misconceptions on controllers' efficacy & safety are present

Component 3: Control of factors contributing to asthma severity

- **Eliminate or reduce problematic environmental exposures:**
  - Tobacco smoke:

    at home and automobiles

  - Allergen exposure in sensitized patients:

    Animal dander:

    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 co-morbid conditions:
  - Rhinitis
  - Sinusitis
  - GORD

Component 4: Principles of asthma pharmacotherapy

Stepwise approach for managing asthma in children

Stepwise Approach for Managing asthma in children 0-4 years

Therapy	Intermittent asthma	Persistent Asthma: Daily medication				
	Step Down if possible(and asthma is well controlled at least 3 months)			Step up if needed(first check inhaler technique, adherence, environmental control and co-morbid conditions)		
	Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**
Preferred	SABA prn	Low-dose ICS	Medium – dose ICS	Medium--dose ICS + either LABA or LTRA	High-dose ICS + either LABA or LTRA	High-dose ICS + either LABA or LTRA and oral corticosteroid
Alternative		Montelukast				

Stepwise Approach for Managing asthma in children 5-12 years

Therapy	Intermittent Asthma	Persistent Asthma: Daily Medication				
	Step Down if possible(and asthma is well controlled at least 3 months)			Step up if needed(first check inhaler technique, adherence, environmental control and co-morbid conditions)		
	Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**
Preferred	SABA prn	Low dose ICS	Either low dose ICS±LABA,LTRA,or theophylline or Medium dose ICS	Medium dose ICS + LABA	High dose ICS + LABA	High dose ICS + LABA and oral corticosteroid
Alternative		LTRA or theophylline		Medium dose ICS + either LABA or theophylline	High dose ICS + either LTRA or Theophylline	High dose ICS + either LTRA or Theophylline and oral corticosteroid

	Recommended action for revising asthma treatment in those who are already on preventers		
	Well controlled	**Not well controlled**	**Very poorly controlled**
Recommended Action			
	Maintain current step. Regular follow-up every 1-6 mo to maintain control. Consider step down if well-controlled for at least 3 mo	Step up (1 Step) and re-evaluate in 2-6 wk. If no clear benefit in 4-6 wk, consider alternative diagnoses or adjusting therapy. For side-effects consider alternative options	Consider short course of oral corticosteroids. Step up (1-2 steps) and re-evaluate in 2 weeks. If no clear benefit in 4-6 wk, consider alternative diagnoses or adjusting therapy. For side-effects consider alternative options

Long term controller medications (preventers)

- Inhaled steroids
- Long acting β_2 agonist (LABA)
- Leukotriene modifiers (leukotriene-receptor antagonists (LTRAs)
- Sustained-release theophylline
- Anti-Ig E-preparation-omalizumab

  (Immunomdulator)

Inhaled steroids

- Beclomethazone HFA 50µg,200µg
- Budesonide HFA 100µg,200µg

ICS s + LABA

- Fluticasone/Salmeterol 50/25µg,125/25µg
- Budesonide/formoterol 80/4.5µg,160/4.5µg
  100/4.5µg,200/4.5µg

LABA

- Salmetarol – has a prolonged onset of action, maximum effect 1 hr after administration
- Formotorl-onset of action 10min
- Both have prolonged duration of effect-12hr
- Major indication- as an add on therapy when there is poor control with ICSs alone
- Serious side effect- tendency to have increase in severe asthma episode

LTRA s

Action

- Bronchodilators
- Anti-inflammatory property
- Reduce-aspirin , exercise & allergen induced bronchoconstriction

Sustained release theophylline

- Bronchodilator
- Anti-inflammatory property
- Not a 1st line therapy
- Has a narrow therapeutic window

Inhalers

Advantages-

- Delivers a small quantity of medication
- Rapid action
- Act on the target tissue
- Less systemic side effects

Disadvantages-

- Expensive
- Needs to teach and supervise the use

Available inhalers

- **Metered dose inhalers (MDIs)**
  - a calculated dose is delivered via inhaler
  - 90% deposits on the oropharynx
  - need a spacer device for small children
  - proper technique should be taught

Available inhalers contd.

