

<b>Title:</b>	Guidelines for Management of Acute Severe Asthma in Children over 2yrs
<b>Version:</b>	<b>3 PCCN 3</b>
<b>Supersedes:</b>	Supersedes: Version 2 <b>Summary of amendments in version 3:</b> Aminophylline as 2nd intravenous agent (after IV magnesium sulfate bolus) Addition of potential to use short magnesium sulfate infusion (4 hours) Salbutamol dosing amended & capped (maximum equivalent to adult dose) Warning that high levels of salbutamol may cause toxicity including raised lactate & SVT Clarification on how to manage bronchospasm in under 2 years
<b>Application:</b>	All children under 16 years age admitted to hospital in North West & North Wales region

<b>Originated /Modified By &amp; Designation:</b>	<b>Originated By:</b> North West (England) and North Wales Paediatric Transport Service <b>Guideline authors:</b> <b>Version 1:</b> 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 <b>Version 2:</b> Rachael Barber, NWTS Consultant and PICU Consultant, RMCH Carrick Allison, Paediatric Anaesthetic Trainee, RMCH Adam Sutherland, Lead Pharmacist, RMCH Elly Turner, Lead respiratory pharmacist, RMCH <b>Version 3:</b> Kate Parkins, PICM Consultant NWTS Ian Sinha, Paediatric Respiratory Consultant, AHFT Claire Murray, Paediatric Respiratory Consultant, RMCH Louise Turnbull, Paediatric Respiratory Consultant, RMCH
<b>Ratified by:</b>	RMCH (Host Trust): - Paediatric Medicines Management Committee (MMC) - Paediatric Policies & Guidelines Committee
<b>Date of Ratification:</b>	08.03.2022
<b>Ratified by:</b>	AHFT: CDEG (Clinical Development & Evaluation Group)
<b>Date of Ratification:</b>	06.06.2022

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<b>Circulated by:</b>	Clinical Lead, North West & North Wales Paediatric Critical Care Network
<b>Dissemination and Implementation:</b>	NWTS & Paediatric Critical Care Network circulation lists
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<b>Planned Review Date:</b>	<b>3 years ie January 2025</b>
<b>Responsibility of:</b>	Clinical lead North West & North Wales Paediatric Critical Care Network & NWTS guideline lead consultant

<b>EqIA Registration Number:</b>	<b>150/12</b>
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## 1. Detail of Procedural Document

Guidelines for Management of Acute Severe Asthma in Children >2yrs.

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

EqIA Registration Number: **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) - medical & nursing
- Paediatric Respiratory Consultants from Royal Manchester Children's Hospital and Alder Hey Children's Hospital
- Representatives from the District General Hospitals within the North West (England) & North Wales Paediatric Critical Care operational delivery network; includes medical, nursing and AHP (paediatrics, anaesthetics, and emergency medicine teams)
- Representatives from both Paediatric Critical Care Units (Royal Manchester Children's Hospital and Alder Hey Children's Hospital) - medical and nursing

These guidelines were circulated amongst the North West and North Wales Paediatric Critical Care Network for comments on 25.03.2021

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the Network's Joint Clinical Leads

For ratification process see appendix 1.

## 4. References and Bibliography

See guidelines.

## 5. Disclaimer

These clinical guidelines represent the views of the North West and North Wales Paediatric Critical Care Network and North West and North Wales Paediatric Transport Service, which were 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.

**Clinical advice is always available 24/7 from NWTS on a case by case basis via the referral line: 08000 84 83 82**

Please feel free to **contact NWTS (01925 853 550)** regarding these documents if there are any queries.

