DOCUMENT CONTROL PAGE	
Title	**Title:** Guidelines for Management of Severe and Life-threatening Bronchiolitis **Version:** Version 2 **Reference Number:** PCCN2
Supersedes	**Supersedes:** Guidelines for Management of Moderate to Severe Bronchiolitis (2012) **Significant Changes:** Significant changes: 1) New reference for HFNC (9), NICE guidance (13) and RCT about nebulised treatment (14) 2) Changes to wording about using nebulised treatment on Page 6
Originator or	**Originated By & Designation:** Dr Nayan Shetty: Consultant Paediatric Intensivist, Alder Hey Children's NHS Foundation Trust Dr Rajesh Phatak: Consultant Paediatric Intensivist, Royal Manchester Children's Hospital and NWTS
Ratification	**Ratified by:** 1. CMFT (Host Trust): - Paediatric Medicines Management Committee (MMC) on: **3rd February 2016** - Divisional Children's Clinical Effectiveness Committee on: **7th July 2016** 2. AHFT: - CDEG (Clinical Development & Evaluation Group) on: **16th September 2016**
Application	**Patients –** Children only Recommended for use for the management of paediatric patients less than 24 months of age in district general hospitals in the North West and North Wales Paediatric Critical Care Network with severe and life-threatening bronchiolitis for whom transfer to the tertiary paediatric intensive care unit may be considered. Local ratification is also advised. Please follow appropriate local / national guidelines such as NICE for less severe cases.
Circula-tion	**Issue Date: 7th October 2016** **Circulated by:** Clinical Lead, North West & North Wales Paediatric Critical Care Network **Dissemination and Implementation:** NWTS & Network circulation lists
Review	**Review Date: 16th September 2019** **Responsibility of:** Clinical Lead & Network Manager, North West & North Wales Paediatric Critical Care Network
Date placed on the Intranet: **7th October 2016**	**Please enter your EqIA Registration Number here: 126/12** **Refer to section 2: Equality, Diversity and Human Rights Impact Assessment**

1 Detail of Procedural Document

Guidelines for Management of Severe and Life-Threatening Bronchiolitis

2 Equality Impact Assessment

EqIA Registration Number: 126/12

3 Consultation, Approval and Ratification Process

This guideline was developed with input from:

- Representatives from the North West & North Wales Paediatric Critical Care Network (PCCN).
- Representatives from both Paediatric Intensive Care Units (Central Manchester University Hospitals NHS Foundation Trust and Alder Hey NHS Foundation Trust).
- North West and North Wales Paediatric Transport Service (NWTS).
- Representatives from the 32 Hospitals within the PCCN.

This guideline has been circulated to the mailing list for the network with a request for comments. Comments received have been reviewed and appropriate amendments incorporated.

For ratification process see appendix 2.

4. Dissemination Implementation

Upon ratification:

- The membership of the North West and North Wales Paediatric Critical Care Network will be informed of the ratification.
- Guidelines will be placed on the websites of both the Network and the North West & North Wales Paediatric Transport Service (NWTS).
- A parallel process will be carried out in Alder Hey NHS Foundation Trust and other hospitals will be able to consider should they wish this document to go through their own ratification process.

5. References and Bibliography

See guidelines.

6. 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 (NWTS), and were produced after careful consideration of available evidence in conjunction with clinical expertise and experience. It is intended that trusts within the Paediatric Critical Care Network will adopt this guideline and educational resource after review 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.

