ACUTE SEVERE ASTHMA GUIDELINE

Title:	**Guidelines for Management of Acute Severe Asthma in Children over 2yrs**
Version:	**4 PCCN 4**
Supersedes:	**Supersedes**: Version 3 **Summary of amendments in version 4:** Included one or two dose dexamethasone has equivalent efficacy and improved compliance compared to prednisolone Included Oxy-PICU saturation targets for invasively ventilated patients Included use of My MART asthma action plan at discharge
Application:	All children under 16 years age admitted to hospital in North West & North Wales region
Originated /Modified By: **Designation:**	**Originated By**: North West (England) and North Wales Paediatric Transport Service **Guideline authors:** **Version 1:** Pete Murphy, Transport Consultant NWTS and Consultant Paediatric Anaesthetist, AHFT Rachael Barber, NWTS Consultant and PICU Consultant, CMFT Aradhana Ingley, Associate Specialist in Paediatrics, Glan Clwyd Hospital, North Wales Adam Sutherland, Senior Clinical Pharmacist, CMFT Fran Child, Consultant Paediatric Respiratory Consultant, CMFT Jon Couriel, Consultant Paediatric Respiratory Consultant, AHFT **Version 2:** Rachael Barber, NWTS Consultant and PICU Consultant, RMCH Carrick Allison, Paediatric Anaesthetic Trainee, RMCH Adam Sutherland, Lead Pharmacist, RMCH Ellie Turner, Lead respiratory pharmacist, RMCH **Version 3:** Kate Parkins, PICM Consultant NWTS Ian Sinha, Paediatric Respiratory Consultant, AHFT Claire Murray, Paediatric Respiratory Consultant, RMCH Louise Turnbull, Paediatric Respiratory Consultant, RMCH **Version 4:** Phillip Ross, PICM GRID Trainee, AHCH Constantinos Kanaris, Paediatric Critical Care Consultant, NWTS Kate Parkins, PICM Consultant, NWTS
Review by:	1. North-West (England) & North Wales Paediatric Critical Care Operational Delivery Network (ODN) 2.Lewis Nicholls, Paediatric Pharmacist, PCC ODN & RMCH
Ratified by:	1. North-West (England) & North Wales Paediatric Critical Care ODN 2. RMCH (Host Trust): Paediatric Policies & Guidelines & Pharmacy & Medicines Management Committees
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Dissemination and Implementation:	NWTS & Paediatric Critical Care Network circulation lists
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Planned Review Date:	**3 years i.e.**
Responsibility of:	Clinical lead North-West (England) & North Wales Paediatric Critical Care ODN & NWTS guideline team
Minor amendment (if applicable) notified to:	
Date notified:	

EqIA Registration Number:	2026-51

1. Detail of Procedural Document: Guidelines for Management of Acute Severe Asthma in Children more than 2 years old.

This guideline is for use by staff working in the District General Hospitals of the North-West (England) and North Wales region and NWTS team to use when caring for those over 2 years of age with an acute severe exacerbation of asthma. It focuses on acute management and potential differential diagnosis that need to be considered.
This does not replace an acute referral to NWTS team for advice on management, but is designed to help both NWTS and the referring team throughout the acute stabilisation period.

2. Equality Impact Assessment

Equality Impact Assessment Please record the decision whether the policy, service change or other key decision was assessed as relevant to the equality duty to: Eliminate discrimination and eliminate harassment Advance equality of opportunity Advance good relations and attitudes between people			
Relevant	YES	Relevant	
Where the decision was RELEVANT, please record details of the outcome of the full impact assessment and summarise the actions that will be taken to eliminate or mitigate adverse impact, advance equality or justification for the impact.		Guideline relevant for paediatric age group only Intended for use across North-West (England) & North Wales region for those under 16 years of age. Appropriate PEWS and observation target ranges included for all age groups. Risk of occult hypoxaemia highlighted IE that it is more than 3 times greater in Black vs White pts AND may over-estimate SpO_2 between 1.5-5%.	
EqIA registration Number for RMCH:		**150/12**	

3. Consultation, Approval and Ratification Process

This guideline was developed with input from:
- North-West (England) and North Wales Paediatric Transport Service (NWTS).
- North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network
- Representatives from the Local Hospital Teams within network above.
- Paediatric Respiratory teams at both AHCH & RMCH

These guidelines were circulated amongst the North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network for comments on the 10th February 2026.

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the PCC ODN guidelines committee May 2026.

For ratification process for network guidelines see appendix 1.

4. Disclaimer

These clinical guidelines represent the views of the North West (England) and North Wales Paediatric Transport Service (NWTS) and the North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network (PCC ODN). They have been produced after careful consideration of available evidence in conjunction with clinical expertise and experience.
It is intended that trusts within the Network will adopt this guideline and educational resource after review and ratification (including equality impact assessment) through their own clinical governance structures.
The guidance does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient.
Clinical advice is always available from NWTS on a case-by-case basis.
Please feel free to **contact NWTS (01925 853 550)** regarding these documents if there are any queries.

