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<b>Title</b>	<b>Title:</b> Guidelines for Management of Acute Severe Asthma in Children >2yrs <b>Version:</b> Version 1 <b>Reference Number:</b> PCCN3
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<b>Author</b>	<b>Originated By:</b> North West and North Wales Paediatric Critical Care Network Guideline authors: 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>Ratification</b>	<b>Ratified by:</b> 1. CMFT (Host Trust): - Paediatric Medicines Management Committee (MMC) on: <b>11th February 2013</b> 2. AHFT: - Critical Care Clinical Business Unit on: <b>3rd May 2013</b> - CDEG (Clinical Development & Evaluation Group) on: <b>17th May 2013</b>
<b>Application</b>	Children only
<b>Circulation</b>	<b>Issue Date:</b> 11th June 2013 <b>Circulated by:</b> Clinical Lead, North West & North Wales Paediatric Critical Care Network <b>Dissemination and Implementation:</b> NWTS & Network circulation lists
<b>Review</b>	<b>Review Date:</b> 11th February 2015 <b>Responsibility of:</b> Clinical Lead & Network Manager, North West & North Wales Paediatric Critical Care Network
<b>Date placed on the Intranet:</b> 11th June 2013	<b>Please enter your EqIA Registration Number here:</b> 150/12

## **1. Detail of Procedural Document**

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

## **2. Equality Impact Assessment**

EqlA Registration Number: **150/12**

## **3. Consultation, Approval and Ratification Process**

This guideline was developed with input from:

- North West and North Wales Paediatric Transport Service (NWTS).
- Representatives from the North West and North Wales Paediatric Critical Care Network (PCCN).
- Representatives from both Paediatric Intensive Care Units (Royal Manchester Children's Hospital and Alder Hey Children's Hospital).
- Representatives from the District General Hospitals within the PCCN.

These guidelines were circulated amongst the North West and North Wales Paediatric Critical Care Network for comments on the 20th April 2012.

All comments received have been reviewed and appropriate amendments incorporated.

These guidelines were signed off by the Network's Clinical Lead on 2nd July 2012.

For ratification process see appendix 1.

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## **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 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.

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

### SEVERE

SaO<sub>2</sub> <92% in air  
Use of accessory muscles  
Difficulty talking or eating  
Agitated  
Heart rate >140(under 5yr), >125bpm (over 5yr)  
Resp rate >40(under 5yr), >30 (over 5yr)

### LIFE THREATENING/NEAR FATAL

SaO<sub>2</sub> <92% in O<sub>2</sub> plus any of:  
Silent chest  
Poor respiratory effort  
Cyanosis  
Altered Consciousness/Exhausted  
**Increased pCO<sub>2</sub> or hypotension are pre-terminal signs**

### SIMULTANEOUSLY

Summon senior help (**Consultant Anaesthetist and Paediatrician**)  
Arrange rapid transfer to HDU/Resus area  
High flow Oxygen via non-rebreathing mask  
Nebulised β<sub>2</sub>agonist every 20 mins  
Nebulised Ipratropium bromide every 20 mins  
Intravenous hydrocortisone  
Intravenous Magnesium sulphate bolus  
and/or Intravenous Salbutamol bolus

Summon **senior** help  
High flow Oxygen to achieve normal saturations (>94%)  
Nebulised β<sub>2</sub>agonist every 20 mins  
Nebulised Ipratropium bromide every 20 mins  
Intravenous Magnesium sulphate bolus  
Oral prednisolone or intravenous hydrocortisone

Improving

If poor response after 1 hour:  
Give Magnesium sulphate bolus if not already given  
Consider IV Salbutamol bolus if not already given  
Continuous nebulisers  
Continuous monitoring—ECG, Saturations, Resps  
Consultant review if not already occurred

Improving rapidly  
Admit HDU

Oxygen to maintain saturations >94%  
Nebulised β<sub>2</sub>agonist 1-4 hourly  
Nebulised Ipratropium bromide 4 hourly  
Continue steroids