Decision algorithm / flowchart for Management of Severe or Life-threatening Bronchiolitis

Features of life threatening illness (Joint Paediatric Consultant and Anaesthetic Review)

Hypoxia (Sats < 88% despite high flow oxygen/ CPAP)

Respiratory acidosis (pH < 7.25) despite CPAP / BiPAP

Exhaustion, grunting, marked recession

Apnoea needing bagging or frequent apneoas with desaturations

Respiratory acidosis

Features of severe illness (Senior Review)

FiO_2 > 0.5 to maintain Sats > 92%

Severe recession, tachypnoea, tachycardia

Frequent apnoeas (>2/h) not needing bagging

Therapeutic end points

Saturations > 92%

pH > 7.25 on cap gas

HR < 99th centile for age[18]

Urine output > 1ml/kg/h

Stop feeds – IV Fluids

CXR, Capillary gas

IV antibiotics

(I) Trial of high flow humidified nasal cannula oxygen

Optiflow / Airvo: flow based on age

(II) Trial of nCPAP/ BiPAP: aim for PEEP 5-10cm H_20

(III) Nebulised medications or Caffeine (NOT ROUTINELY RECOMMENDED) see page 6

Initially reassessment in 1 hour

Achieving Rx end points

Stable or getting better

No

Yes

Escalate Rx

Urgent anaesthetic review (if not already at bed side)

Discuss with NWTS

Intubate and ventilate

DO NOT delay intubation waiting for NWTS*

Continue Rx

Medical review 6-12 hourly

OG tube , Feeds if stable

Sedation if difficult to settle on NCPAP (Chloral hydrate 25-30 mg/kg via OGT is appropriate in most cases)

Guidelines for Management of Severe and Life-Threatening Bronchiolitis

Bronchiolitis is an acute infectious disease of the upper and lower respiratory tract. Severe symptoms are due to lower respiratory tract infection and obstruction of the small airways by respiratory secretions.

Clinical diagnosis is based on infant's age, presentation (coryza, cough, tachypnoea, fine crackles and wheeze) and seasonal occurrence. Non – respiratory presentation include apnoea (central or obstructive in origin), encephalitis, myocarditis, arrhythmias.

Causative pathogens include RSV (80%), metapneumovirus, parainfluenza, influenza, adenovirus, rhinovirus, boca virus and mycoplasma.

Confirmation of diagnosis may be helpful in stopping antiviral agents initiated for influenza A infection and to aid infection control. Diagnosis may be confirmed by rapid antigen tests (85 – 90% sensitive)[1] or PCR technique done on nasopharyngeal or lower respiratory secretions. Chest x-ray (CXR) may show evidence of hyperinflation with lobar infiltrates or atelectasis (30%).

Approximately 3 - 5% of hospitalised infants need intensive care admission. This is greater (30-40%) in high risk group.

<u>Factors associated with worse clinical course</u>

Congenital heart disease – particularly lesions associated with pulmonary hypertension [2, 4]

Chronic lung disease [3, 4]

Prematurity (less than 34 weeks corrected gestation at presentation)

Less than 6 weeks of age at presentation [5]

Immune deficiency[4]

Adenovirus bronchiolitis associated with worse outcome [6]

<u>Differential diagnoses to consider depending on symptomatology — Avoid Confirmation Bias* !</u>

Tachypnoea with chest X ray shadows (Bacterial bronchopneumonia, Aspiration secondary to reflux , TAPVC or PAPVC —> Total or partial anomalous Pulmonary Venous connection)

Isolated tachypnoea / recessions—Underlying airway abnormalities, tracheobronchomalacia

Tachypnoea + Poor perfusion + Murmur — cardiac disorders (Coarctation / Critical AS)

Apnoea—Pertussis, NAI, sepsis, metabolic disorders

Older children— Foreign body inhalation, Asthma, anaphylaxis

Bronchiolitis may precipitate heart failure in some children with congenital heart disease (just as any other infection or inflammatory pathology would)

Management on the Paediatric Ward

Assessment

Moderate disease: **(Manage as per local / national paediatric guideline such as NICE guideline)**
- FiO2 < 0.5 to maintain saturations >92%.
- Tachypnoea, tachycardia, use of accessory muscles of respiration, poor feeding.

Severe to potentially Life-threatening disease: (**Senior paediatric review essential)**
- FiO2 > 0.5 to maintain Saturations > 92% AND
- Severe recession, tachypnoea, tachycardia , frequent apnoeas (>2/h) but not needing bagging.