ACUTE SEVERE ASTHMA GUIDELINE

NO OR POOR RESPONSE

SUMMON SENIOR HELP

Give 15 L/min O_2 to achieve normal saturations (≥ 92%)

Consider High Flow Humidified Nasal Cannula Oxygen

GIVE: **PO prednisolone / dexamethasone** OR **IV hydrocortisone** AND

Combined nebulised **β₂agonist + ipratropium bromide** every 20 mins

IF POOR RESPONSE AFTER 3 COMBINED NEBULES:

Give **IV magnesium** sulfate 40 mg/kg (max 2 g)

(0.16 mmol/kg, max 8 mmol) bolus over 20 mins

IF NOT IMPROVING RAPIDLY (i.e. within 10-20min):

Load IV aminophylline 6 mg/kg (IBW if BMI >50%) (max 500mg)

over 20 mins (if not on oral theophyllines)

Then start IV aminophylline infusion

2-11 years @ 1 mg/kg/hr; 12-17 years @ 0.5-0.7 mg/kg/hr

IF NO IMPROVEMENT WITHIN 30 MINUTES

OR CONTINUING TO DETERIORATE:

START short (4 hrs) IV magnesium sulfate infusion (best option)

OR give **2nd bolus** dose **IV magnesium sulfate**

PAUSE & REASSESS after 20 -30 mins:

If no improvement/deteriorating:

Bolus IV salbutamol 15 microgram/kg over 5 mins.

PAUSE & REASSESS after 20 mins including blood gas + lactate

URGENT CONSULTANT ANAES/PAEDS REVIEW

CONTACT NWTS FOR ADVICE: 08000 84 83 82

STILL NO IMPROVEMENT

Give **3rd** bolus **IV magnesium** if **not** on magnesium infusion

Start **IV salbutamol infusion** 1 microgram/kg/min **(MAX 20 micrograms/min)**

Give **Nebulised adrenaline** 400 micrograms/kg (max 5 mg)

Consider CXR/antibiotics/alternative diagnoses whilst reassessing.

Blood gas + lactate

PREPARE FOR INTUBATION

IMPENDING CARDIO-RESPIRATORY ARREST

SpO_2 ≤ 92% in O_2 PLUS any of: Cyanosis

Worsening agitation; ↓Level of consciousness

Poor respiratory effort or Exhaustion or Silent chest

PRE-TERMINAL SIGNS: High CO_2 Acidaemia (pH ≤ 7.2)

Hypotension

INTUBATE & VENTILATE

See page 5 & Intubation guideline

ACUTE SEVERE ASTHMA

SpO_2 <92% in air

Use of accessory muscles

Difficulty talking or eating

Agitated

	< 5 years	> 5 years
HR	> 140/min	> 125/min
RR	> 40/min	> 30/min

HIGH RISK CLINICAL SIGNS

Agitated/confused or drowsy

Unable to talk or feed

SpO_2 ≤ 92% in air, pO_2< 8 kPa

pCO_2 'normal' (4.6-6 kPa)

Silent chest

Exhaustion/poor respiratory effort

INDICATIONS FOR CXR

Surgical emphysema

Severe / Life-threatening asthma not responding to treatment

OR to exclude:

Pneumothorax,

Lobar collapse/consolidation

FB or mediastinal mass

REFER TO NWTS EARLY IF:

- Require IV magnesium infusion
- Require IV salbutamol infusion
- pCO_2 normal or rising
- Exhaustion or silent chest etc

BLOOD GAS MEASUREMENTS

Consider if severe/life-threatening AND not responding treatment

NB Normal or high pCO_2 = worsening asthma & respiratory failure

Capillary blood gases give accurate pH + pCO_2 results

ALWAYS check lactate

DIFFERENTIAL DIAGNOSIS

Anaphylaxis/Allergy

Severe or Atypical Pneumonia

Sepsis (esp. ↑lactate)

Mediastinal Mass

Foreign body

Pulmonary oedema

Inhalational injury

Anatomical airway abnormalities or malacia

Hyperventilation

ACUTE SEVERE ASTHMA GUIDELINE

OXYGEN: Give high flow oxygen via a tight-fitting face mask or nasal cannula at sufficient flow rates to achieve $SpO_2 \geq 92\%$. High flow humidified nasal cannula oxygen (eg optiflow, airvo or vapotherm) should be considered early, aiming for a flow 2 L/kg/min Max 50-60 L/min. Non-invasive ventilation may be considered for some patients, but ONLY after discussion with NWTS AND anaesthetic/adult intensive care review. Contra-indications to NIV include: severe acidosis (pH <7.25 associated with higher failure rates), pt exhausted, GCS ≤ 8/15, haemodynamically unstable, excessive secretions.

NEBULISERS: Oxygen-driven nebulisation is recommended @ 6-8 L/min flow

SALBUTAMOL:	**Under 5yrs**	**2.5 mg**	**Over 5yrs**	**5 mg**
IPRATROPIUM BROMIDE:	**Under 12yrs**	**250 micrograms**	**Over 12yrs**	**500 micrograms**

ALWAYS combine nebulised ipratropium bromide with salbutamol (β_2 agonist) to achieve significantly more bronchodilatation than β_2 agonist alone. If poor response to initial dose of β_2 agonist repeat doses should be given in combination with ipratropium every 20 minutes for the first hour.

Then 4-hourly ipratropium should continue to be given combined with salbutamol (synergistic effect if combined)

MAGNESIUM: dose = 150 mg per nebuliser (mixed with salbutamol + ipratropium bromide) in **1st hour ONLY**.

Limited evidence any benefit if used in severe asthma. None in milder cases. May be used if no IV access.

STEROIDS: ORAL consider either dexamethasone OR prednisolone within one hour of presentation

Dexamethasone: 0.6 mg/kg (max 16 mg) od for 1-2 days

Better tolerated, causes less vomiting & has longer half-life compared to prednisolone.