If no improvement after 20 min:  
Start Salbutamol or Aminophylline infusion  
Contact consultant anaesthetist  
Contact NWTS(08000 848382)

If not improving rapidly (within 10-20min):  
IV Salbutamol infusion and/or IV Aminophylline loading dose + infusion  
Consider CXR/blood gas/antibiotics  
Consider alternative diagnoses  
See advice on intubation page 6  
**Contact NWTS 08000 848382 for advice**

See Page 8 and [www.crashcall.net](http://www.crashcall.net) for dilutions  
Intravenous salbutamol and Aminophylline are incompatible  
Salbutamol is compatible with Magnesium

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

**Oxygen:** Children with life-threatening asthma or SpO<sub>2</sub> <94% should receive high-flow oxygen via a tight-fitting face mask or nasal cannula at sufficient flow rates to achieve normal saturations

**Nebulised  $\beta_2$ -agonist:** Oxygen-driven nebulisation is recommended

<b>Salbutamol:</b>	<b>Under 5yrs</b>	<b>2.5milligrams</b>	<b>Terbutaline:</b>	<b>Under 5yrs</b>	<b>5milligrams</b>
	<b>Over 5yrs</b>	<b>5milligrams</b>		<b>Over 5yrs</b>	<b>10milligrams</b>

**Nebulised Ipratropium bromide:**

<b>Under 12yrs</b>	<b>250 micrograms</b>	<b>Over 12yrs</b>	<b>500 micrograms</b>
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Combining nebulised ipratropium bromide with nebulised  $\beta_2$ -agonist produces significantly more bronchodilatation than  $\beta_2$ -agonist alone. If poor response to initial dose of  $\beta_2$ -agonist subsequent doses should be given in combination with ipratropium every 20 minutes.

**Steroids:**

<b>Prednisolone:</b>	<b>Under 5yrs</b>	<b>20milligrams od</b>	<b>5-12yrs</b>	<b>30milligrams od</b>
	<b>&gt;12 yrs</b>	<b>40milligrams od</b>		

**If on maintenance steroids increase dose to 2milligrams/kg od (max 60milligrams)**

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

Benefits apparent within 3-4 hours. Oral and intravenous steroids are of equivalent efficacy so intravenous steroids should be reserved for those unable to retain oral medications or most severely affected. Continue until clinically improved.

<b>Intravenous Salbutamol:</b>	<b>Bolus</b>	<b>15micrograms/kg over 5 minutes (max 250micrograms)</b>
	<b>Infusion</b>	<b>1-5 micrograms/kg/minute in severe refractory asthma</b>

15microgram/kg bolus over 5 minutes is equivalent to 3microgram/kg/min infusion for the same period

**Start at 1-2micrograms/kg/min**

Patient should be on continuous cardiac monitoring & have minimum of 12 hourly U&Es

Nebulised  $\beta_2$ -agonists should be continued whilst patient is receiving intravenous salbutamol

Doses above 2microgram/kg/min **MUST** be discussed with NWTs/PICU

<b>Aminophylline: Loading dose</b>	<b>5milligrams/kg over 20 min (Omit if on oral theophyllines/aminophylline)</b>
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<b>Infusion</b>	<b>0.5-1milligrams/kg/hr</b>
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Patient should be placed on continuous cardiac monitoring & have minimum of 12 hourly U&Es

Therapeutic monitoring: Check levels at 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
	15-20mg/L	Half infusion rate
	>20mg/L	STOP infusion and recheck levels in 6 hours

**Magnesium sulphate: 40milligrams/kg (max 2grams) intravenously over 20 min**

In practice this is often first intravenous therapy used as safe and causes less tachycardia.

A second dose may be given after discussion with NWTs or paediatric respiratory team.