Life-threatening disease: **(Joint review by senior paediatric and anaesthetic team essential)**
- Hypoxia (saturations < 88% despite maximum deliverable oxygen)
- Respiratory acidosis (pH < 7.2) despite CPAP/ BiPAP
- Exhaustion, grunting, marked respiratory distress
- Apnoea needing bagging or frequent apnoea with desaturations

Monitor:
- Intermittent (respiratory rate and blood pressure) and continuous (pulse oximetry and heart rate) measurements should be standard for patients with severe disease. Using early warning scores modified for paediatrics has been shown to identify hospitalised children who are likely to deteriorate and need PICU admission.[7]

- Strict fluid balance (intake – output) chart for those with severe and life-threatening disease

- Capillary gases with serum lactate (for severe disease and **prior to** discussion with NWTS), renal biochemistry and serum sodium (if on intravenous fluids, risk of hyponatremia).

Management (for severe and life-threatening disease) [Appendix 2]

- Ensure nose not blocked with secretions (0.9% saline +/- gentle suction may be needed).
- High flow **humidified** oxygen (via head box or mask) or high flow nasal cannula (HFNC)[19] therapy such as Optiflow/Airvo *(Retrospective observational study showed reduced need for intubation 9% vs. 23% [p=0.043, absolute risk reduction 14%, NNT 7]*[8]*. No randomised trials in this group of patients but in less severe cases HFNC has been helpful only temporarily)*[9]*.*
- Aim for oxygen saturations above 92%.
- Keep NBM if severe respiratory distress or FiO2> 0.5 (in patients anticipated to need intubation). Restrict intravenous fluids to 2/3rd maintenance, choice of fluid depending on trust policy (avoid very hypotonic fluids such as 0.18% sodium chloride + 4% dextrose) monitor blood sugar and titrate fluids based on serum electrolyte results.
- It may be appropriate to use 30 mg/kg chloral hydrate by NGT/PR in the feisty infant not tolerating CPAP/SiPAP, to achieve a “good seal” and ensure compliance with Rx. This should be a “Consultant –only” decision. The same dose can be repeated if found to be useful [Refer to BNFc].

- Insert Oro Gastric Tube (8 Fr in less than 6 months and 10 Fr in children over 6 months is suggested) on free drainage. Decompress / aspirate stomach regularly. *Can be fed cautiously ONLY via oro / nasogastric tube, if stable over a period of time.* Replace IV fluids by feeds at 2/3rd maintenance and increase to full maintenance if serum Na has not dropped on review.

- Aim for urine output 1 – 2ml/kg/h. If not, may be dehydrated and needs more fluids (consider a fluid bolus [10 – 20ml/kg/d] if acidotic or if haemodynamically unstable).

- Bronchiolitis is often associated with secondary bacterial infection. Antibiotics should be started if strong evidence of bacterial infection or if severe disease. *(Cochrane Review – no evidence that antibiotics helpful in mild to moderate disease[10]. Prospective studies from Alder Hey[11] and US[12] suggests high incidence of secondary bacterial infection among those requiring PICU admissions).*

- Symptomatic (nebulised) treatment

  Nebulised treatment is not routinely indicated for all patients with bronchiolitis[13]. Nebulised therapy is unlikely to avoid need for respiratory support (NIV / I+V) and as such, should not delay review by senior clinical team. (User discretion advised as anecdotal benefit from nebulised therapy in individual patients is occasionally seen)
  If nebulised treatment is used, on demand regimen is better than fixed schedule *(RCT using 0.9% saline or adrenaline led to shorter estimated mean length of hospital stay, use of oxygen supplement and ventilator support and fewer inhalation treatments)*[14]

  For patients with bronchiolitis the following nebulised medications have been tried
  Nebulised 0.9% sodium chloride, [3—5ml] as required
  Nebulised Hypertonic Saline, 3 to 5% (2.5 to 5ml), as required, max 4 times a day
  Nebulised Adrenaline 400microgram/kg (max 5mg) [1-3ml of 1:1000 solution, diluted with 0.9% sodium chloride]
  Ipratropium bromide (Nebulised Atrovent®) 125 – 250 microgram
  Nebulised Salbutamol 2.5mg

  Nebulised bronchodilators may be more beneficial in older children with significant wheeze on presentation and a previous history of wheeze or strong family history of asthma. Refer to section Specific Problems (Page 8)

  When starting nebulised treatment look for therapeutic effect such as reduced work of breathing, slower respiratory rate or better saturations and **only continue if it helps**.