Prednisolone: **2 mg/kg od started within 1 hour presentation for 3-5 days**
Max 40 mg unless on maintenance steroids when max dose is 60 mg

IV Hydrocortisone: **4 mg/kg 6 hourly intravenously (max 100 mg per dose)**

Always use iv hydrocortisone if vomiting or for those with severe asthma

Benefits steroids are apparent within 3-4 hours. Oral and intravenous steroids have equivalent efficacy. One or two dose dexamethasone has equivalent efficacy and improved compliance compared to prednisolone. Continue until clinically improved. Tapering is unnecessary unless course of steroids continues for > 14 days

MAGNESIUM SULFATE BOLUS (UNLICENSED): **see page 8** **for more information on dosing/administration**

Bolus: 40 mg/kg (max 2 grams) = 0.16 mmol/kg (max 8 mmol) intravenously over 20 min

For easier prescribing / administration use banded doses according to patient weight **(page 8)**

Do not wait for magnesium levels before giving first dose, toxicity rarely seen below level 4 mmol/L AND is rare if patient has normal renal function. **Dose may be repeated in severe cases within 1-2 hours.**

SHORT INTRAVENOUS MAGNESIUM SULFATE INFUSION (UNLICENSED): **see page 9** **for more information**

Dose: 50 mg/kg/hr for 4 hours (max. 8 gram/4 hr) may be used to treat acute severe exacerbations of asthma. **Magnesium has a rapid onset of action (within minutes) and is rapidly eliminated (renal excretion).**

NB If starting a short magnesium infusion, please discuss with NWTS

A clinically non-significant fall in BP (~ 5 mmHg) may occur following a bolus or during an infusion of magnesium sulfate. If hypotensive, give 10 mL/kg fluid (MAX 500 mL), ideally balanced crystalloid eg Plasmalyte 148 or Hartmann's solution (if not available use 0.9% sodium chloride). Always review post-bolus to check hypotension resolved.

NB ALL hypotensive pts should have an urgent medical review. On review consider potential causes eg sepsis or hypovolaemia (2^{ry} to increased insensible losses and poor intake) and treat appropriately.

IV AMINOPHYLLINE: Loading: 6 mg/kg (max 500 mg) over 20 min use IBW if pt BMI >50% (omit if taking oral theophylline/aminophylline). **See page 10**

NB higher loading dose recommended as this is more likely to achieve the therapeutic range 10-20 mg/L.

Infusion: Under 12 years: 1 mg/kg/hr **Over 12 years: 0.5-0.7 mg/kg/hr**

Adjust dose/infusion rates according to plasma theophylline levels **(see page 10).** **HALVE m**aintenance rates if on a CYP inhibitor – common examples: macrolides (eg erythromycin, clarithromycin), quinolones (e.g. ciprofloxacin)

INTRAVENOUS SALBUTAMOL: **Bolus: (> 2 years) 15 microgram/kg over 5-10 minutes (max 250 microgram)**
See page 11 **Infusion: 1 microgram/kg/minute in severe refractory asthma**

NB MAX infusion 20 microgram/min (TOTAL dose NOT per kg)

Monitor for hypokalaemia and signs toxicity. Ideally, ↓ nebulised β_2-agonists to 4 hourly when on infusion.

If evidence of salbutamol toxicity (see page 11), reduce or stop infusion & reduce rate nebulised β_2-agonists.

Metabolic and lactic acidosis are worsened by hypovolaemia. Check blood gases + lactate min 6 hrly.

NB Children under 2-years-old with clinical picture consistent with severe bronchospasm are likely to respond better to IV magnesium sulfate and aminophylline rather than salbutamol

All pts receiving IV magnesium sulfate / aminophylline / salbutamol must be admitted to ward/HDU.

MONITORING: ECG, SpO_2, RR, BP (min every 10 – 15 mins during $MgSO_4$ infusion), & until improving.

Repeat 4-6 hourly blood gases including lactate & min. 12 hourly U&Es

IV salbutamol & aminophylline CANNOT run together via same PVL.
BOTH compatible (via multi-tail or 3-way tap) with Plasmalyte 148 +/- 5% glucose or 0.9% sodium chloride +/- 5% glucose
IV magnesium is compatible (via multi-tail or 3-way tap) with IV salbutamol

ACUTE SEVERE ASTHMA GUIDELINE

INTUBATION IN ACUTE SEVERE ASTHMA IS A HIGH-RISK PROCEDURE

See NWTS intubation Guideline www.nwts.nhs.uk/clinicalguidelines/regionalguidelines-a-z

<table>
<tr><td>INDICATIONS FOR INTUBATION</td><td colspan="2">Cardiac/Respiratory Arrest
Exhaustion
Hypoxia ie $SpO_2 \leq 92\%$ despite escalation of treatment
High CO_2 (> 6 kPa) rare in acute asthma = sign of fatigue/exhaustion
Acidaemia (pH ≤ 7.2)
Altered sensorium ie agitation, confusion, ↓ GCS
Silent chest / poor air entry / inability to talk in short sentences</td><td>NB Asthma Severity may be difficult to assess:
↑HR = universal with β_2 agonist
RR varies with respiratory drive +/- fatigue
NB slow rate suggests fatigue
Agitation or drowsiness may occur
Any concerns => joint review by paediatric & anaesthetic consultants</td></tr>
<tr><td rowspan="4">RISKS AT INTUBATION

Intubation Guideline including difficult airway guideline

(See link above)</td><td>RISK</td><td colspan="2">OPTIONS TO MITIGATE RISK</td></tr>
<tr><td>Low oxygen reserve
Rapid ↓SpO_2 at induction/post-intubation
Difficult CO_2 clearance</td><td colspan="2">Most experienced available intubator
Pre-oxygenate for 3-5 mins in 100% O_2
Apnoeic Oxygenation at laryngoscopy:
HHFNCO_2 @ 2L/kg/min MAX 50-60 L/min OR
nasal specs @ 0.2L/kg/min MAX 10 L/min
Use largest fitting/cuffed ET tube
SLOW respiratory rate via BVM/ETT
Place NGT ASAP post-intubation & aspirate</td></tr>
<tr><td>Relative hypovolaemia