**NO OR POOR RESPONSE**


**SUMMON SENIOR HELP**  
Give 15 L/min O<sub>2</sub> to achieve normal saturations (> 94%)  
Consider High Flow Humidified Nasal Cannula Oxygen  
Nebulised β<sub>2</sub> agonist every 20 mins  
Nebulised Ipratropium bromide every 20 mins  
PO prednisolone / dexamethasone **OR** IV hydrocortisone

**IF POOR RESPONSE AFTER 3 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** (within 10-20min):  
Give **Aminophylline** loading 6 mg/kg (max 500mg) over 20 mins  
(if not on oral theophyllines)  
Then start 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:**  
Give **2nd** bolus dose intravenous **magnesium sulfate**  
**OR** consider short (4 hrs) **magnesium sulfate infusion**  
Give **salbutamol bolus** over 5 mins & pause & reassess  
Blood gas + lactate  
**URGENT CONSULTANT ANAES/PAEDS REVIEW**  
**CONTACT NWTS FOR ADVICE: 08000 84 83 82**

**STILL NO IMPROVEMENT**  
Consider **3rd** bolus IV **magnesium** if not on magnesium infusion  
Start **salbutamol infusion** 1 microgram/kg/min (MAX 20 micrograms/min)  
**Nebulised adrenaline** 400 micrograms/kg (max 5 mg)  
Consider CXR/antibiotics/alternative diagnoses  
Blood gas + lactate  
**PREPARE FOR INTUBATION**

 **IMPENDING CARDIO-RESPIRATORY ARREST**  
SpO<sub>2</sub> ≤ 92% in O<sub>2</sub> PLUS any of: Cyanosis  
Worsening agitation / level of consciousness  
Poor respiratory effort or exhaustion or silent chest  
**PRE-TERMINAL SIGNS: High CO<sub>2</sub> Acidaemia (pH ≤ 7.2)**  
**Hypotension**

**INTUBATE & VENTILATE**

**SEVERE ASTHMA**  
SpO<sub>2</sub> <92% in air  
Use of accessory muscles  
Difficulty talking or eating  
Agitated  
HR >140 /min (< 5yr)  
HR >125 / min (>5yr)  
RR > 40 / min (<5yr)  
RR > 30 / min (>5yr)

**HIGH RISK CLINICAL SIGNS**  
Agitated or drowsy  
Unable to talk or feed  
SpO<sub>2</sub> ≤ 92% in air, pO<sub>2</sub> < 8 kPa  
pCO<sub>2</sub> '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

**BLOOD GAS MEASUREMENTS**  
Consider if severe/ life-threatening features not responding treatment  
**Normal or high pCO<sub>2</sub> = worsening asthma & respiratory failure**  
Capillary blood gases give accurate pH + pCO<sub>2</sub> results  
**ALWAYS** check lactate

**DIFFERENTIAL DIAGNOSIS**  
Anaphylaxis/Allergy  
Severe or Atypical Pneumonia  
Sepsis (esp. ↑ lactate)  
Hyperventilation  
Mediastinal Mass  
Foreign body  
Pulmonary oedema  
Inhalational injury

**OXYGEN:** Use high-flow oxygen via a tight-fitting face mask or nasal cannula at sufficient flow rates to achieve SpO<sub>2</sub> ≥ 94%. High-flow humidified nasal cannula oxygen (eg optiflow, airvo or vapotherm) may be considered early, aiming for a flow 2 L/kg/min Max 50-60 L/min.

**NEBULISERS:** Oxygen-driven nebulisation is recommended

<b>Salbutamol:</b>	<b>Under 5yrs</b>	<b>2.5 mg</b>	<b>Over 5yrs</b>	<b>5 mg</b>
<b>Ipratropium bromide:</b>	<b>Under 12yrs</b>	<b>250 micrograms</b>	<b>Over 12yrs</b>	<b>500 micrograms</b>

Combine nebulised ipratropium bromide with β<sub>2</sub>-agonist to achieve significantly more bronchodilatation than β<sub>2</sub>-agonist alone. If poor response to initial dose of β<sub>2</sub>-agonist subsequent doses should be given in combination with ipratropium every 20 minutes for the first hour then 4 hourly (with ipratropium).

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

**Dexamethasone: 0.6 mg/kg (max 16 mg) od for 3 days**

**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**

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

**Always use iv hydrocortisone if vomiting or for those most severely affected.**

Benefits apparent within 3-4 hours. Oral and intravenous steroids are equivalent efficacy. Continue until clinically improved. Tapering is unnecessary unless course of steroids continues for > 14 days

**MAGNESIUM SULFATE BOLUS (UNLICENSED): for more information see page 8**

**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 see page 8**

Do not wait for magnesium levels before giving first dose, toxicity rarely seen below level 4 mmol/L.

