

Definitions Asthma is a chronic inflammatory condition associated with reversible hyperreactivity of the intra-pulmonary airways. May be extrinsic (allergic) or intrinsic.

Chronicity	Days with symptoms	Nights with symptoms	Peak flow
Mild intermittent or Infrequent episodic	<2x per week or sig. episodes>6wks apart	<2x per month	>80%
Mild persistent or Frequent episodic	3 - 6x per week or sig. episodes<6wks apart	>2x per month	>80%
Moderate persistent	Daily, multiple ED pres	>1x per week	60 - 80%
Severe persistent	Continual	Frequent	<60%

Epidemiology

- Prevalence in Australia: 5-10% Adults, ~15% Children - higher in ages 2-6y (?from including misdiagnosed viral-associated wheeze) - recently falling. 9% of US children.
- M>F children but more F persist into adulthood
- FamHx, maternal smoking & atopy associations
- Higher incidence in developed countries, but possibly more severe in less developed ones
- ?Breast feeding protective

Risk Factors

RF for exacerbation:

- Viruses esp recent upper respiratory infection
- Allergy - contact with animals with fur and/or feathers, house dust mites (in mattresses, pillows, furniture, carpets) or pollen exposure
- Airborne chemicals or irritants incl perfumes, exposure to smoke
- Changes in weather
- Exercise
- Strong emotional expression (laughing or crying)
- Drug exposure (aspirin, beta blockers)
- Food additives/preservatives, e.g. tartrazine dye

RF for death:

- Labile asthma - sudden severe attacks
- History in past 12mo of any of:
 - >3 ED visits, >2 hospitalisations, or ICU adm
 - Intubation
 - Recent withdrawal from PO steroids or current use of PO steroids,
 - Co-morbidities such as cardiac disease, HIV, psychiatric disease
 - Illicit drug use
 - Poor patient perception of airflow obstruction and its severity

Pathophysiology

- Initial spastic bronchoconstriction
- Release of inflammatory mast cell mediator (e.g. histamine, PGD_2 , LTC_4 , LTD_4 , and LTE_4) → mucous hypersecretion, mucosal oedema, increase in bronchial smooth muscle tone
- Finally inflammatory & immune cell (eosinophils, basophils, neutrophils & T-helper cells) infiltration, exacerbating these changes which narrow the intrathoracic airways

Complications

- Pneumothorax, pneumomediastinum, pneumopericardium, subcut emphysema
- Mucous plugging, segmental atelectasis
- Nosocomial pneumonia
- Respiratory failure
- Drug toxicity, electrolyte disturbance ($\downarrow K^+$, $\downarrow PO_4$, $\downarrow Mg^{2+}$)
- Anoxic brain injury, death
- Others: MI, BSL, lactic acidosis,

Clinical Features

History

Asthma pattern, triggers, Cx & Mx (inhaler & PO steroids freq, hospital admissions, PEFr)

This episode:

- Assess possible precipitants & RF for death
- Presence of typical symptoms for patient (cough, wheezing, dyspnoea, chest tightness)
- Onset and the duration of symptoms
- What Rx given so far
- FamHx, Allergies, Other PMHx incl atopy, other medications, smoking/rec drugs

Examination

- Vital signs (HR, BP, RR, T, SaO₂)
- Decide on likely severity:
 - **Mild:** Cough, wheeze, no respiratory distress, active, talks in sentences, PEFr/FEV1 >60% pred, SaO₂ >94%
 - **Moderate:** Cough, wheeze, mild respiratory distress, reduced activity, talks in phrases, may have pulsus paradoxus, PEFr/FEV1 40-60% pred, SaO₂ 90-94%
 - **Severe:** Marked respiratory distress, unable to feed/single words, reduced breath sounds, pulsus paradoxus, cyanosis, PEFr/FEV1 <40% pred if capable, SaO₂ <90%
 - **Life-threatening:** Exhaustion (feeble respiratory effort), decreased LOC, silent chest, bradycardia, hypotension, PEFr/FEV1 unable to perform, SaO₂ <80%

