Clinical Guidance

Paediatric Critical Care: Severe Asthma

Summary
This guidance offers advice for staff treating children with severe asthma. It offers advice on treatment, ventilation techniques and patient assessment. It also refers to treatment within a PICU setting. Advice on salbutamol dosing differs between British Thoracic Society guidelines and the BNF. STRS has chosen the lower dosing due to concerns of salbutamol toxicity. There is also evidence that patients requiring critical care are more likely to have mucus plugs rather than bronchospasm.

Document Detail	
Document type	Clinical Guideline
Document name	Paediatric Critical Care: Severe Asthma
Document location	Evelina London website
Version	v3
Effective from	*14th July 2021*
Review date	*14th July 2024*
Owner	PICU Head of Service
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Approved by, date	Evelina London Clinical Guidelines Committee, July 2021
Superseded documents	v2
Related documents	British Thoracic Society 2019 guidance on asthma
Keywords	Evelina, child, Paediatric, intensive care, STRS, Retrieval, Paediatric critical care, asthma, wheeze, PICU.
Relevant external law, regulation, standards	
This clinical guideline has been produced by the South Thames Retrieval Service (STRS) at Evelina London for nurses, doctors and ambulance staff to refer to in the emergency care of critically ill children. This guideline represents the views of STRS and was produced after careful consideration of available evidence in conjunction with clinical expertise and experience. The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.	

Glossary: MgSO4 is magnesium sulphate, DNAse= Dornase Alfa

Change History		
Date	Change details, since approval	Approved by
July 21	Avoid nebs with salbutamol infusion as toxicity Advice for post extubation care and follow up clarified	ELCGC

Severe Asthma

Asthma is reversible airflow obstruction (β2 bronchodilator responsive).
Lack of reversibility/paradoxical deterioration with treatment: a) mucus plugs b) rarely other pathology (tracheomalacia, vascular rings, foreign body, congestive cardiac failure and compressive airway masses).
Risk factors for fatal asthma: (usually pre-hospital event) brittle asthma, heavy use β2 bronchodilators, previous ICU admission

Standard treatment for acute asthma (as per BTS guideline)[1]

FIRST LINE

- Oxygen to maintain saturation >94%
- Salbutamol MDI 2-10 puffs (can be repeated)
- Nebulised Salbutamol 2.5 -5mg MAX every 20-30 minutes
- Ipratropium bromide 250 micrograms nebulized, then 4 to 6 hourly
- Oral prednisone 20mg if <5yr, 40mg if >5yr
  2mg/kg if on maintenance steroids, MAX 60mg (3 days usually enough)
  4mg/kg IVI hydrocortisone (Max 100mg) if oral not tolerated

SECOND LINE

Worsening clinical status

- 40 mg/kg IVI $MgSO_4$ over 30min (Max 2 grams) (may help mucus plug lysis)
  (Consider 2nd dose if positive response. Side effect hypotension - monitor BP)
- IVI Salbutamol infusion (0.5 to 1mcg/kg/min – **MAX 20micrograms/min**)
  Monitor for hypokalemia. Side effect = tachycardia, lactic acidosis
  Risk of increasing > 1mcg/kg/min OR additional nebs as side effects ↑
  (agitation, tachycardia, hypokalaemia, lactic acidosis-worsens resp function)
- If Aminophylline DGH policy:5 mg/kg over 20 min then 0.5-1mg/kg/h
  (Max dose: 0.8mg/kg/h if 9-15 yrs, ≥16 yrs 0.5mg/kg/h). Monitor
  levels as narrow therapeutic range and side effects common

Consider intubation if failure to respond to above therapy:

- Saturation< 92% despite high flow nasal cannula/facemask O_2
- Hypercarbia CO_2 > 6kpa (rare in acute asthma = sign of fatigue),
- Inability to speak short sentences (severe airflow obstruction)
- Poor air entry/absent wheeze

Intubation is high risk (may be difficult to ventilate – use cuffed ETT)

- Pre oxygenate adequately (3 min). Rarely CO_2 may rise with O_2.
- Ketamine (2mg/kg IV) / Rocuronium 1mg/kg as muscle relaxation.
- BP may fall if dynamic hyperinflation / air trapping: may need IV fluid boluses
- Use end tidal (if dead space high, end tidal 50-60% of true CO_2) if end tidal does not reach plateau = incomplete expiration
- Post intubation CXR mandatory
- **Don't manually decompress chest** (risk cardiac arrest if air trapping is dynamic)