**Dose may be repeated in severe cases within 1-2 hours.**

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

**Dose: 50 mg/kg/hr for 4 hours (max. 8 gram/4 hr)** may be used to treat acute severe exacerbations of asthma. NB If considering starting a magnesium infusion, **please discuss with NWTS**

Clinically non-significant fall in BP (~ 5 mmHg) may occur following a bolus or during infusion MgSO<sub>4</sub>.

If hypotensive, give 10 mL/kg fluid, ideally balanced crystalloid (eg Plasmalyte 148 or Hartmann's solution) or if not available 0.9% sodium chloride, and review.

Consider if hypotension due to sepsis or hypovolaemia (2<sup>TV</sup> to increased insensible losses and poor intake).

**AMINOPHYLLINE: Loading: 6 mg/kg (max 500 mg) over 20 min** (omit if on oral theophylline/aminophylline)

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

Doses should be adjusted according to plasma theophylline levels (see page 10)

**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. Reduce nebulised β<sub>2</sub>-agonists to 4 hourly when on infusion.

If evidence of salbutamol toxicity (see page 11), stop nebulised β<sub>2</sub>-agonists and reduce rate infusion.

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

**MONITORING:** ECG, SpO<sub>2</sub>, RR, BP, 4-6 hourly blood gases including lactate & minimum 12 hourly U&Es

**All patients receiving IV magnesium sulfate/ aminophylline /salbutamol must be admitted to hospital.**

**Intravenous salbutamol and aminophylline cannot run together via same PVL.  
Either are compatible (via multi-tail connector or 3-way tap) with 0.9% sodium chloride +  
5% glucose, Plasmalyte 148 or Plasmalyte 148 + 5% glucose  
Magnesium may be given via same PVL as salbutamol**

**INTUBATION IN ACUTE SEVERE ASTHMA  
IS A HIGH RISK PROCEDURE**

See NWTS intubation Guideline [www.nwts.nhs.uk](http://www.nwts.nhs.uk)

<p><b>Indications for Intubation</b></p>	<ul style="list-style-type: none"> <li>• Cardiac/Respiratory Arrest</li> <li>• Exhaustion</li> <li>• Hypoxia ie SpO<sub>2</sub> ≤ 92% despite escalation of treatment</li> <li>• High CO<sub>2</sub> (&gt; 6 kPa) rare in acute asthma = sign of fatigue/exhaustion</li> <li>• Acidaemia (pH ≤ 7.2)</li> <li>• Altered sensorium ie agitation, confusion, decreased GCS</li> <li>• Silent chest / poor air entry / inability to talk in short sentences</li> </ul>	<p><b>NB Asthma Severity may be difficult to assess:</b></p> <ul style="list-style-type: none"> <li>• Tachycardia is universal with β<sub>2</sub> agonist</li> <li>• Respiratory rate varies with respiratory drive +/- fatigue NB slow rate suggests fatigue</li> <li>• Agitation or drowsiness may occur</li> </ul> <p><b>If any concerns ask for joint review by paediatric and anaesthetic consultants</b></p>
<p><b>Risks at Intubation</b></p>	<p><b>RISK</b></p>	<p><b>OPTIONS TO MITIGATE RISK</b></p>
	<p><b>Low oxygen reserve Rapid desaturation Difficult CO<sub>2</sub> clearance</b></p>	<p><b>Most experienced available intubator</b> Pre-oxygenate Apnoeic oxygenation using nasal cannulae 2L/kg/min high flow ideal or 0.2L/kg/min nasal specs Use largest fitting/cuffed ET tube SLOW respiratory rate</p>
	<p><b>Relative hypovolaemia</b></p>	<p>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</p>
<p><b>Delayed gastric emptying</b></p>	<p>Modified rapid sequence induction Eg ketamine + fentanyl + rocuronium Nasogastric tube ASAP after intubation</p>	
<p><b>Drugs for induction</b></p>	<p><b>Avoid histamine-releasing drugs</b> if possible (atracurium, thiopentone, morphine) Use <b>ketamine</b> and/or <b>fentanyl</b> Volatile anaesthetic agent available for use immediately post-intubation (bronchodilator)</p>	
<p><b>Alternative bronchodilators: ONCE ventilated</b></p>	<p><b>Ketamine infusion</b> <b>Volatile anaesthetic agents</b> <b>Adrenaline 1:10,000 0.1mL/kg IV or via ETT can be used in extremis</b></p>	
<p><b>Ongoing sedation &amp; management</b></p>	<p>Use either ketamine or fentanyl plus midazolam infusions Avoid morphine and atracurium as both cause histamine release Use low respiratory rate (with long expiratory phase) when hand ventilating to improve oxygenation + CO<sub>2</sub> clearance &amp; reduce risk pneumothorax</p>	