Investigations

- Oximetry - doesn't always correlate with degree of alveolar hypoventilation.
- PEFr if >5y (~[5 x Height/cm] - 400 l/min in children) - effort/technique dependent, not greatly useful in acute setting, but may be of use to highlight dips or monitor Rx.
- FEV1 - For older child & adult
- Arterial blood gas if severe to look for rising PCO₂ & exhaustion
- U&E - if iv salbutamol to be used (checking for hypokalaemia)
- [CXR - if severe, high Temp, PTX suspected, 1st presentation, focal signs, not improving]

Differential Diagnosis

- Episodic viral wheeze
- CF, bronchiolitis or bronchitis, COAD, pneumonia
- Anaphylaxis
- Cardiac asthma
- FB ingestion, croup & upper airway obstruction
- Neoplasm or carcinoid syndrome
- Recurrent PE
- Systemic vasculitis involving the lungs

Management

- O_2 (60-100%) to maintain $SaO_2 > 94\%$. ?Consider high-flow in sev children.
- **Mild:** Inh salbutamol. Then if chest not clear or still distressed → **Moderate**, else d/c.
- **Moderate:** Inh salbutamol x 3 q20min + prednisolone. If no improvement → **Severe**
If partial improvement: continue stretching salbutamol q1-4h, r/v before each due dose. Admit if not progressing sufficiently to d/c. Otherwise (for **Mild** & **Moderate**) when clear/undistressed at 3-4hr post-dose & PEFr > 60%: r/v technique, d/c on inh salbutamol q4h for 1-2 days and taper, ± 3 day prednisolone course, formal asthma Mx plan, f/u appt.
- **Severe:** Cont. neb salbutamol through high flow O_2 . Add ipratropium. Get IV access. Take ABG, bloods & consider CXR. IV magnesium ± salbutamol. Give IV steroid. Admit HDU.
- **Life-threatening:** As for **Severe**. IV salbutamol. Beware SIADH/↓K+/↑lactate. Consider CPAP or in extremis: IPPV, adrenaline, aminophylline, ketamine/GA. Adm ICU.
- Antibiotics: Not routinely indicated. Consider only if likely bacterial infection.

Acute Drug Summary

- **Short acting β -agonists** - first line. E.g. salbutamol, terbutaline, adrenaline
 - Inh salbutamol - minimises systemic effects (**SE:** ↑HR, tremor, headache, ↓K+). Pat. gets ≤10% neb dose. *NB. Oral β -agonists not effective in asthma.*
 - (<20kg) 4-6 puffs inhaled via spacer/MDI or 2.5mg neb q20min-q4h-prn
 - (>20kg) 8-12 puffs inhaled via spacer/MDI or 5mg neb q20min-q4h-prn
 - Continuous nebs 20ml/hr of 5mg/ml sol
 - IV salbutamol (5mg/5ml) - no meta-analysis evidence for use in **Severe**. May → lactic acidosis & Q/V mismatch. Various regimes.
 - Child: (15mcg/kg over 10min OR 5mcg/kg/min for 1hr) then 1mcg/kg/min
 - Adult: bolus 5mcg/kg over 1min then infusion at 5-10mcg/kg/hr
 - Adrenaline - α & β_1 effects too. No good evidence better than selective agents.
 - **Moderate:** 5ml 1:1000 Neb. **Life-threatening:** 0.1ml/kg 1:10,000 IM.
- **Corticosteroids** - normally for 3-5d (if course < 10d then do not need to taper)
 - PO prednisolone init dose 2mg/kg/day then 1mg/kg/day PO (max 50mg)
 - IV methylprednisolone 1mg/kg q6h (max 50mg) for 24h then bd for 24h then daily
 - IV dexamethasone 0.15mg/kg to 8mg or IV hydrocortisone 4mg/kg to 200mg q6h
 - High-dose inhaled CS may have some acute benefit, but growth SE in children
- **Anticholinergics** - augments β -agonists in **Severe**. Debatable use for **Moderate**.
 - Inh ipratropium bromide q20min x3 → q6h
 - (<20kg) 4 x 20mcg puffs inhaled via spacer/MDI or 250mcg neb
 - (>20kg) 8 x 20mcg puffs inhaled via spacer/MDI or 500mcg neb
- If **Severe** and failure of standard Rx:
 - **IV $MgSO_4$ 50%** 1.2-2.4g=10-20mmol (child 0.1ml/kg=50mg/kg=0.02mmol/kg) bolus over 20-60min (infusion 0.06ml/hr or nebs controversial). **SE:** ↓BP, ↓LOC.
 - **IV aminophylline** - Narrow therapeutic range. (SE: vomiting, headache, abdo pain, palpitations, and intractable seizures)
 - Adults: 5mg/kg over 30min (if not reg med) then infusion 0.6mg/kg/hr
 - Children 5mg/kg over 30min, then 1mg/kg/hr
 - **Heliox:** 60+%He: O_2 mixture with lower density (& better flow) than air mixtures.
- If **Life-threatening** and failure of standard Rx:
 - IV ketamine 1-2mg/kg then up to 5-40mcg/kg/min infused for sedation/bronchodilation OR inh sevoflurane/isoflurane at 1-2% inspired conc.

