Chapter 12: Pulmonology

Asthma

Definition

Diagnostic criteria for asthma in children 6-11 years and adolescents

- History of variable respiratory symptoms
  - Wheeze, shortness of breath, chest tightness, cough
  - Often worse at night or on waking
  - Triggered by exercise/allergens/cold air/laughter
  - Worse with viral infections
- Confirmed variable expiratory airflow imitation
  - Documented expiratory airflow limitation
  - Reduced Forced Expiratory Volume to forced vital capacity ratio in 1 second (FEV1/FVC) ratio
  - Documented excessive variability in lung function
  - Positive bronchodilator reversibility test
  - Significant increase in lung function after 4 weeks of anti-inflammatory treatment
  - Positive exercise challenge test
  - Excessive variation in lung function between visits
  - Excessive variability in twice daily Peak Expiratory Flow (PEF) over 2 weeks

Diagnostic criteria in children 5 years and under

- Recurrent wheezing occurs in a large proportion of children 5 years and younger, typically with viral upper respiratory tract infections. Deciding whether this is an initial presentation of asthma is difficult.
- A diagnosis of asthma in young children with a history of wheezing is more likely if they have:
  - Recurrent or persistent non-productive cough that may be worse at night or accompanied by wheezing or breathing difficulties
  - Wheezing or coughing that occurs with exercise, laughing or crying, or

exposure to tobacco smoke in the absence of an apparent respiratory infection
    - Reduced activity - not running, playing or laughing at the same intensity as other children, tires easily during walks
    - A history of other allergic disease (eczema or allergic rhinitis), allergen sensitisation or asthma in first degree relatives
    - Clinical improvement during 2-3 months of controller (medication that prevent asthmatic attacks) treatment and worsening after cessation

Prevention/promotion

- Every child with a diagnosis of asthma should have appropriate reliever medication such as a salbutamol inhaler
- Every child using an inhaler must use a spacer
- Education on potential triggers and avoidance of the same
- Increased awareness in community
- Advocacy for availability of appropriate medications in health facilities
- Educate on importance of not discriminating /stigmatizing children with asthma
- Addressing myths and misconceptions about asthma (asthma medication do not kill)

Risk factors

- Genetics: positive family history of asthma /eczema/allergic rhinitis
- Viral infections at a young age: recurrent viral infections e.g. viral induced wheeze or bronchiolitis
- Allergies: Family history of allergies
- Other environmental exposures e.g. tobacco smoke, dust mites, cold, pets, cockroaches, moulds, damp houses

Signs and symptoms

- Common symptoms
    - Dyspnoea
    - Increased coughing
- Vital signs and general appearance
    - Tachypnoea
    - Tachycardia
    - Pulsus paradoxus
    - Hypoxaemia
    - Low mental status
- Signs of bronchoconstriction
    - Prolonged expiratory phase

- Expiratory wheezing
- Silent chest
- Hyperresonance on percussion
- Inferior displacement and poor movement of the diaphragm

- Signs of increased work of breathing
  - Use of accessory muscles

Classification of severity of acute exacerbations

	MILD	MODERATE	SEVERE	LIFE THREATENING
Breathlessness	While walking	While at rest (infant—softer, shorter cry, difficulty feeding)	While at rest (infant—stops feeding)	Extreme dyspnoea Anxiety
Posture	Can lie down	Prefers sitting	Sits upright	Upright, leaning forward
Talks in…	Sentences	Phrases	Words	Unable to talk
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
Respiratory rate †	Increased	Increased	>30 breaths/min in > 5years old > 50 in <5yrs olds	>30 / min in > 5years old > 50 / min in <5yrs olds
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	Absence of wheeze

			exhalation	
Pulse rate (beats/ min) ‡	<100	100-120	>120	Bradycardia
Oxygen saturation	> 92%	> 92%	<92%	<92%
PEFR	> 80%	60-80%	<60%	<60%
Pulsus paradoxus	Absent <10 mm Hg	May be present 10-25 mm Hg	Often present >25 mm Hg (adult) 20-40 mm Hg (child)	Absence suggests respiratory muscle fatigue