Cardiovascular instability</td><td colspan="2">Anticipate hypotension
Good PVL / IO access
Give 20mL/kg fluid bolus PRE-induction
Prepare DILUTE adrenaline
IE take 0.1 mL/kg from Minijet syringe 1:10,000 adrenaline (using 3-way tap)
Make this up to 10 mL 0.9% sodium chloride
Use 1-2 mL aliquots to maintain BP</td></tr>
<tr><td>Delayed gastric emptying
Swallowed air => stomach distension & splinting diaphragm</td><td colspan="2">Modified rapid sequence induction
USE ketamine + fentanyl + rocuronium
Nasogastric tube ASAP post-intubation & aspirate</td></tr>
<tr><td>On-going difficulties with bronchospasm</td><td colspan="2">Induction agents:
USE ketamine +/- fentanyl + rocuronium
AVOID atracurium, thiopentone, morphine
(ie histamine-releasing drugs)
Have a volatile agent available post-intubation as bronchodilator</td></tr>
<tr><td>MANAGEMENT POST INTUBATION</td><td colspan="3">SEDATION: Fentanyl +/- midazolam infusion
ALTERNATIVE BRONCHODILATORS if bronchospasm persists despite max. IV treatment:
Volatile agents eg sevoflurane
Ketamine infusion
Adrenaline 1:10,000 0.1mL/kg IV or via ETT/nebulised may be used in extremis
VENTILATION: Use low respiratory rate (with long expiratory phase) when hand ventilating to improve oxygenation + CO_2 clearance & reduce risk pneumothorax (see page 6)
REMEMBER HYPOXIA KILLS, HYPERCAPNOEA DOES NOT!
For further strategies see page 6
AVOID morphine and atracurium as both cause histamine release</td></tr>
</table>

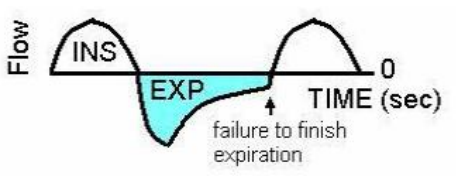
DIFFICULTIES WITH VENTILATION IN ACUTE SEVERE ASTHMA

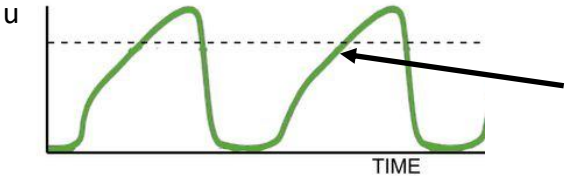
REMEMBER HYPOXIA KILLS, HYPERCAPNOEA DOES NOT!

HIGH PEAK PRESSURES: may cause barotrauma, pneumothorax, air leaks or ↓cardiac output

STRATEGIES: Try PCV or square wave ventilation
Limit Pmax (aim < 35-40 cmH_2O)
Permissive hypercapnia (ie tolerate pH ≥ 7.15; pCO_2 7-14 kPa)
Aim SpO_2 = 88-92% (>94% if pulmonary hypertension or neuroprotection)
Large, cuffed ETT will reduce resistance and minimal leak
Keep muscle relaxed initially especially whilst high pCO_2

INCOMPLETE EXPIRATION = Slow emptying of alveoli causes worsening gas exchange, progressive gas





Loss of plateau or 'shark fin appearance' to ET CO_2 trace

STRATEGIES: Try slow respiratory rates (for age) + long expiratory times (I:E ratio ≥ 1:3)
Allow completion of expiration ie flow to reach zero before next breath
Manual decompression (disconnect ETT and manually compress chest)

VOLATILE ANAESTHETIC eg sevoflurane can be used via anaesthetic machine/ventilator as an additional bronchodilator. Caution: watch for hypotension (see page 12 for appropriate targets for BP)

KETAMINE INFUSION may be used as an alternative bronchodilator – see NWTS emergency drugs guides for prescribing & administration information.

PHYSIOTHERAPY + 0.9% sodium chloride lavage (see below) may help
Always use a **slow bagging rate** (for age) to reduce air trapping.

INTRINSIC PEEP

Aim to match extrinsic PEEP to intrinsic PEEP to reduce gas trapping ie 6-8 cmH_2O

MUCUS PLUGGING

Suction +/- physio with 0.9% sodium chloride lavage 0.5 mL/kg max 5 mL via ETT
NB may make situation worse if inadequately sedated and not muscle relaxed
Alternative to 0.9% sodium chloride = Nebulised N-acetylcysteine
- mix 2.5 mL 20% solution N-acetylcysteine with 2.5 mL 0.9% sodium chloride, & then nebulise 2.5 mL of final concentration (or nebulise 2.5 mL 10% solution N-acetylcysteine)

Discuss EARLY with NWTS

MANAGEMENT OF ACUTE WHEEZE IN CHILDREN UNDER 2 YEARS OF AGE

This guideline is not appropriate for use in children under 2-years-old. For those under 2-years-old, several different diagnoses need to be considered and the response to treatment is highly variable. Such children should be managed on an individualised basis and early consultant review essential.