Initial ventilation principles (saturations > 90% are adequate)

- Use pressure control mode with muscle relaxation (SIMV may autotrigger).
- High peak pressure (PIP) to move chest. MAX plateau press = 35 cm H_20
- If severe, PIP 40-50 cm H_20 may be needed if inspiratory peak to plateau >10
- Fixed PEEP at 5 cm H_20 (do not routinely measure auto-PEEP to adjust)
- SLOW RATE 10 - 15 bpm (flow should reach zero before next breath)
- High CO_2 is acceptable (7-14kPa) provided control achieved and improving
- End tidal CO_2 often does not correlate with arterial CO_2 (deadspace ventilation)
- In ICU setting use tidal volume and flow loops (see figures)
- Measure inspiratory peak to plateau difference to estimate large airway resistance
- Ensure adequate minute ventilation (tidal volumes may need to be 8-10ml/kg min and inspiratory breath should start as soon as expiration finishes)
- If ventilation difficult, use manual bagging with enough pressure to move the chest. Allow enough time for expiration (plateau on $ETCO_2$)
- PERSISTING HYPERCARBIA – Troubleshoot cause (Tube obstruction or leak, pneumothorax, mucous plugs)

CXR to look for:

- Atelectasis / consolidation
- Pneumothorax
- Alternative diagnosis (airway compression, foreign body)

Gases

- Arterial/venous blood gas can be useful to monitor: lactate (salbutamol toxicity), K+, CO_2 if concerns of fatigue
- Do not use cap gas-(CO_2 error high)

Asthma severity can be difficult to assess

- Tachycardia universal with β_2 stimulants
- Respiratory rate varies with respiratory drive vs fatigue (slow breathing suggests fatigue)
- Agitation or drowsiness may occur

Concerned or lack of response to therapy seek consultant paediatric & anaesthetic review

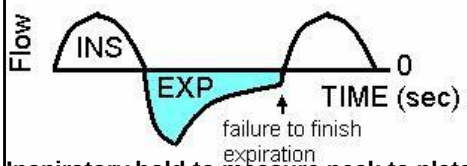
In PICU

- Reduce IV salbutamol < 0.5 mcg/kg/min as can cause lactic acidosis (↑ glycolysis)
- NO nebs if ventilated or on IV salbutamol
- Early physiotherapy opinion
- Bronchoscopy if diagnosis uncertain or poor response to treatment
- As patient improves use pressure support 10-30cm H_20 (not SIMV).Titrate to WOB.
- Refer to tertiary respiratory team who must review prior to discharge or transfer to referring hospital
- Review asthma therapy after extubation and consider length of steroids
- Allergy review if history suggests anaphylaxis

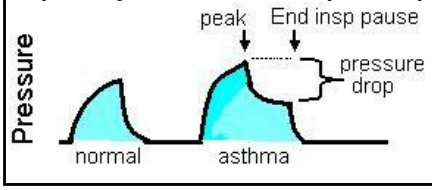
Criteria for endotracheal dornase alfa

- PIP > 28 cm H_20
- Insp peak to plateau pressure > 10 cm H_20
- Not ventilated but > 48hrs of IV salbutamol & no clinical improvement
- In severe cases bronchoscopy with PICU consultant
- Response to dornase alfa may be dramatic: reduce PIP as tidal volumes increase

Flow time loops ensuring complete expiration



Inspiratory hold to measure peak to plateau



Investigations and follow up arrangements

- Chest Xray review
- Full blood count inc. eosinophil/WBC differential
- Serum IgE (and specific IgE – house dust mite, aspergillus, moulds mix, cat & dog).
- Serum tryptase (within 1st 24hrs admission to hospital)
- Bronchoalveolar lavage (if ventilated) – Cytology (differential count incl. fat laden macrophages), Culture (bacterial, fungal & AFB's)
- Respiratory viral panel (incl. HSV and CMV)
- Inpatient paediatric asthma team review prior to discharge or transfer to referral hospital
- GP/local paediatrician review in 48hrs
- Respiratory (asthma consultant) clinic in 2-4 weeks & severe and difficult asthma service follow up in 3 months

References: 1) www.brit-thoracic.org.uk 2) Stather, Crit Care, 2005 3) Durward, CritCare Med 2000 4)Tobin, Crit Care Resus 2005

ELCGC Ref: 21065l

Review by 14th July 2024