Differential Diagnosis

- Pneumonia
- Inhaled foreign body
- Bronchiolitis (especially infants) or viral induced wheeze (especially toddlers)
- Cardiac disease
- Allergy/anaphylaxis
- Loeffler's syndrome

Management

Primary level

Mild Asthma

- Salbutamol inhaler via spacer (and facemask if <3 years)
  - 100 -200 micrograms (1 - 2 puffs) every 20 minutes for 1 hour
    or
  - Nebulised Salbutamol 2.5mg every 15 minutes for 3 times
- Target oxygen saturation 94 -98%
- Discharge with advice:
  - Check good inhaler and spacer technique
  - Avoid allergens
  - Return if worsens
  - Add in daily inhaled steroid inhaler via spacer if frequent episodes
- For primary health facility, refer all cases with moderate asthma to be

managed at secondary or tertiary level

Secondary level

Moderate Asthma

- Salbutamol inhaler via spacer (and facemask if <3years)
  - <4yrs - 500mcg (5 puffs) every 20 mins x3
  - >4 yrs - 1mg (10 puffs) every 20 mins x3
- Prednisolone:
  - < 5 years - 20mg PO OD 3/7
  - > 5years - 30mg PO OD x 3/7
- Clinician to review child after three treatments.
  - Admit if there is no improvement
  - Look carefully for life-threatening features
  - Continue 2-4 hourly salbutamol via spacer
- Add in daily inhaled steroid inhaler via spacer if frequent episodes

Severe/Life-threatening asthma

- Oxygen
  - 5L/min via face mask
- Salbutamol nebulisers (3 back-to-back to start with)
  - < 4 years: 2.5 mg
  - > 4 years: 5 mg
- Steroids
  - < 5 years - 20mg PO OD 3/7
  - > 5years - 30mg PO OD x 3/7

    or
  - Oral or IV dexamethasone 0.6 mg/kg STAT - (max. 10 mg)

    or
  - Hydrocortisone IV (<5 yrs: 50mg; >5 yrs: 100mg IV STAT)
- 2/3 maintenance IV fluids plus 20 mmol KCl per litre of fluid

Monitor for deterioration or improvement. If there is no improvement or if there is worsening refer to tertiary level on oxygen

Tertiary level

Mild/Moderate asthma

Manage as in secondary level above

Severe/Life-threatening asthma

- Oxygen
  - 5L/min via face mask
- Give salbutamol nebuliser 3 times back-to-back then reassess
  - If good response, stretch the nebs to hourly
- Steroids
  - Oral or IV dexamethasone 0.6 mg/kg STAT - (maximum 10 mg)
    or
  - Hydrocortisone IV (<5 yrs: 50mg; >5 yrs: 100mg IV STAT)
    or
  - Prednisolone 2 mg/kg (maximum 40 mg/dose)
- 2/3 maintenance IV fluids plus 20 mmol KCl per litre of fluid

IV Magnesium-sulphate

- 40 mg/kg maximum 2g (diluted to at least 10 %)
- If you have a 50% ampule, dilute 4mL of the 50% magnesium sulphate with 16mL 0.9%
- saline (Not ringers' lactate) to make a 10% concentration
- Give 0.4mL/kg of this 10% solution IV slowly over 20 min
- Monitor BP (hypotension)

Consider IV Aminophylline

- Consult paediatrician
- Loading dose = 5mg/kg (maximum 300 mg) diluted with normal saline (maximum concentration 25mg/mL) and administered over 20 minites

- Watch for tachycardia (pulse rate of >180/min), headache or convulsion, vomiting, flushing
- Intensive care unit admission if a patient has signs of impending respiratory failure

Discharge plan/follow up

- Prescribe salbutamol via spacer 200 - 400 mcg (2 -4 puffs) 4 hourly for 2-3 days, then as required
- Complete 3 days of prednisolone **or** give a second dose of dexamethasone (24 hours after the first one) before discharge
- Consider rethinking pre-existent background therapy, may need additional 'controller' medication
- Advise when to seek help (e.g. breathlessness not controlled by inhalers, sudden increase in the need for 'relievers')
- Identifying and avoiding possible triggers
- Follow up in PEN-Plus clinic after 2 weeks then according to need thereafter

- Teach inhaler and spacer technique (ensure you observe)