NB Children under 2-years-old with clinical picture consistent with severe bronchospasm may respond better to IV magnesium sulfate and aminophylline rather than salbutamol (see bronchiolitis guideline)

RISK FACTORS FOR NEAR-FATAL / FATAL ASTHMA

Severe asthma	Previous near-fatal asthma; History of anaphylaxis
	Previous admissions especially HDU or PICU +/- repeat attendances to A&E
	Requiring 3 or more classes of asthma medication
Plus:	Adverse behavioural/psychological features; Learning difficulties
	Poor compliance; Failure to be brought to appointments
	Fewer GP contacts; Self-discharge from hospital
	Psychosis, depression, psychiatric illness or deliberate self-harm
	Alcohol or drug abuse
	Obesity
	Looked after children

CRITERIA FOR REDUCING BRONCHODILATOR THERAPY

Normal respiratory effort; Normal ability to speak; Reducing oxygen requirement

DISCONTINUING INTRAVENOUS BRONCHODILATORS

AMINOPHYLLINE: Elimination half-life 3-5 hours. Reduce dose by 50% original dose every 6 hours
After discontinuing infusion, aminophylline is cleared within 24 hours

SALBUTAMOL: Elimination half-life 4-6 hours. Reduce dose by 0.5 microgram/kg/min every 6 hours
After discontinuing infusion, salbutamol will be cleared within 24 hours

NB: Substantial systemic absorption of salbutamol occurs via GI tract when given by inhalation or nebulisers, so intravenous infusions should be discontinued before stopping nebulised salbutamol

Each patient should receive nebulised β_2 agonists every 2 hours and nebulised ipratropium bromide every 4 hours whilst weaning off intravenous bronchodilators.

NB: Rebound may occur 24—48 hours after stopping either infusion so observe in hospital

Some patients with particularly brittle asthma may require a slower weaning regime

DISCHARGE PLANNING AFTER SEVERE ASTHMA ATTACK (IDEALLY INCLUDING ASTHMA NURSE REVIEW):

- Check inhaler technique
- Start/revise patient's reliever & preventer treatment OR My MART asthma action plan (MART = maintenance & reliever therapy)
- Check patient & family have a written asthma action plan for subsequent attacks with clear instructions on when to use inhalers & when to seek urgent medical attention if symptoms worsening.
- Contact GP to arrange **primary care follow up** within 48 hours
- **Local paediatric** (respiratory) review for those who required iv aminophylline and/or IV salbutamol.
- **REFER all acute life-threatening or invasively ventilated patients TO TERTIARY PAEDIATRIC RESPIRATORY team for follow-up**

APPENDIX 1: ADDITIONAL DRUG INFORMATION IV MAGNESIUM

INTRAVENOUS MAGNESIUM SULFATE BOLUS (UNLICENSED): first-line iv therapy: safe and less likely to cause tachycardia. Some evidence that higher doses magnesium may be of benefit clinically but this is not currently recommended in the BTS guidelines. In practice repeating the dose 1-2 hours after initial dose is clinically safe (as long as renal function normal).

Discuss all patients requiring multiple doses with NWTS.

Magnesium sulfate 50% injection contains 500mg/mL magnesium sulfate.

Dose: 40mg/kg over 20 minutes (max. dose 2g) can be administered centrally or peripherally.

Always dilute 50% solution before administration (see below). Aim level: 1.5-2 mmol/L

A clinically non-significant fall in BP (~ 5 mmHg) may occur as magnesium sulfate causes vasodilation. If hypotensive, give 10 mL/kg fluid, ideally balanced crystalloid e.g. Plasmalyte 148 or Hartmann's solution (if not available use 0.9% sodium chloride). Always review post-bolus to check hypotension resolved.

NB ALL hypotensive pts need an urgent medical review. On review consider potential causes e.g. sepsis or hypovolaemia (2^{ry} to increased insensible losses and poor intake) and treat appropriately.

Contra-indications: Myasthenia gravis; Severe renal impairment

Overdose: Depends on size of overdose: progressive muscle weakness, significant hypotension and ultimately respiratory failure reported, but unlikely to occur if plasma levels are less than 3.5 mmol/L.

MAGNESIUM SULFATE BOLUS DOSE			
WEIGHT (kg)	**DOSE Magnesium sulfate (40mg/kg)**	**VOLUME Magnesium sulfate 50%**	**Further DILUTION before administration**
5-5.9kg	200mg	0.4mL	**ALWAYS** further **dilute** required dose magnesium sulfate 50% up to 20 mL with 0.9% sodium chloride before administration
6-6.9kg	250mg	0.5mL	
7-7.9kg	300mg	0.6mL	
8-8.9kg	300mg	0.6mL	
9-9.9kg	350mg	0.7mL	
10-11.9kg	400mg	0.8mL	
12-13.9kg	500mg	1 mL	
14-15.9kg	550mg	1.1mL	
16-17.9kg	600mg	1.2ml	
18-19.9kg	700mg	1.4mL	
20-21.9kg	800mg	1.6mL	
22-23.9kg	900mg	1.8mL	
24-25.9kg	950mg	1.9mL	
26-27.9kg	1000mg	2 mL	
28-29.9kg	1100mg	2.2mL	
30-34.9kg	1200mg	2.4mL	
35-39.9kg	1400mg	2.8mL	
40-44.9kg	1600mg	3.2mL	
45-49.9kg	1800mg	3.6mL	
50kg & above	2g	4mL	

MAGNESIUM SULFATE SHORT (OVER 4 HOURS) INFUSION

SHORT INTRAVENOUS MAGNESIUM SULFATE INFUSION (UNLICENSED): safe and less likely to cause tachycardia than either aminophylline or salbutamol. Some evidence that high dose magnesium infusion may be of benefit clinically, and may be more effective in leading to improvement in symptoms than a bolus dose. **Magnesium has a rapid onset of action (within minutes) and is rapidly eliminated (renal excretion).** A high dose magnesium infusion is not currently recommended in the BTS guidelines.
In practice, it has been shown to be safe and is used in other circumstances eg pre-eclampsia.
Discuss all patients starting on a short magnesium infusion with NWTS.