## Non-pharmacological interventions in acute severe asthma

### CXR should be considered in following situations

- Surgical emphysema
- Persistent unilateral signs suggesting pneumothorax, lobar collapse or consolidation
- Life-threatening asthma not responding to treatment
- Mechanically ventilated patient

### Blood gas measurements

- In moderate to severe asthma pH is normal and pCO<sub>2</sub> low
- Normal or increased pCO<sub>2</sub> indicates worsening asthma and imminent respiratory failure
- Capillary blood gases can be of use in severe asthma in children
- Children receiving large doses of  $\beta_2$ agonists may develop a lactic acidosis which will resolve as the dose of  $\beta_2$ agonist is reduced

### Antibiotics

- The majority of acute asthma attacks are triggered by viral infections
- Decision for antibiotics should be made on clinical grounds

### Physiotherapy

- No role in unventilated asthmatic patient

### Alternative Diagnoses to consider in child that is not improving

- |                               |                     |                    |
|-------------------------------|---------------------|--------------------|
| Anaphylaxis/Allergic Reaction | Severe Pneumonia    | Atypical Infection |
| Hyperventilation              | Inhalational injury | Foreign body       |
| Pulmonary oedema              |                     |                    |

# Intubation in Acute Severe Asthma is a High Risk Procedure

<p><b>Indications for Intubation</b></p>	<p>Cardiac/Respiratory Arrest Exhaustion Hypoxia despite high flow oxygen Worsening respiratory acidosis Altered sensorium (agitation, confusion, decreased GCS)</p>	
<p><b>Risks of Intubation</b></p>	<p>Low oxygen reserve Rapid desaturation Difficult to ventilate</p> <p>Relative hypovolaemia</p> <p>Delayed gastric emptying</p>	<p>Pre-oxygenation Most experienced available operator Use largest fitting/cuffed ET tube</p> <p>Anticipate hypotension. Good iv access Give 20ml/kg fluid bolus pre-induction Prepare vasopressors e.g. metaraminol</p> <p>Rapid sequence induction</p>
<p><b>Drugs for induction</b></p>	<p>Avoid histamine-releasing drugs if possible (atracurium, thiopentone) Use ketamine or fentanyl Volatile anaesthetic agent available for immediately post-intubation</p>	
<p><b>Other bronchodilators</b></p>	<p>Ketamine Volatile anaesthetic agents Adrenaline 1:10,000 0.1ml/kg iv/via ETT can be used in extremis</p>	
<p><b>Ongoing sedation</b></p>	<p>Use ketamine and fentanyl or midazolam Avoid morphine as causes histamine release</p>	

## Difficulties with Ventilation in Acute Severe Asthma

**REMEMBER HYPOXIA KILLS, HYPERCAPNOEA DOES NOT!**

**High Peak Pressures** causing barotrauma/pneumothorax/air leaks/reduced cardiac output

**Strategies:** Try PCV or square wave ventilation  
Limit pmax(<35)  
Permissive hypercapnia (pH>7.15)  
Large, cuffed ETT will reduce resistance and leak  
Keep paralysed initially especially whilst high pCO<sub>2</sub>

**Incomplete Expiration** Slow emptying of alveolus causes poor gas exchange, progressive gas trapping and ↑ residual volume

**Strategies:** Try low respiratory rates 10-20 and long expiratory times (I:E ratio >1:2 )  
Manual decompression (disconnect ETT and manually compress chest)  
  
Physiotherapy may help providing slow bagging is used

### **Intrinsic PEEP**

Aim to match extrinsic PEEP to intrinsic PEEP to reduce gas trapping

### **Mucus Plugging**

Suction and physiotherapy with saline lavage (can make worse if inadequately sedated)

**Discuss EARLY with NWTS**

### Criteria for reducing bronchodilator therapy

- Normal respiratory effort
- Normal ability to speak
- Reduction in oxygen requirement

### Discontinuing Intravenous Bronchodilators

#### **Aminophylline:**

- Elimination half-life 3-5 hours
- Reduce dose by 50% of original dose every 6 hours
- Following cessation of infusion, aminophylline will be cleared within 72 hours

#### **Salbutamol:**

- Elimination half-life 4-6 hours
- Reduce dose by 1microgram/kg/min every 6 hours
- Following cessation of infusion, salbutamol will be cleared within 48 hours
- NB:** Substantial systemic absorption of salbutamol occurs via GI tract when administered by inhalation so intravenous infusions should be discontinued before stopping nebulised salbutamol