Steps for use inhaler with spacer

Shake inhaler Insert inhaler into the hole in the bottle Teach the child to form a tight seal around the mouthpiece of the bottle Apply a puff from the inhaler into the bottle Count for 10 seconds whilst the child breathes in and out (10 breaths) Take inhaler out of bottle and shake to mix Repeat steps 1-6 to give the number of puffs needed
For children under 3 years Attach a face mask to the mouthpiece of the bottle. If the mask has holes in it, put tape over these. Then follow above steps. This requires 2 people

Chronic Management of Asthma

- Children with asthma need thorough evaluation and on-going care to improve quality of life and reduce complications.
- On each visit, the patient needs to be evaluated as outlined in the table below:

Assessment of asthma in children > 5 years

Asthma symptom control	
Day symptoms	How often does the child have cough, wheeze, dyspnoea or heavy breathing (number of times per week/day)? What triggers the symptoms? How are they handled?
Night symptoms	Cough, awakenings, tiredness during the day?
Reliever (Short Acting B-agonists (SABA)) use	How often is reliever medication used? (Distinguish between pre-exercise use and use for relief of symptoms)
Level of activity	What sports/hobbies/interests does the child have? How does the child's level of activity compare with their peers or siblings? How many days is the child absent from school?
Risk Factors for adverse outcomes	

Exacerbations	How do viral infections affect the child's asthma? What are other exacerbating factors (URTI, exercise, exposure to pollen or dust, heating system in the house, second-hand smoke). Do symptoms interfere with school or sports? How long do the symptoms last? How many episodes have occurred since their last medical review? Any urgent doctor/emergency department visits? Any hospitalizations and what interventions were done during hospital stay? What was the duration of stay if admitted? Does the child have a written action plan?
Lung Function Tests	Plot FEV_1 and FEV_1/FVC ratio. Plot the values to see trends over time. Check technique of lung function tests
Side-effects	Yearly height checks and plot growth velocity. Ask about frequency and dose of inhaled corticosteroids
Treatment factors	
Inhaler technique	Ask the child to show how they use the inhaler and spacer
Adherence	Is there any controller medication in the home at present? On how many days does the child use their controller weekly? Is it easier to remember to use it in the morning or evening? Where is the inhaler kept? Check expiry date of inhaler
Goals/concerns	Does the child or their parent have any concerns about their asthma? What is the child/ parent/carer's goals for treatment?

Asthma symptom control	
Comorbidities	
Allergic rhinitis	Any itching/sneezing/nasal obstruction? Can the child breathe through their nose? What medications are being taken for nasal symptoms?
Eczema	Sleep disturbance, use of topical corticosteroids?
Food allergy	Is the child allergic to any foods?
Obesity	Check age-adjusted BMI. Ask about diet and physical

	activity
Other investigations (if needed)	
2-week diary	If no clear assessment can be made based on the above questions, ask the child or parent/carer to keep a daily diary of asthma symptoms, reliever use and peak expiratory flow rate (best of 3) for 2 weeks

- After taking the history, classify the child's symptoms into the appropriate category of severity classification. Asthma can be classified as intermittent or persistent

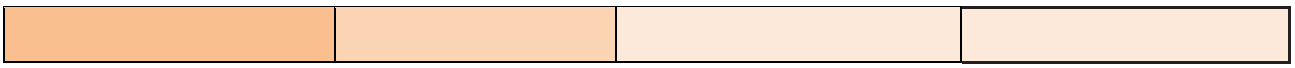
Classification of asthma severity in children > 5 years

Components of severity	Classification of severity			
	Intermittent	Persistent		
		Mild	Moderate	Severe
Symptoms	2 days/week	> 2 days / week but not daily	Daily	Throughout the day
Night-time awakenings	2 times/month	3-4 times / month	> 1 time per week but not nightly	Often 7 times / week
SABA use for symptom control	2 days/week	> 2 days / week but not daily	Daily	Throughout the day
Lung function	Normal FEV_1 between exacerbations FEV_1 > 80% FEV_1/FVC >85%	FEV_1 > 80% FEV_1/FVC >85%	FEV_1 60 - 80% FEV_1/FVC 75 - 80%	FEV_1 <60% FEV_1/FVC <75%
Exacerbations requiring oral systemic corticosteroids	0 – 1 / year	> 2 / year		