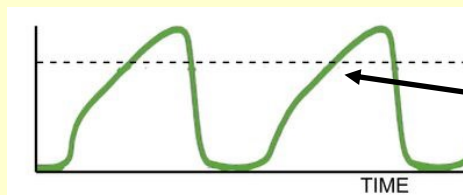
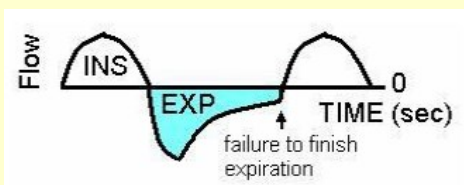
## Difficulties with Ventilation in Acute Severe Asthma

**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<sub>2</sub>O)  
Permissive hypercapnia (ie tolerate pH ≥ 7.15; pCO<sub>2</sub> 7-14 kPa)  
Aim SpO<sub>2</sub> ≥ 94%  
Large, cuffed ETT will reduce resistance and minimal leak  
Keep muscle relaxed initially especially whilst high pCO<sub>2</sub>

**INCOMPLETE EXPIRATION** Slow emptying of alveoli causes poor gas exchange, progressive gas trapping and increasing residual volume



**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

**Physiotherapy** with 0.9% sodium chloride lavage may help but use a **slow** bagging rate

### Intrinsic PEEP

Aim to match extrinsic PEEP to intrinsic PEEP to reduce gas trapping ie 6-8 cmH<sub>2</sub>O

### MUCUS PLUGGING

Suction with 0.9% sodium chloride lavage 0.5 mL/kg max 5 mL via ETT

This may make situation worse if inadequately sedated and not muscle relaxed

An alternative: nebulised N-acetylcysteine

- mix 2.5 mL 20% solution N-acetylcysteine with 2.5 mL 0.9% sodium chloride, and then nebulise 2.5 mL of final concentration (or nebulise 2.5 mL 10% solution N-acetylcysteine)

In extreme cases, Dornase Alpha (see BNFC) may improve severe mucous plugging.

**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 age 2 years. In such children, a number of 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 involvement should be obtained.

**NB Children < 2 years with clinical picture consistent with asthma / severe bronchospasm may respond better to magnesium sulfate and aminophylline rather than salbutamol (see bronchiolitis guideline)**

**PATIENTS AT RISK OF NEAR-FATAL / FATAL ASTHMA**

<b>Severe asthma</b>	<ul style="list-style-type: none"> <li>Previous near-fatal asthma; History of anaphylaxis</li> <li>Previous admissions especially HDU or PICU +/- repeat attendances to A&amp;E</li> <li>Requiring 3 or more classes of asthma medication</li> </ul>
<b>Plus</b>	<ul style="list-style-type: none"> <li>Adverse behavioural/psychological features; Learning difficulties</li> <li>Poor compliance; Failure to attend appointments</li> <li>Fewer GP contacts; Self-discharge from hospital</li> <li>Psychosis, depression, psychiatric illness or deliberate self harm</li> <li>Alcohol or drug abuse</li> <li>Obesity</li> <li>Looked after children</li> </ul>
<p>Have lower threshold for hospital admission + consider tertiary FU for children with above risk factors</p>	