- Case reports suggest benefit from using Caffeine for apnoeas associated with bronchiolitis[15]. Doses used were (20mg/kg loading dose as **caffeine citrate** i.v over 30min followed by 10mg/kg second and 5mg/kg third dose if required) or aminophylline (5mg/kg i.v loading dose [if not already on theophylline at home] followed by oral theophylline). *(Small [12 patients] uncontrolled trials of using caffeine and aminophylline have shown favourable response with complete resolution of apnoea thus averting PICU admission).* This treatment is not recommended routinely due to lack of evidence from larger trials — **seek senior review**. Decision to use methylxanthines for apnoeas should take into consideration number of apnoeas, associated desaturations and presence of respiratory acidosis. Other diverse and serious conditions that may present with apnoeas (sepsis, NAI, cardiac etc) should be excluded.

Indications for CPAP / SiPAP[16] (initial reassessment within 1 hour)

Clinical – severe disease not improving with initial treatment or getting worse.

Biochemical – respiratory acidosis (pH < 7.25) on blood gas. *Note some chronic lung disease patients may have high PCO_2 but normal pH.*

Indications for intubation **(anaesthetic and senior paediatrician review)**

Features of life-threatening illness. **Refer to Algorithm on Page 4**

Clinical – marked increased work of breathing, impending exhaustion (often associated with agitation or reduced conscious level), recurrent apnoeas.

PCO_2 > 10kPa (>75mmHg) with respiratory acidosis (pH < 7.25) despite non-invasive support.

Hypoxia despite high flow oxygen and or CPAP / BiPAP.

Intubation

Please do not delay intubation waiting for NWTS!

Beware patient with gross facial dysmorphisms who might be difficult intubations.

Involve local anaesthetic team early. For neonates, intubation should be based on local arrangements and remains a team effort between anaesthetists and paediatricians.

Refer to standard intubation guidelines and local expertise.

Ketamine (1-2mg/kg) i.v bolus for induction helpful due to its bronchodilator properties and is more cardio-stable. Increased respiratory secretions are not a major problem in our experience.

Management after Intubation

- Standard sedation policy applies. Refer to www.crashcall.net for dosage and infusions.
- Initiate muscle relaxants in preparation for transport (avoid atracurium if significant problems with bronchospasm).
- Lung protective strategy should be applied for ventilation
  - Limit Peak Inspiratory Pressures (< 30).
  - Tidal volume 5-7ml/kg
  - Use PEEP (5 – 10 depending on oxygenation).
  - Avoid rates > 30, may lead to gas trapping. (recommend inspiratory time 0.7 to 1.0 sec)
  - I:E ratio start 1:2. (may need 1:1 in severe illness)
  - Aim for saturations > 92% and permissive hypercarbia with pH > 7.25.
- CXR to confirm ET tube position, extent of lung involvement and to exclude pneumothorax.
- Start broad spectrum antibiotics to treat community acquired chest infection (if not already started).
- Manual IPPV and ET suction after instillation of 0.9% sodium chloride particularly if on high ventilator pressures.
  Consider local physiotherapist review whilst awaiting NWTS / transfer .
- Beware of progressive hyperinflation and gas trapping presenting as low minute volume and rising pCO_2. May have to disconnect from ventilator and perform manual decompression of chest.