INFUSION DOSE: 50 MG/KG/HR FOR 4 HOURS TOTAL (MAX. 8 GRAMS/4 HR)

This can be administered peripherally or centrally.
NB adjust to ideal body weight if BMI >91st (overweight) or 98th (obese) centile in order to avoid overdose
Always dilute 50% solution (500 mg/mL) before administration to 100 mg/mL
Aim level: 1.5-2 mmol/L
Watch for hypotension, especially if dehydrated as magnesium sulfate causes vasodilation.
If hypotensive give 10 mL/kg fluid bolus, ideally balanced crystalloid (eg Plasmalyte 148 or Hartmann's solution). If not available use 0.9% sodium chloride. Review response following bolus.
Contra-indications: Myasthenia gravis; Severe renal impairment
Overdose: Depends on size of overdose: progressive muscle weakness, significant hypotension and ultimately respiratory failure reported, but unlikely to occur if plasma levels are less than 3.5 mmol/L

HOW TO MAKE UP & RUN A MAGNESIUM SULFATE INFUSION:

Magnesium Sulfate 50% (500 mg/mL): draw up 10 mL and make up to 50 mL with 5% glucose
Final concentration = 10% solution = 100 mg/mL
Using this concentration: dose (mg) x wt (kg)/100 = mL /hr

WEIGHT (kg)	Rate (mL/hr) = 50 mg/kg/hr
5 kg	2.5 mL/hr
6 kg	3
7 kg	3.5
8 kg	4
9 kg	4.5
10 kg	5
12 kg	6
15 kg	7.5
17 kg	8.5
20 kg	10
22 kg	11
25 kg	12.5
27 kg	13.5
30 kg	15
32 kg	16
35 kg	17.5
37 kg	18.5
40 kg & above	20

IV AMINOPHYLLINE INFUSION FOR PERIPHERAL ADMINISTRATION:

- Draw up 500 milligrams aminophylline and add to 500mL 0.9% sodium chloride
- Final concentration = 500milligrams in 500mL i.e. 1milligram/mL aminophylline
- Aminophylline is compatible with up to 40mmol/litre Potassium chloride

LOADING DOSE: 6 MG/KG OVER 20 MINS (MAX DOSE 500MG) USE IBW if patient BMI >50%

OMIT LOADING DOSE IF CURRENTLY ON ORAL THEOPHYLLINE AT HOME

NB higher loading dose recommended than stated in BNFc, as pharmacokinetic studies have shown that when use 6 mg/kg, more likely to achieve the therapeutic range 10-20 mg/L (see references) which can be crucial in acute life-threatening asthma.

INFUSION RATE: **1 MONTH -11 YEAR** **1 MG/KG/HR = 1ML/KG/HR**

12-17 YEARS **0.5-0.7 MG/KG/HR = 0.5-0.7 ML/KG/HR**

Therapeutic monitoring: Use local guidance, but if not available check levels every 4-6 hours until stable and then every 24 hours

Therapeutic range 10-20mg/l

NB Plasma levels correlate well with clinical effect but **NOT** with toxicity

Response to monitoring:

<5mg/L	Increase dose by 50% and recheck in 6 hours
5-15mg/L	Continue. Recheck 24 hours
15-20mg/L	Half infusion rate and recheck in 6 hours
>20mg/L	STOP infusion and recheck levels in 6 hours. Restart at half the previous infusion rate once levels <15mg/l

NB Using peripheral concentration aminophylline ie 1 mg / mL			
Weight	**0.5 mg/kg/hr**	**0.7 mg/kg/hr**	**1mg/kg/hr**
5 kg	**2.5 mL/hr**	**3.5 mL/hr**	**5 mL/hr**
10 kgs	**5 mL/hr**	**7 mL/hr**	**10 mL/hr**
15 kg	**7.5 mL/hr**	**10.5 mL/hr**	**15 mL/hr**
20 kg	**10 mL/hr**	**14 mL/hr**	**20 mL/hr**
25 kg	**12.5 mL/hr**	**17.5 mL/hr**	**25 mL/hr**
30 kg	**15 mL/hr**	**21 mL/hr**	**30 mL/hr**
35 kg	**17.5 mL/hr**	**24.5 mL/hr**	**35 mL/hr**
40 kg	**20 mL/hr**	**28 mL/hr**	**40 mL/hr**
45 kg	**22.5 mL/hr**	**31.5 mL/hr**	**45 mL/hr**
50 kg	**25 mL/hr**	**35 mL/hr**	**50 mL/hr**
55 kg	**27.5 mL/hr**	**38.5 mL/hr**	**55 mL/hr**
60 kg	**30 mL/hr**	**42 mL/hr**	**60 mL/hr**
65 kg	**32.5 mL/hr**	**45.5 mL/hr**	**65 mL/hr**
70 kg	**35 mL/hr**	**49 mL/hr**	**70 mL/hr**

SALBUTAMOL INTRAVENOUS INFUSION MAX: 20 MICROGRAM / MINUTE (TOTAL DOSE)

ALWAYS pause and reassess patients after salbutamol bolus dose, as some patients will significantly improve and NOT require a salbutamol infusion.