**CRITERIA FOR REDUCING BRONCHODILATOR THERAPY**

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

**DISCONTINUING INTRAVENOUS BRONCHODILATORS**

<b>Aminophylline:</b>	<p>Elimination half-life 3-5 hours. Reduce dose by 50% original dose every 6 hours</p> <p>After discontinuing infusion, aminophylline is cleared within 24 hours</p>
<b>Salbutamol:</b>	<p>Elimination half-life 4-6 hours. Reduce dose by 0.5 microgram/kg/min every 6 hours</p> <p>After discontinuing infusion, salbutamol will be cleared within 24 hours</p>
<p><b>NB:</b> 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</p> <p><b>Each patient should receive nebulised <math>\beta_2</math> agonists every 2 hours and nebulised ipratropium bromide every 4 hours whilst weaning off intravenous bronchodilators.</b></p> <p><b>NB: Rebound may occur 24—48 hours after stopping either infusion so observe in hospital</b></p> <p>Some patients with particularly brittle asthma may require a slower weaning regime</p>	

**DISCHARGE PLANNING AFTER SEVERE ASTHMA ATTACK:**

- Check inhaler technique
- Start or review dosage of preventer treatment
- Written asthma action plan for subsequent attacks with clear instructions on use bronchodilators and when to seek urgent medical attention if worsening symptoms.
- Contact GP to arrange **primary care follow up** within 48 hours
- **Local paediatric** (respiratory) review for those who required iv aminophylline and/or salbutamol.
- **Refer all life-threatening or invasively ventilated patients to tertiary paediatric respiratory team**

## APPENDIX 1: ADDITIONAL DRUG INFORMATION MAGNESIUM

**NEBULISED MAGNESIUM:** limited evidence benefit if used in severe asthma. No benefit in milder case.  
Dose: 150 mg per nebuliser (mix with salbutamol + ipratropium bromide) in 1st hour of treatment.

**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. 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 use balanced crystalloid (eg Plasmalyte 148 or Hartmann's solution) or if not available 0.9% sodium chloride, and then review.

Consider if hypotension may be due to sepsis or hypovolaemia (secondary to increased insensible losses and poor intake).

**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 4 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	<b>ALWAYS</b> 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 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 >25 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)
5 kg	2.5
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

**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).**

**OMIT LOADING DOSE IF CURRENTLY ON ORAL THEOPHYLLINES AT HOME**

**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 none available check levels every 4-6 hours until stable and then every 24 hours

**Therapeutic range 10-20mg/l**

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 infusion

**Recommendation:** always pause and reassess patients after salbutamol bolus dose, as some patients will significantly improve and not require a salbutamol infusion.

**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

**BOLUS infusion rate 2-17 years:** 15microgram/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:** 5microgram/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 less likely to effectively relieve bronchospasm than when used to treat an older child.

Magnesium sulfate or aminophylline more likely to be effective in this age group

**PERIPHERAL infusion rate: 0.3mL/kg/hr = 1 microgram/kg/minute.**

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

**MAX INFUSION RATE: 20 MICROGRAM / MINUTE (TOTAL DOSE)**

**NB Using peripheral concentration salbutamol ie 200 microgram/mL**

Weight	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.**

**Signs of salbutamol toxicity:**

Hypokalaemia	Hyperglycaemia	Agitation
Tachycardia	Tachyarrhythmia eg SVT	
Metabolic acidosis	Raised lactate	

NB If evidence of salbutamol toxicity, stop nebulised  $\beta_2$ -agonists and reduce rate infusion.

**Increasing tachypnoea whilst on salbutamol infusion may indicate toxicity and metabolic acidosis rather than acute worsening of asthma**

**RAISED lactate 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).

Adenosine may cause bronchospasm in known asthmatics: only use with caution in acute severe asthma.