Specific problems

- **Extensive collapse – consolidation** due to mucous plugging requiring high pressure ventilation.
  Potential therapies/ interventions :
  IPPV and ET suction after instillation of 1 – 2ml of 0.9% sodium chloride to relieve mucous plugging (may have to be done several times).
  Chest physiotherapy.
  Sedate and muscle relax

- **Bronchospasm** particularly in older children
  Potential therapies / interventions :
  (Use with clear end points such as reduction in respiratory rate, improvement in oxygenation and extent of tachycardia pre and post treatment). **If no response, escalate Rx (as per Flowchart Page 13). [Stop if unhelpful]**
  Trial of bronchodilators particularly if previous history of wheeze and older children, however beta2 stimulants particularly infusions may cause more problems (lactic acidosis and tachypnoea) with no effect on bronchospasm.
  If bronchospasm persists in the ventilated patient, use low rate (14-20), with I:E ratio at least 1:2 (may need longer expiratory times, but most patients need a decent Ti > 0.7 sec)
  Sedation (fentanyl + midazolam) and muscle relaxant (avoid atracurium).
  Ensure airways clear of secretions (IPPV and suction after 0.9% sodium chloride instillation, physiotherapy).

- **Hyponatremia** secondary to inappropriate / excess / hypotonic fluids on a background of raised ADH secretion [17]
  Potential therapies/ interventions :
  When commencing IV Fluids empirically restrict fluids to 2/3rd maintenance unless evidence of dehydration (clinical and/or biochemical).
  Use standard paediatric maintenance fluid composition as per local trust policy.
  Maintain strict fluid balance (input / output) chart, daily weight (if possible) and U&E.
  If evidence of hyponatremia ensure using 0.9% sodium chloride / 5% dextrose or equivalent solution and monitor serum sodium levels. May have to restrict fluids further.

Transport Considerations

- Keep patient adequately sedated and muscle relaxed with appropriate hemodynamic monitoring
- Ensure clear airway (ET suction) before departure from referring hospital.
- Confirm acceptable blood gas before departure.
- If concerned about pneumothorax exclude it radiologically (may need repeat CXR) before departure.
- Use $ETCO_2$ monitoring through out journey.
- If deterioration en route consider hand ventilation, suction or manual decompression in addition to DOPE (Displacement, Obstruction, Pneumothorax, Equipment)
- Refer to generic transport guidelines for further information

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18. Fleming S, Thompson M et al. Normal ranges of heart rate and respiratory rate in children from birth to 18 years of age: systematic review of observational studies. Lancet 2011; 377:1011-1018.

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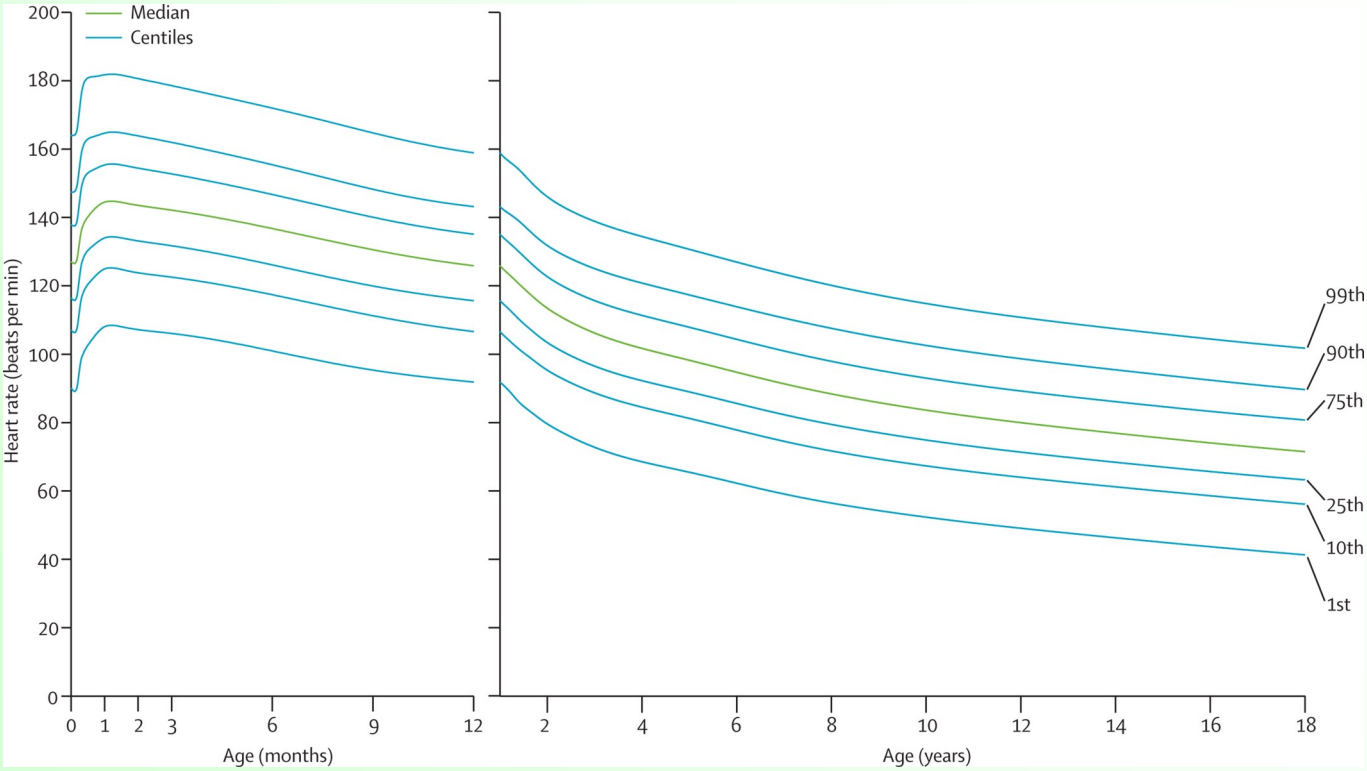
Appendix 1