NIPPV/Mechanical Ventilation

- BIPAP: CPAP ↓work of breathing and PS may improve gas exchange. May ↓need for ETT.
- Intubation indications (last resort as high risk of barotrauma with PPV). Use cuffed ETT.
 - Apnoea/cardiac arrest or decreased LOC
 - Exhaustion or rising PCO_2 despite maximal therapy
 - Severe hypoxia or acidosis
- RSI: Use ketamine if possible. Propofol or midazolam/fentanyl are alternatives.
- Aim: Oxygenation without barotrauma from hyperinflation & auto-PEEP (both common)
- Use
 - Volume cycle ventilator or hand bag, not time-cycled
 - Low RR (6-8bpm or half of normal for age)
 - Low tidal volumes (5-6ml/kg)
 - Long I:E ratio (1:3-6)
 - Inspiratory flow rate 60-100L/min
 - Minimal PEEP $\leq 5\text{cmH}_2\text{O}$ (so no ↑hyperinflation)
 - PAP < 40cmH₂O
 - Permissive hypercarbia (up to pH 7.15 & PCO_2 80mmHg) & aim $SpO_2 > 91\%$
 - Sedate (fentanyl plus propofol or midazolam. Avoid morph→histamine) ± paralyse to prevent ↑PAP by patient agitation,
 - If ↓BP + hyperinflated*, interrupt IPPV ?PTX ± apply external chest decompression

Non-acute therapies

Inhaled long acting β -agonists - salmeterol, eformoterol. Last about 12hrs.

Inhaled corticosteroids - Beclomethasone, budesonide, fluticasone. Can cont if on PO steroid.

Leukotriene receptor antagonists - PO montelukast 5-10mg OD. For chronic sev, exercise and aspirin-related asthma. ?Role in episodic viral wheeze. May spare steroid/ β -agonist use. Research continues for IV efficacy in acute exacerbations.

Cl channel blockers - Sodium cromoglycate. Dry powder or MDI. Inhib. mast cell degranulation. Useful as prophylaxis in allergic or exercise-induced asthma.

Methylxanthines - theophylline - small therapeutic window. **SE** incl N/V, arrhythmias, fits.

- *Chronic poor control* or inability to tolerate steroids may req additional immunosuppression, e.g. cyclosporin or methotrexate. Alternatives include continuous SC terbutaline, anti-IgE monoclonal antibody omalizumab q2-4weekly or four weekly SC

New therapies: vaccine against IL-13, omalizumab (anti-IgE monoclonal Ab), Chinese herbs

Prognosis

- Overall mortality <2% of presentations, increases to >10% if req. mechanical ventilation.
- Reduced childhood growth, usually as a result of poor control.
- Inhaled steroids >400mcg (beclometasone) or >200mcg (fluticasone)/day may slow growth velocity but not affect attainment of normal height.
- Doses >800mcg/day (beclometasone) or >400mcg (fluticasone)/day may risk adrenal suppression.
- Absence from school and educational disadvantage

Prevention

- Address RF for exacerbations & avoidance of precipitants.
- Asthma education
- Stress compliance with Rx, preventers and asthma Mx plan.