Patient should receive nebulised  $\beta_2$ 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 for this time**

### Discharge planning of child after severe asthma attack:

- Check inhaler technique
- Start or review dosage of preventer treatment
- Written asthma plan
- Contact GP to arrange Primary care follow up within 48 hours
- Paediatric team follow up within 2 months
- Refer to Paediatric Respiratory Specialist if life-threatening features



## How to Make up Intravenous Bronchodilators for Infusion

### Salbutamol for **peripheral** administration:

- Remove 100ml from a 500ml bag of 5% glucose or 0.9% sodium chloride
- Add 100milligrams salbutamol (20 of PINK 1milligram/ml ampoules) to this bag
- Concentration = 200microgram/ml

Infusion rate:  $0.3\text{ml/kg/hr} = 1\text{microgram/kg/minute}$

### Salbutamol for **central** administration:

- Draw up 25ml (25milligram) (5x ampoules) of neat salbutamol 1milligram/ml into syringe
- $1\text{microgram/kg/min} = (0.06 \times \text{weight in kg}) \text{ ml/hr}$

### Aminophylline for **peripheral** administration:

- Add 500milligrams aminophylline to 500ml 0.9% sodium chloride
- $1\text{milligram/kg/hr} = (1 \times \text{weight in kg}) \text{ ml/hr}$

### Aminophylline for **central** administration:

- Add  $(50 \times \text{weight in kg})$  milligrams aminophylline to 50ml with 0.9% sodium chloride or 5% glucose
- $1\text{ml/hr} = 1\text{milligram/kg/hr}$

### Magnesium sulphate:

- 40milligram/kg (0.08ml/kg of 50% solution)
- 50% magnesium sulphate solution = 500milligram/ml
- For **peripheral** administration, dilute to a maximum of 200milligram/ml with 0.9% saline or 5% dextrose
- For **central** administration, can be given neat

## **References**

**BTS/SIGN British Guideline on the Management of Asthma—a National Clinical Guideline** May 2008, Revised January 2012

**Management of Acute Severe Asthma in children (aged >2years) version 3**

Royal Manchester Children’s Hospital, CMFT

Dr Fran Child, Paediatric Respiratory Consultant

Ms Hong Thoong, Lead Paediatric Medicines Pharmacist

*May 2010*

Acute Asthma. Bohn D, Kissoon, N **Paediatric Critical Care Medicine**  
*2001:151-163*