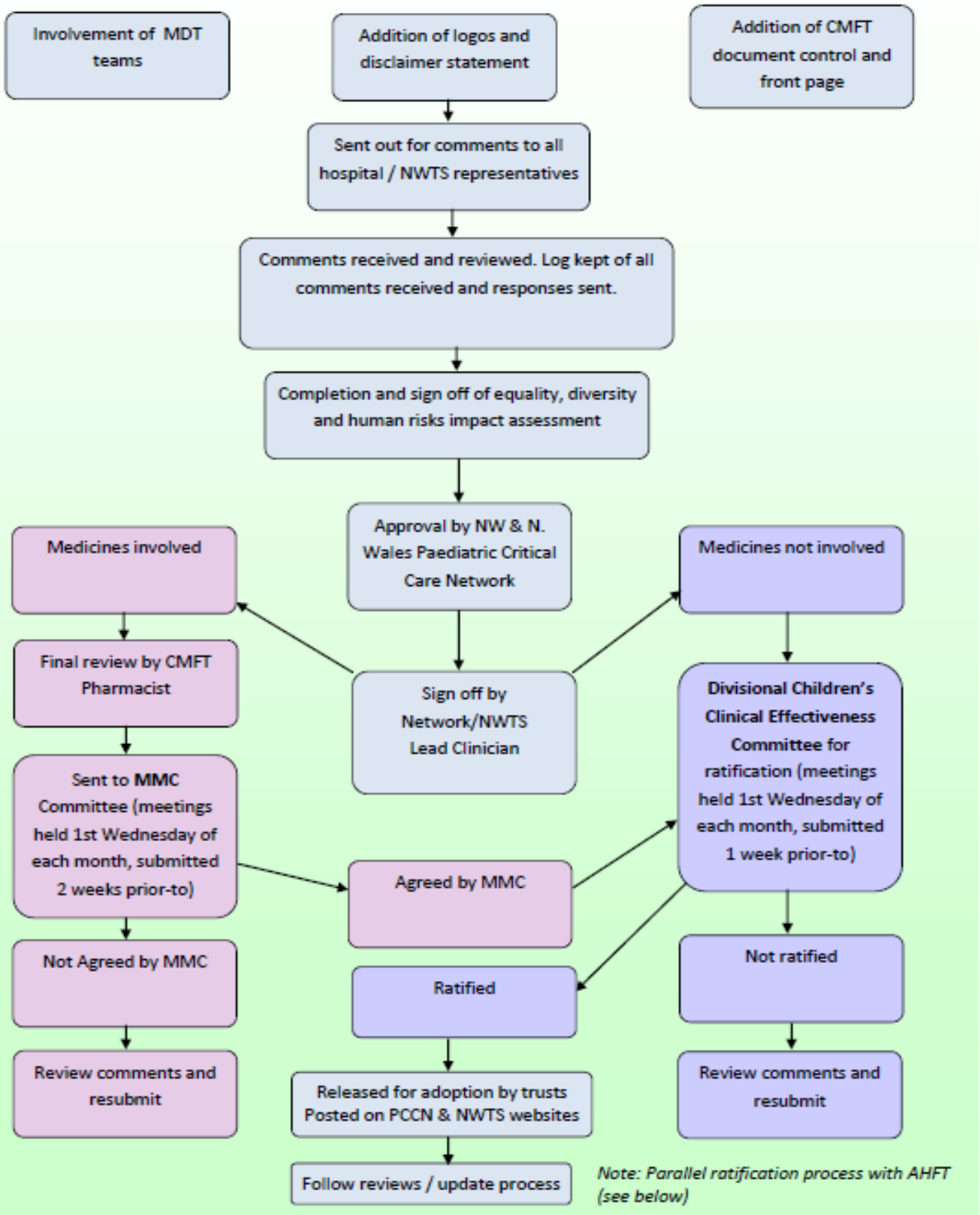
Normal heart rate centile charts in children [19].