BOLUS dose rate 2-17 years: 15 microgram/kg (MAX 250 microgram) bolus over 5-10 mins

Draw up required dose and dilute to a final volume 5 mL with sodium chloride 0.9% or glucose 5%

BOLUS dose 1-23 months: 5 microgram/kg (MAX 250 microgram) over 5-10 min

Draw up required dose and dilute to a final volume 5 mL with sodium chloride 0.9% or glucose 5%

NB much less likely to effectively relieve bronchospasm than when used to treat an older child.

IV magnesium sulfate or aminophylline are preferred treatment as more likely to be effective in this age group

Making up PERIPHERAL SALBUTAMOL infusion:

- Draw up 10 mg salbutamol (IE 10mL salbutamol 1 mg/mL)
- Make up to 50mL with 5% glucose or 0.9% sodium chloride
- Final concentration = 10 mg in 50 mL i.e. 200 micrograms/mL salbutamol

PERIPHERAL infusion rate: 0.3mL/kg/hr = 1 microgram/kg/minute MAX: 20 MICROGRAM / MINUTE (TOTAL DOSE)

CONTINUOUS IV INFUSION: 0.5-1 MICROGRAM/KG/MINUTE

NB Using peripheral CONCENTRATION salbutamol ie 200 microgram/mL		
WEIGHT kg	**1 microgram/kg/min**	**2 microgram/kg/min**
10kg	**3mL/hr**	**6 mL/hr**
15kg	**4.5mL/hr**	**6 mL/hr**
ALL pts ≥ 20kg	**6mL/hr**	**6 mL/hr**
MAXIMUM DOSE = 20 micrograms/min = 6mL/hr **This is standard infusion rate for any patient greater than or equal to 20 kg**		

No clinical benefit salbutamol infusion rates greater than total dose 20 microgram / minute.

NB high doses are associated with an increased risk of salbutamol toxicity including triggering SVT.

SIGNS OF SALBUTAMOL TOXICITY:

Hypokalaemia	**Hyperglycaemia**	**Agitation**
Tachycardia	**Tachyarrhythmia eg SVT**	
Metabolic acidosis	**Raised lactate**	

Management salbutamol toxicity: ideally stop infusion (at minimum half rate). Reduce frequency nebulisers

Increasing tachypnoea whilst on salbutamol infusion may indicate toxicity rather than worsening of asthma if metabolic acidosis noted on blood gas. It is a compensatory mechanism ie body is aiming to normalise pH, rather than worsening of asthma (NB always check that wheeze/air entry improving on examination).

RAISED lactate (≥ 2 mmol/L) is likely to be secondary to salbutamol but always reassess patient as it may be due to other causes eg sepsis or hypovolaemia, especially if lactate was high on admission (pre-salbutamol).

MANAGEMENT OF SVT FOLLOWING SALBUTAMOL INFUSION

SVT has been reported in those receiving salbutamol loading doses and infusions at the higher dose range (ie more than 20 microgram/min total or 2 microgram/kg/min).

CAUTION: Adenosine may cause bronchospasm in known asthmatics or those with acute severe asthma.

Please discuss with NWTS / paediatric cardiology consultant on call for advice on alternative agents.

ACUTE SEVERE ASTHMA GUIDELINE

TARGETS for managing any critically sick child			
ALL AGES	**SpO_2 ≥ 94% unless cyanotic CHD**	**Lactate ≤ 2 mmol/L**	**Glucose: ≥ 3 mmol/L**

CAUTION inaccurate pulse oximetry (SpO_2) readings can occur in severe anaemia, high carbon monoxide levels and hypoperfusion. IN ADDITION, SpO_2 may inaccurately over-read masking hypoxaemia (occult or unrecognised hypoxaemia), i.e. ARTERIAL (true) oxygen saturation < 88% when SpO_2 ≥ 92%.
Risk of occult hypoxaemia is >3xs greater in Black vs White pts AND may over-estimate SpO_2 between 1.5-5%.

AGE	TARGET MEAN BP	AGE	TARGET MEAN BP
0-11 Months	45-55	5-12 Years	60
1-4 Years	55-60	>13 Years	60-65

Respiratory Rate (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 months	0-10	11-20	21-30	31-49	50-59	60-69	≥70
1-4 years	0-10	11-20		21-39	40-49	50-59	≥ 60
5-12 years	0-10	11-15	16-20	21-24	25-39	40-49	≥ 50
>13 years	0-10		11-15	16-24	25-29	30-39	≥ 40

ALL AGES Score	Respiratory Distress (Score up to 4)
0 = none	None
1 = mild	Nasal flaring, subcostal recession
2 = moderate	Tracheal tug, intercostal recession, inspiratory or expiratory noises
4 = severe	Supraclavicular recession, grunting, exhaustion, impending respiratory arrest

ALL AGES Score	Oxygen Saturations (Score up to 4)
0	95-100%
2	92-94%
4	≤ 91%

ALL AGES Score	Oxygen Requirement (Score up to 4) - ALL AGES
0	Room Air
2	0.01 up to 4 litres/min
4	4 or more litres/min **NB** High flow humidified NC oxygen, NIV CPAP or BiPAP score 4 (irrespective of O_2 requirement)

Heart Rate (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 Months	0-80	81-90	91-110	111-149	150-169	170-179	≥ 180
1-4 Years	0-60	61-70	71-90	91-139	140-149	150-169	≥ 170
5-12 Years	0-60	61-70	71-80	80-119	120-139	140-159	≥ 160
>13 Years	0-50	51-60	61-70	71-99	100-119	120-129	≥ 130