- Chronic management of asthma should follow a stepwise approach depending on the severity level (Table above)

Starting Asthma treatment in children > 5 years

	Reliever	Preferred controller	Other controller options
Step 1 (Intermittent) Symptoms less than twice a month	**As needed short acting beta-2 agonist (SABA)** **OR** **Low dose Inhaled corticosteroid (ICS)-formoterol maintenance and reliever (MART)**	Low dose Inhaled Corticosteroids (ICS[1]) taken whenever SABA[2] taken.	Consider daily low dose ICS
Step 2 (Mild persistent) Symptoms twice a month or more, but less than daily		Daily low dose ICS + SABA when having acute symptoms	Daily leukotriene receptor agonist (LTRA[3]) **OR** Low dose ICS taken whenever SABA taken
Step 3 (Moderate / severe persistent) Symptoms most days, or waking with asthma once a week or more		Low dose ICS or Long Acting Beta Agonist (LABA[4]) **OR** Very low dose ICS-Formoterol MART	Low dose ICS + LTRA
Step 4 (Severe persistent) Symptoms most days, or waking with asthma once a weeks or more, and low lung function		Medium dose ICS-LABA[5] **OR** Low dose ICS-formoterol MART **Refer for expert advice**	Add tiotropium or add LTRA **Short course oral corticosteroid may also be needed for patients presenting with severely uncontrolled asthma**
Step 5 (Severe persistent)		Refer for phenotypic assessment +/- higher dose ICS-LABA or add on therapy e.g. IgE	Add on anti-IL5 or add-on low dose OCS, but consider side effects



1 ICS - Beclomethasone (<2yrs 100mcg BD, 2-12yrs 200mcg BD, 12-18 years 200-400mcg BD)
2 SABA - Salbutamol, Albuterol, Levoalbuterol
3 LTRA - Monteleukast and zafirlukast
4 LABA - Formoterol, Salmetorol, Indacaterol
5 ICS-LABA - Budesonide-formoterol

Laryngomalacia

Definition

Congenital abnormality of laryngeal tissues that leads to supraglottic collapse during inspiration leading to airway obstruction

- Commonest congenital cause of stridor in children
- Symptoms begin within first 2 months of life

Risk factors/causes

- Neurological abnormalities
- Laryngeal anatomical abnormalities
- Genetic syndromic disorders
- Male sex

Signs and Symptoms

- Inspiratory stridor worse in supine position, when upset, crying, during feeding and when they have a respiratory tract infection
- Failure to thrive in severe cases

Investigations

- Flexible or direct laryngoscopy with infant breathing spontaneously (gold standard)
- Visualization of an omega-shaped epiglottis and/or collapse of supraglottic structures over the glottis during inspiration

Differential diagnoses

- Vocal cord paralysis
- Subglottic stenosis
- Laryngeal papillomatosis
- Foreign body aspiration
- Subglottic haemangioma
- Laryngeal web

Management

Primary level
Refer all cases

Secondary level

Refer all cases

Tertiary level

- Consult Ear, Nose and Throat (ENT) team or paediatric surgeons
  - Supraglottoplasty- Only severe and persistent cases
- For confirmed patients
  - Reassure the parents -90% resolve by 2 years of age
  - Swallowing therapy (nursing upright after feeds, smaller frequent feeds, and feed thickeners) and acid suppression therapy (Proton pump inhibitors like Omeprazole or histamine receptor blockers e.g. famotidine) for associated gastroesophageal reflux disease

Follow up

- Close follow up is required especially for those being managed conservatively
- Monitor weight gain during routine under-5 visits

Obstructive Sleep Apnoea

Definition

Episodes of partial or complete upper airway obstruction occurring during sleep leading to interrupted breathing

Causes/risk factors

- Male
- Obesity
- Aden tonsillar hypertrophy
- Craniofacial abnormalities e.g. retrognathia, micrognathia, midfacial hypoplasia
- Allergic rhinitis
- Nasal polyps
- Endocrinopathies e.g. hypothyroidism, acromegaly
- Neuromuscular conditions e.g. muscular dystrophies, cerebral palsy
- Metabolic disorders e.g. mucopolysaccharidoses
- Genetic syndromes e.g. Prader-Willi syndrome, down syndrome