Appendix 2

Alder Hey Children's NHS Foundation Trust | North West & North Wales Paediatric Critical Care Network | Central Manchester University Hospitals NHS Foundation Trust

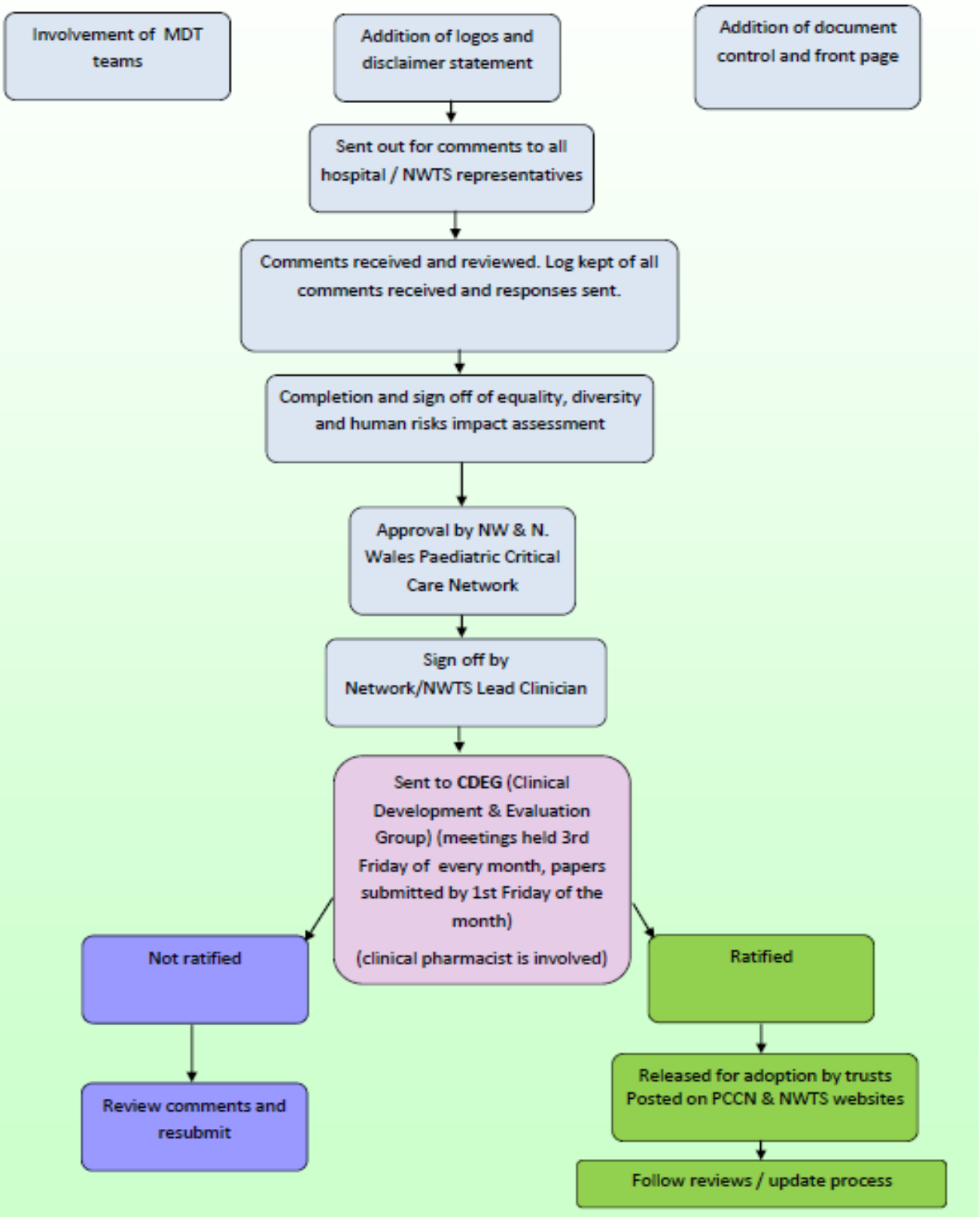
Ratification of Guidelines with Host Organisation (CMFT)