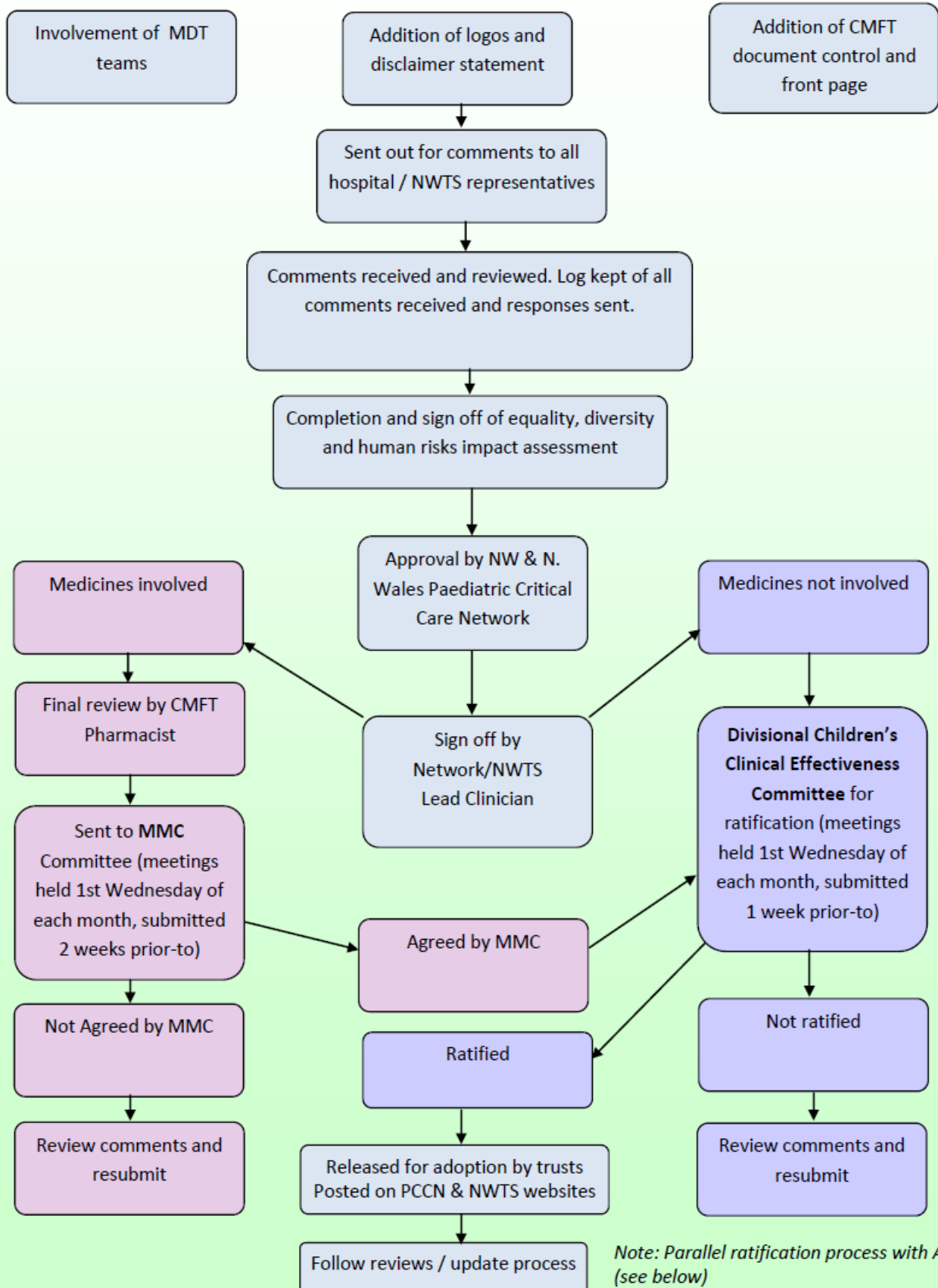
**British National Formulary for Children 2011-12**