Breath Actuated Devices

e.g **turbohaler & autohaler.**

May improve lung deposition in children with poor technique of MDI otherwise no advantage over MDI

Available inhalers contd.

Dry powder inhalers

- compact and easy to use
- drug delivery depends on inspiratory efforts of the child
- can use for children above 5-6 yrs

Estimated equipotent daily dosage of ICS

Drug	Low daily dose µg	Medium dose µg	High dose µg
Beclomethasone dipropionte	100	200-400	>400
Budesonide	200	>200-400	>400
Fluticasone propionate	100	200-500	>500

Inhaler devices

Age group	**Device**
Upto 2 years	Pressurized MDI + holding chamber
2 – 3 or 4 years	Pressurized MDI + spacer + face mask
4 - 6 years	Pressurized MDI + spacer With or without face mask
> 6 years	Pressurized MDI + spacer DPI or breath-actuated

Inhalers and devices

Training on inhaler devices

- Repeated training is necessary
- Demonstrate to both mother and child
- DPIs need deep inspiration
- Spacers need only normal tidal breathing in small children
- Cleaning of spacers

Asthma exacerbations and their management

Exacerbations

- are defined as an acute or sub acute deterioration in symptom control that is sufficient to cause distress or risk to health necessitating a visit to a health care provider or treatment with systemic steroids.

- Often asthma exacerbations are worse at night 12am-8am

Early symptoms of acute exacerbation

- An increase in wheeze and shortness of breath
- An increase in coughing specially nocturnal cough
- Lethargy and exercise intolerance
- Impairment of daily activities including feeding
- A poor response to reliever medications

Severity of asthma exacerbation

Formal Evaluation of Asthma Exacerbation severity in the urgent or emergency care setting				
	MILD	**MODERATE**	**SEVERE**	**SUBSET: RESPIRATORY ARREST IMMINENT**
SYMPTOMS				
Breathlessness	While walking	While at rest(infant-softer, shorter cry, difficulty feeding)	While at rest(infant-stop feeding)	
	Can lie down	Prefers sitting	Sits upright	
Talks in	Sentences	Phrases	Words	
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
SIGNS				
Respiratory rate	Increased	Increased	Often>30 breaths/min	
Use of accessory muscles; Suprasternal retractions	Usually not	Commonly	Usually	Paradoxical thoracoabdominal movement
Wheeze	Moderate; often only end-expiratory	Loud; throughout exhalation	Usually loud; throughout inhalation and exhalation	Absence of wheeze
Pulse rate(beats/min)	<100	100-120	>120	Bradycardia
Pulsus paradoxus	Absent ;<10mm Hg	may be present 10-25 mm Hg	often present >25 mm Hg (adult) 20-40 mm Hg(child)	Absence suggests respiratory muscle fatigue
FUNCTIONAL ASSESSMENT				
Peak expiratory flow(predicted or personal best)	≥70%	Approx.40-69% or response lasts <2hr	<40%	<25%
paO2(breathing air)and/or	Normal(test not usually necessary)	≥60mm Hg	<60 mm Hg; possible cyanosis	
PaCO2	<42mm Hg	<42 mm Hg	≥42 mmHg; possible respiratory failure	
SaO2(breathing air)at sea level	>95%	90-95%	<90 %	

Drugs used in the treatment of mild to moderate exacerbations

- Short acting β_2 agonist – best method of delivery is by a MDI + spacer. Other methods - oral for mild exacerbations, nebulization for moderate exacerbations.

- Short course of oral steroids -1-2 mg/kg prednisolone (maximum 20 mg for under 2 years and 30 mg for 2-5 years) preferably as a single daily dose for 3-5 days.