Blood Pressure Systolic (Score up to 4)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
0-11 Months	0-50	51-60	61-70	71-89	90-99	100-109	≥ 110
1-4 Years	0-50	51-60	61-80	81-99	100-119	120-129	≥ 130
5-12 Years	0-70	71-80	81-90	91-109	110-119	120-129	≥ 130
>13 Years	0-80	81-90	91-100	101-119	120-129	130-139	≥ 140

Capillary Refill Time (CRT) (Score up to 2)							
Score	**4**	**2**	**1**	**0**	**1**	**2**	**4**
All Ages		≥ 3 secs		<3 secs		≥ 3	

ACUTE SEVERE ASTHMA GUIDELINE

CHECK IF YOUR PATIENT HAS ANY ADDITIONAL RISK FACTORS (NPEWS)		
RISK FACTOR	**THINK!**	
☐ Baseline vital signs outside normal reference ranges	Always score relevant PEWS value even if this is normal for the patient eg cyanotic heart disease	Vital sign: Eg SpO_2 Patient's normal value: Eg SpO_2 = 75-85%
☐ Tracheostomy / Airway Risk / Difficult Intubation	Do you need additional help in an airway emergency? Needs review by local anaesthetics & ENT teams. Consider d/w NWTS early	
☐ Invasive/Non-invasive ventilation/high flow	Check oxygen requirement on additional respiratory support. Remember High Flow/BiPAP & CPAP score max 4 on oxygen delivery	
☐ Neutropenic/immunocompromised	Sepsis recognition & escalation has a lower threshold	
☐ <40 weeks corrected gestational age	Sepsis recognition & escalation has a lower threshold (beware hypothermia)	
☐ Neurological condition (ie meningitis, seizures)	Remember: check pupil response if anything other than ALERT on AVPU	
☐ Neurodiversity or Learning Disability	Be aware of the range of responses to pain & physiological changes	

NPEWS ESCALATION LEVEL	ACTIONS	MEDICAL REVIEW	OBSERVATIONS / PLAN
E0 – no concerns **Score = 0**	None	Not required	Continue current observations
E1 – Increased monitoring **Score = 1- 4**	Inform Nurse-in-Charge Consider medical review (ST3+ or equivalent) Ensure feedback to parents	As required Discuss with Nurse-in-Charge whether medical review required	Reassess within 60 mins & document ongoing plan
E2 – Needs clinical review (within 30 mins) **Score = 5-8**	Review by Nurse-in-Charge Ensure feedback to parents	Within 30 mins Review by ST3+ or equivalent Discuss stabilisation plan with consultant	Reassess within 30 mins & document ongoing plan Continuous SpO_2 monitoring
E3 – Needs rapid review (within 15 mins) **Score = 9-12**	Immediate review by Nurse-in-charge Discuss medical plan with consultant Senior feedback to parents	Within 15 mins Alert to ST3+ or equivalent Stabilisation plan to be agreed after review by consultant Consider NWTS referral after consultant review	Reassess every 30 mins Continuous monitoring SpO_2, RR, & ECG Record full GCS if change in AVPU
E4 – Needs emergency review (immediate) **Score > 12**	Immediate review by Nurse-in-Charge Consider immediate 2222 call for immediate emergency medical response Inform paeds consultant Senior feedback to parents	Immediate Alert to ST3+ or equivalent Consultant review ASAP Anaesthetic review Consider NWTS referral after appropriate initial interventions	Reassess every 15 mins Continuous SpO_2, ECG, & RR Record full GCS if change in AVPU

NB Escalation levels can also be selected and triggered if parent or carer expresses concern that their child needs increased monitoring +/- clinical review despite PEWS, OR parent or nursing gut instinct irrespective of score.

Medical Plan for Stabilisation:

Structured plan must be documented including:

1. Specific actions to be taken
2. Expected outcome
3. Outcome deadline / in timeframe
4. Escalation if outcome not met by deadline / in timeframe

Resources

For Drug Doses:

British National Formulary for Children

Emergency Drug Guide via NWTS website home page - for intubation drugs / sedation regime / inotropes
https://www.nwts.nhs.uk/emergency-drug-guides

Emergency Drug Guide (wt based) via NWTS website home page - for intubation drugs / sedation regime / inotropes
https://www.nwts.nhs.uk/emergency-drug-guides
Guidelines for <16 years: www.nwts.nhs.uk/clinicalguidelines
STOPP tool: Safe Transfer of Pediatric Patients which includes risk assessment prior to transfer, and checklists
NWTS LocSIPPS: includes sizes of ETT, suction, NGT, CVL & arterial lines and checklist for paediatric intubation
Guidelines include: intubation and difficult airway, sepsis including inotropes, insertion of intraosseous needle, collapsed neonate or infant, management of under 16 years outside PCC level 3 unit, and transfer
Education: www.nwts.nhs.uk/education-website
Includes recordings of NWTS education eg time critical transfers, sepsis, airway management etc
Login details for NWTS education site are available from your nursing, AHP and medical paediatric critical care operational delivery network links
OR via email: info@nwts.nhs.uk

CONTACT NUMBERS:
NWTS (North-West (England) & North Wales Paediatric Transport Service): **Referrals 08000 84 83 82**
General enquiries: 01925 853 550
Regional Paediatric Intensive Care Unit Alder Hey Childrens Hospital: 0151 252 5241
Regional Paediatric Intensive Care Unit Royal Manchester Childrens Hospital: 0161 701 8000

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North-West (England) and North Wales Paediatric Critical Care Operational Delivery Network
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For the most up to date version of this guideline please visit PCC / SiC / LTV https://northwestchildrensodnhub.nhs.uk
Or NWTS website: https://www,nwts.nhs.uk/clinicalguidelines/regionalguidelines-a-z

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