Prevention/promotion

- Weight loss
- Sleeping on the sides

Signs and Symptoms

- Snoring (stertor) during sleep
- Restless sleep with waking, gasping or choking
- Morning headaches: older children
- Excessive daytime sleepiness and aggressiveness
- Hyperactivity: Especially younger children as a sign of sleepiness
- Poor suckling
- failure to thrive in infants
- Enuresis
- Nocturnal sweating
- Night terrors

Investigations

- In-laboratory polysomnography: Gold standard
- Continuous overnight pulse oximetry
- Charting of overnight severity of stertor, apnoea and any stimulation/intervention needed

Differential diagnosis

- Gastroesophageal reflux disease
- Central sleep apnoea
- Hypoventilation disorders
- Narcolepsy

Management

Primary level Refer all cases
Secondary level See the tertiary level guidance below
Tertiary level Management depends on cause: • Aden tonsillar hypertrophy can be treated by surgery • Consult maxillofacial surgeons for structural facial problems • Continuous Positive Airway Pressure (CPAP) mask when sleeping or other upper airway modification • appliances • Lifestyle modification in children with obesity • Positional therapy. Patients should sleep in lateral position instead of supine

Follow up

- Growth and development and to assess for any complications

Bronchiectasis

Definition

Irreversible abnormal dilatation and anatomic distortion of the bronchial tree. Results from cyclic bronchial inflammation, infections and progressive airway destruction

Causes/risk factors

- Post infectious: e.g. tuberculosis, severe pneumonia, measles, pertussis
- Aspiration syndromes
- Airway obstruction: Tumour, vascular ring
- Missed foreign body aspiration
- Genetic disorders e.g. Cystic fibrosis, primary ciliary dyskinesia, alpha 1 antitrypsin deficiency
- Immune deficiency e.g. allergic broncho-pulmonary aspergillosis, immunoglobulin A and G deficiencies
- Congenital bronchiectasis

Prevention/promotion

- Childhood vaccination for pertussis, pneumococcus, measles and haemophilus influenzae type B, Respiratory Syncytial Virus (RSV)
- Screening for TB in immunosuppressed and early treatment

Signs and symptoms

- Chronic productive cough
- Shortness of breath
- Haemoptysis
- Finger clubbing
- Crackles, wheeze – on auscultation
- May also have a barrel chest
- Failure to thrive

Investigations

- FBC, HIV test
- Chest X-ray
- Sputum/gastric aspirate for culture, sensitivity and gene Xpert
- Lung function tests
- Sweat chloride or genetic testing- Cystic fibrosis
- Chest X-ray

- High resolution CT chest- gold standard
- Milk scan and upper GI contrast- aspiration syndromes
- Bronchoscopy- missed foreign body

Differential diagnosis

- Bronchiolitis obliterans
- Childhood interstitial lung disease
- Infections e.g. TB

Management

Primary level

Refer all cases

Secondary level

See the tertiary level guidance below

Tertiary level

Acute exacerbation

- Oxygen therapy if necessary
- Empirically start antibiotics while awaiting sputum results
- Chest physiotherapy and optimize airway clearance techniques
- Mucolytic therapy/ hypertonic saline nebulisers

Long term goals and therapy

- Chest physiotherapy
- Prevent infections and exacerbations:
  - Ensure all vaccines are up to date
  - Avoid triggers
  - Regular sputum cultures
  - Prophylactic antibiotics in immunosuppressed e.g. cotrimoxazole
- Growth and development
  - Adequate nutrition
  - Micronutrient supplementation
  - Pancreatic enzyme replacement therapy- cystic fibrosis
- Prevent further lung damage and complications
  - Immune modulator therapy- azithromycin 10mg/kg 3x a week- (for 3 months; then long term if good response; stop if no response after 3 months)
  - Inhaled corticosteroids if wheezing

Follow up

- Review in general medical clinic monthly initially, 3-6 months if stable
- During every visit
    - Do sputum culture
    - Spirometry if available
    - Anthropometry
- If poorly controlled localized disease- consider lobectomy

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