Doses of medications for mild exacerbations

Drug(po)	**<2yr**	**2-6 yr**	**>6yr**
Salbutamol	0.1/mg/kg tds	1-2mg/dose tds/qds	2mg/dose tds/qds
Terbutaline	75µg/kg tds	75 µg/kg tds	2.5mg bd/tds

Oral theophyllines can be given to get a synergistic effect, 10mg/kg/day.

Inhaled salbutamol 2 puffs as needed basis

- Can be managed at OPD/ETU/GP Surgery

Moderate exacerbation

- Salbutamol inhaler 2-8 puffs every 20 minutes as necessary maximum up to 1 hour (only 3 times) then every 1-4hrs as needed

- If not improving or earlier if the child deteriorates needs urgent admission to a hospital and a short course of oral steroids.

Management of severe exacerbations

- Manage in ETU or Paediatric casualty wards
- Respiratory arrest imminent (Life threatening asthma) in ETU first & then in ICU/HDU

Initial management of acute severe asthma exacerbations in HDU/Padiatric casualty

- **Oxygen if indicated** (target spo_2 is 94%)

  Use a tightly fitting mask with expiratory vents 6-8 l/min or nasal prongs 1-2 l/min
- **Nebulization** with short acting beta 2 agonists (SABA) - salbutamol
- **Systemic glucocorticoids** (IV has no added advantage over oral therapy provided patient can take orally)
- **Supportive** – Hydration, monitoring

Severe exacerbations contd.

- Oxygen : correction of hypoxemia
- Nebulization with bronchodialators :

  rapid relief of airway obstruction
- Systemic steroids : prevention of progression or recurrence of symptoms
- Routine use of antibiotics not indicated

Inhaled β_2 agonist therapy

- Nebulisation – at hospital setting

  Salbutamol o.5 ml < 5 years

  1 ml > 5 years as often as every 20min/back to back

✓Then every 1-4hrs as needed or upto 0.5mg/kg/hr by continuous nebulization.

✓Dilute with N/S to 3ml total nebulized volume

- Via inhaler device – Salbutamol MDI 2-8 puff every 20 minutes in first hour – oxygen may be necessary

Inhaled β_2 agonist therapy contd.

- Nebulised salbutamol without oxygen can result in pulmonary vasodilatation and increased cardiac output. V/Q mismatch

- Ideally oxygen be given before, concurrently with a nebulised bronchodilator to maximize alveolar oxygenation in areas of poor ventilation and then be continued after nebulization

Nebulised Ipratropium bromide

- When used in combination it improves lung functions and reduces hospital admissions.
- 0.25 mg/nebulizer when initial response is poor
- Add 0.25 mg/nebulizer from beginning for life threatening asthma.

Systemic glucocorticoid therapy

- **Prednisolone**: 1-2 mg/kg (maximum 20 mg for under 2 years and 30 mg for 2-5 years) preferably as a single daily dose for 3-5 days.