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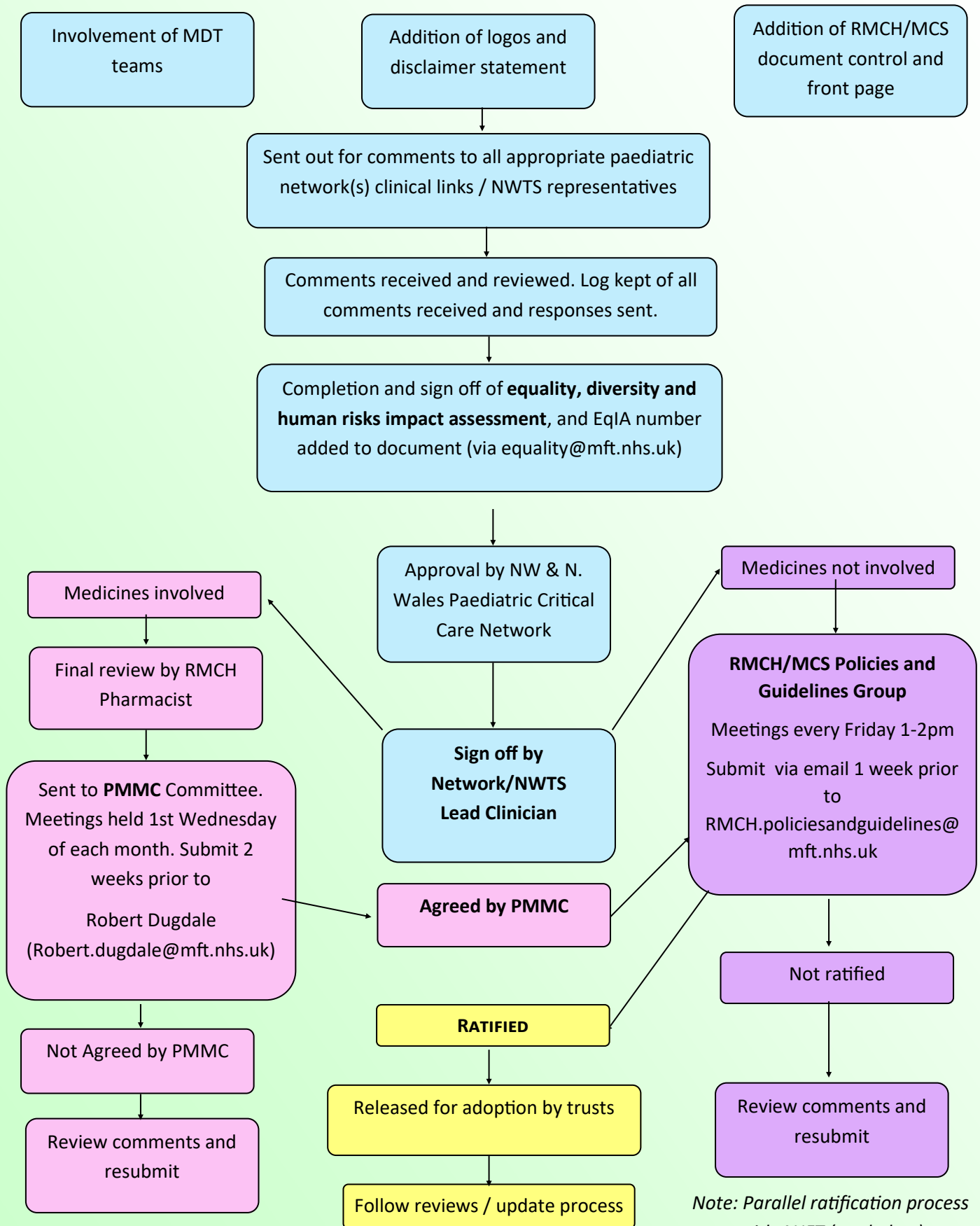
**Lexicomp 18th Edition**