Appendix 2 continued

Alder Hey Children's NHS Foundation Trust | North West & North Wales Paediatric Critical Care Network | Central Manchester University Hospitals NHS Foundation Trust

Ratification of Guidelines with Alder Hey



List of Abbreviations used in Guidelines

Abbreviation	Explanation
ADH	Antidiuretic Hormone
CPAP	Continuous Positive Airway Pressure
CXR	Chest X-ray
ET	End Tidal
ET CO2	End tidal CO2
FiO2	Fraction of inspired oxygen in gas mixture
HFNC	High Flow Nasal Cannula
HR	Heart rate
I:E ratio	Inspiratory to Expiratory ratio
IPPV	Intermittent Positive Pressure Ventilation
IV	Intravenous
KCl	Potassium Chloride
NCPAP	Nasal Continuous Positive Airway Pressure
NNT	Number Needed to Treat
NWTS	North West & North Wales Paediatric Transport Service
OGT	Orogastric Tube
PCO2	Partial pressure of carbon dioxide in blood
PCR	Polymerase Chain Reaction
PEEP	Positive End Expiratory Pressure
pH	Measure of acidity or basicity of an aqueous solution
PICU	Paediatric Intensive Care Unit
RCT	Randomised Controlled Trial
RSV	Respiratory Syncitial Virus
Rx	Treatment
Sats	Saturation
SIADH	Syndrome of Inappropriate Antidiuretic Hormone
SiPAP	Biphasic CPAP (Sigh PAP)
U&E	Urea and Electrolytes

Resources

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

Contact numbers:
Regional Paediatric Intensive Care Unit Alder Hey Children's Hospital 0151 252 5241
Regional Paediatric Intensive Care Unit Royal Manchester Children's Hospital 0161 701 8000
NWTS (North West & North Wales Paediatric Transport Service) 01925 853 550

Guidelines consulted:
Bronchiolitis Guidelines (CATS)
CPAP Guidelines (North West and North Wales Paediatric Critical Care Network)

NICE guidelines

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Consulted parties:
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PICU, Alder Hey Children's Hospital

Date of Approval: 16th September 2016

Date of Review: 16th September 2019

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Please visit our website for the most up to date version of this guideline: www.nwts.nhs.uk

NWTS North West & North Wales Paediatric Transport Service

NHS North West & North Wales Paediatric Critical Care Network