or

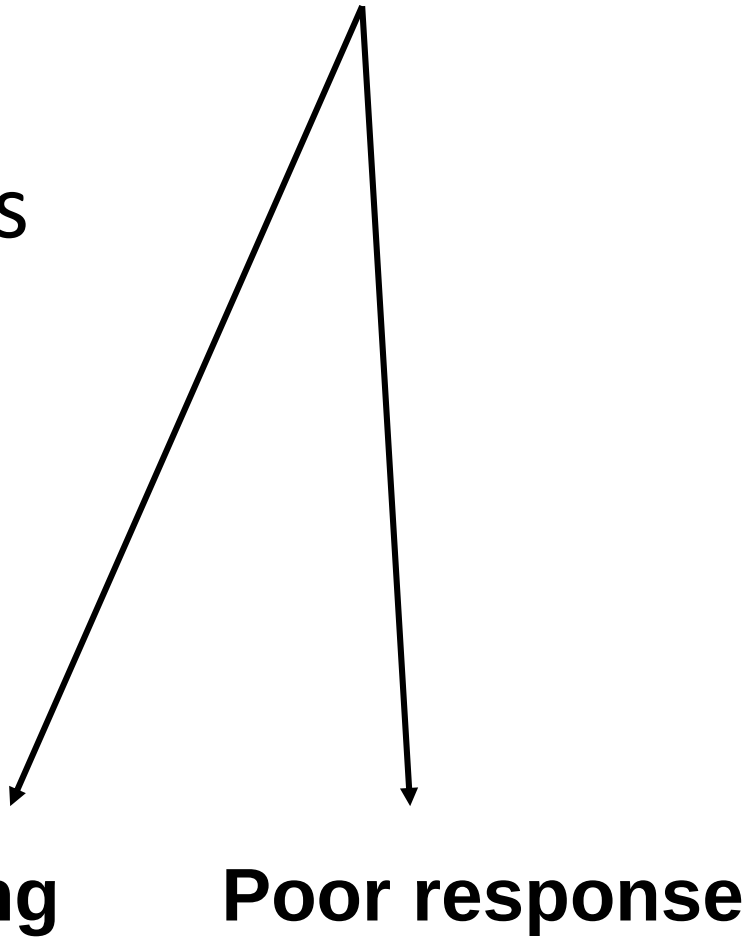
- **Hydrocortisone:** 4 mg/kg IV 6 hourly

or

- **Methylprednisolone:** 1 mg/kg IV 6 hourly on Day 1, every 12 hours on Day 2 & then daily

Re-assess in 20 minutes

- Level of consciousness
- Respiratory rate
- Pulse rate
- Oxygen saturation



Responding

- Admit to paediatric casualty ward/ PCU
- Continue nebulised bronchodialators 1-4hrs
- Continue prednisolone 1- 2mg/kg/day for 3-5 days (preferably as a single dose)
- Send home when improves.

i.e. sustained improvement in symptoms, normal physical findings,SpO_2 >92% in room air for 4 hrs & PEF >70%

Poor response

- Frequent nebulisation with bronchodilators every 20 minutes/back to back in the first hour
- Discuss with senior clinician & look for complications
- May need IV fluids if on high flow oxygen or severely dyspnoeic. **Normal requirement or slightly less**
- Arrange admission to paediatric casualty ward or ICU
- Record respiratory rate, pulse rate and oxygen saturation every 1-4 hrs

Poor response – contd.

- Bolus IV Aminophylline (If not on oral theophyllines)

  5mg/kg in 2ml/kg of normal saline over 30 min

  Followed by infusion 1mg/kg/hr

  OR

- IV Salbutamol bolus 15µg/kg over 10 min

  IV salbutamol infusion 1-5µg/kg/min

- Magnesium sulfate infusion 40mg/kg (max 2g) over 20 minutes can be considered for above 5 yrs
- SC / IM adrenaline 10 µg/kg can be considered
- Consider Chest X-ray, arterial blood gases , complete blood count

IV magnesium sulfate

- Causes broncho-dilatation by competing with calcium at calcium-mediated smooth muscle binding sites
- Not indicated routinely. Can be used as an adjunctive therapy
- Needs blood pressure monitoring

When response is still poor

- Arterial blood gas analysis
  - Type I respiratory failure
  - Type II respiratory failure
- Arrange ICU/HDU (high dependency unit) transfer
- Exclude pneumothorax

Exercise induced asthma (EIA)

- Occurs during or minutes after vigorous activity, reaches its peak 5 to 10 minutes after stopping the activity, and usually resolves in another 20 to 30 minutes.

- β_2 agonists use as close to exercise as possible may be helpful for 2-3 hours

- Salmeterol has been shown to prevent EIA for 10-12 hours.
- Sodium Cromoglycate and nedocromil are also effective.

- Long-term control therapy, if appropriate.

Nocturnal asthma

- Long acting sustained release theophyllines

Complications of asthma

- Respiratory failure
- Peumothorax and pneumo-mediastinum
- Growth failure, chest deformities
- School disturbances
- Economical losses


Thank
you!