**FOR DRUG DOSES:**

**British National Formulary for Children 2019-2020**

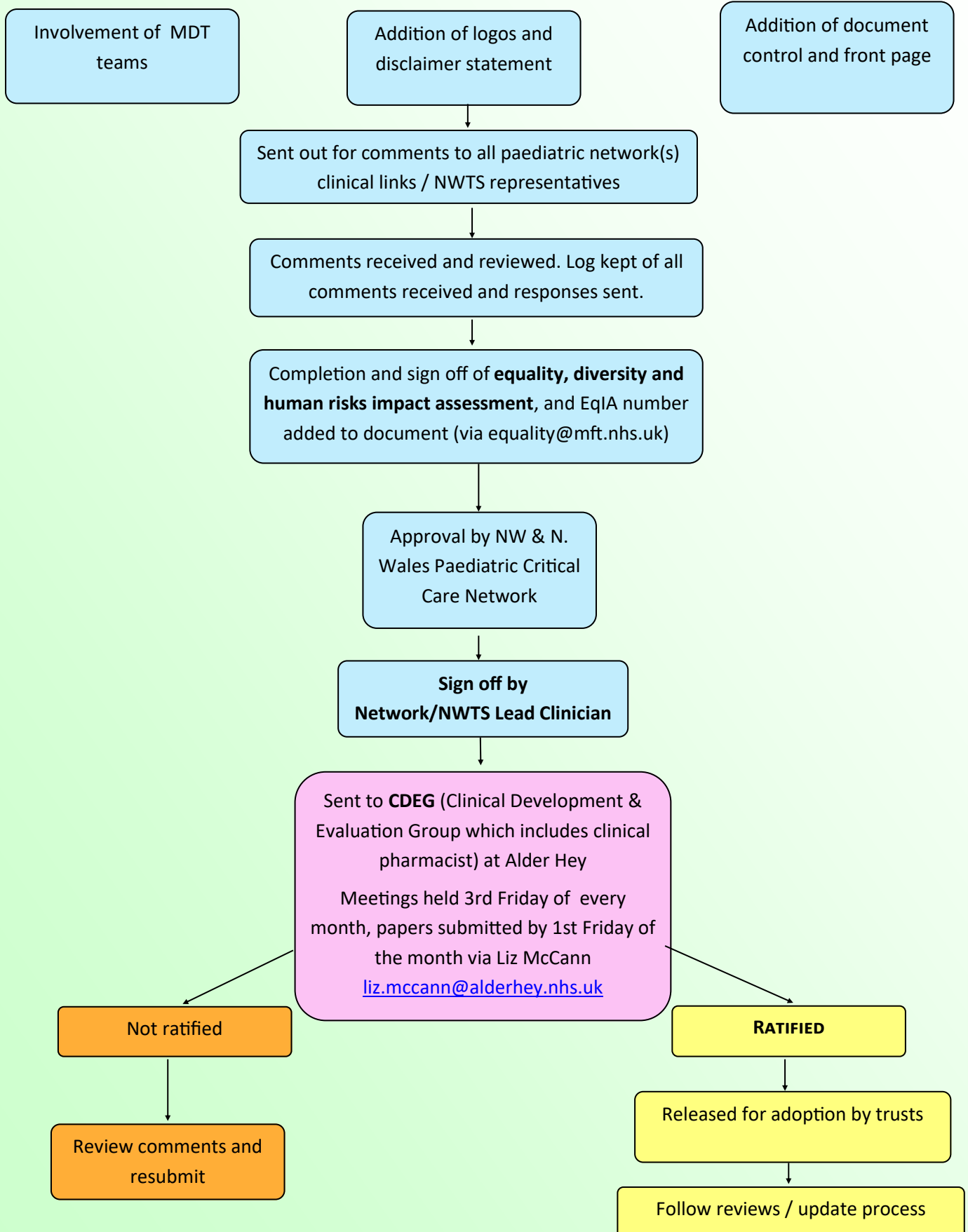
[www.crashcall.net](http://www.crashcall.net)

**Ratification of Guidelines with Host Organisation (MFT)**



*Note: Parallel ratification process with AHFT (see below)*

**Ratification of Guidelines with Alder Hey**



## Resources

[www.crashcall.net](http://www.crashcall.net) - for intubation drugs / sedation regime

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Please visit NWTS website for the most up to date version of this guideline: [www.nwts.nhs.uk](http://www.nwts.nhs.uk)