***www.crashcall.net*** for drug doses

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

## Appendix 1

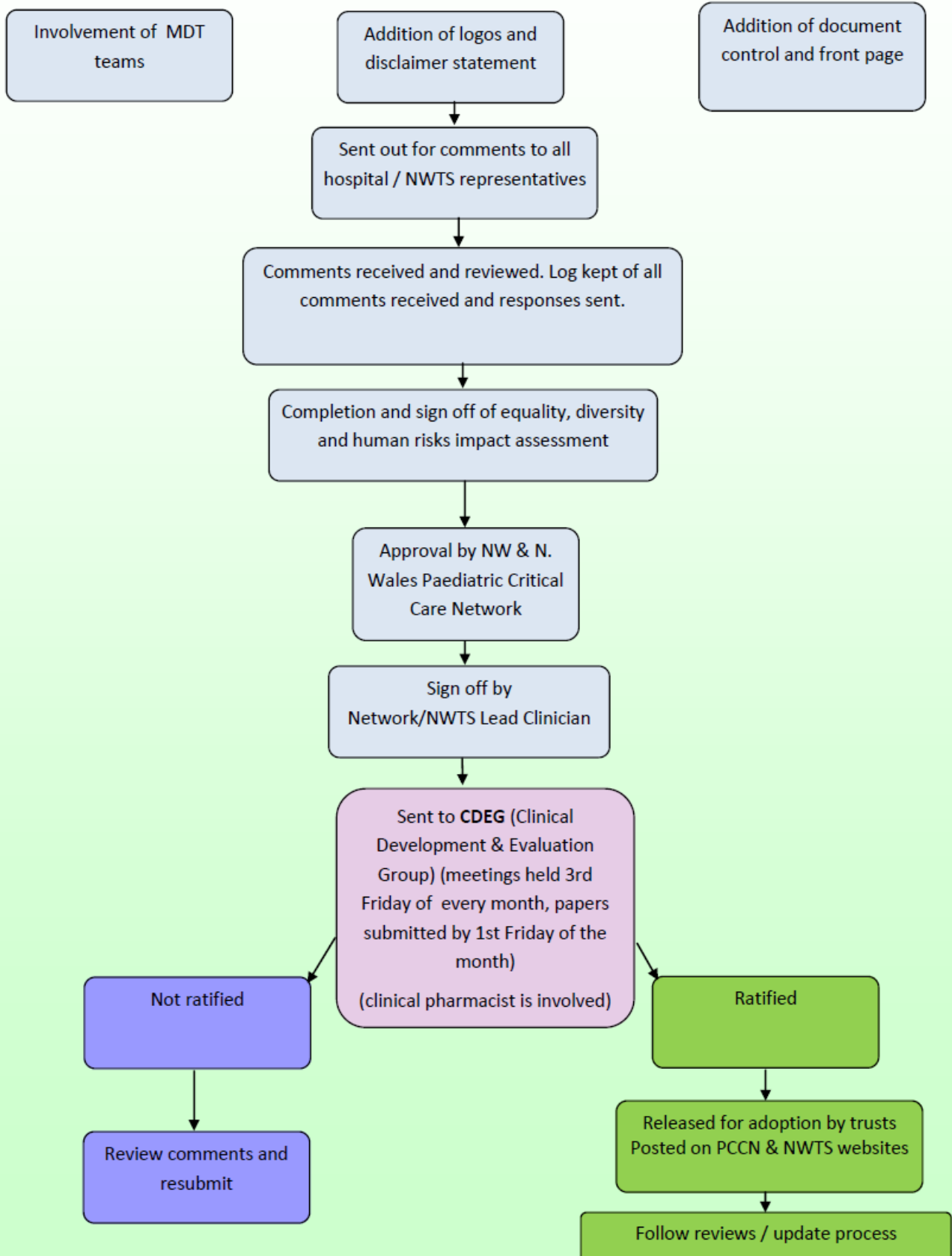
### Ratification of Guidelines with Host Organisation (CMFT)



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

Appendix 1 continued

## Ratification of Guidelines with Alder Hey



## Resources

**www.crashcall.net** - for intubation drugs / sedation regime

**Contact numbers:**

Regional Paediatric Intensive Care Unit Alder Hey Childrens Hospital 0151 252 5241  
Regional Paediatric Intensive Care Unit Royal Manchester Childrens Hospital 0161 701 8000  
NWTs (North West & North Wales Paediatric Transport Service) 01925 853 550

**Guideline authors:**

Authors:

Pete Murphy, Transport Consultant NWTs and Consultant Paediatric Anaesthetist, Alder Hey  
Rachael Barber, NWTs Consultant and PICU Consultant, Royal Manchester Children's Hospital  
Aradhana Ingley, Associate Specialist in Paediatrics, Glan Clwyd Hospital, North Wales  
Adam Sutherland, Senior Clinical Pharmacist, Royal Manchester Children's Hospital  
Fran Child, Consultant Paediatric Respiratory Consultant, Royal Manchester Children's Hospital  
Jon Couriel, Consultant Paediatric Respiratory Consultant, Alder Hey

**Consulted parties:**

North West & North Wales Paediatric Transport Service (NWTs)  
North West and North Wales Paediatric Critical Care Network  
PICU, Royal Manchester Children's Hospital  
PICU, Alder Hey Children's Hospital

**Date of Approval by Host Trust: 11th February 2013**

**Date of Review: 11th February 2015**

Guideline contact point: [Rachael.Barber@nwts.nhs.uk](mailto:Rachael.Barber@nwts.nhs.uk)

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