LRI Children's Hospital

Humidified High Flow Nasal Cannula (HHFNC) Oxygen Therapy

Staff relevant to:	Medical and Nursing staff
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Contents

1. Introduction and Who Guideline applies to

Leicester Children's Hospital (LCH) medical and nursing guideline for the initiation and on-going management of Humidified High Flow Nasal cannula (HHFNC) Oxygen Therapy in children with respiratory distress who are in-patients in Leicester Children's Hospital. Currently this guideline covers all LCH wards (except PICU, CICU and Paediatric Cardiac Ward)** ward 1 may be consulted in future**

Acknowledgements:
The introduction of HHFNC oxygen therapy in the ward areas of LCH is possible because of the initiative and drive of Ward 11 staff, led by Sister Rachel Speight, in collaboration with ward 12 and CICU staff by excellent cross-boundary approach.

2. Guidance:

Humidified High Flow Nasal cannula (HHFNC) Oxygen therapy (also referred to as 'High Flow' and in our hospital 'Vapotherm') delivers optimally heated and humidified oxygen via a specifically designed nasal cannula interface. It is the refined modern day equivalent of humidified head box oxygen therapy, and is used to the reduce work of breathing in patients with respiratory distress due to a number of indications, predominantly viral bronchiolitis. A number of different systems have been developed to deliver HHFNC Oxygen (e.g. Optiflow, Airvo) and include Vapotherm, which is the system used in LCH.

2.1 Mechanism of action

HHFNC Oxygen is thought to reduce work of breathing by a number of mechanisms;

Provides optimal humidity:
Lung compliance and mucociliary function are rapidly compromised by gas that is not heated and humidified. Bronchoconstriction associated with airway cooling is reduced

Decreases energy expenditure:
The humidity also reduces the evaporative losses from the mucosa of the immature airway (<2 yrs), reducing the energy required for gas conditioning

Provides distending pressure:
A variable level of positive airway pressure is delivered improving lung compliance and gas exchange by lung recruitment. The amount of pressure delivered is dependent on the flow and size of the patient and the fit of the nasal cannula (See Figure 1). It is very important that the cannula fits and is checked hourly to ensure position in the nostril. In bronchiolitic infants, this has been measured at 4.7cm/H20 at flows of 2L/kg/min

Reduces work of breathing:
Providing gas flows that are equal or greater than the patient's peak inspiratory flow decreases the resistive work of breathing

Improves alveolar ventilation:
The nasal passages and oropharynx are continuously flushed and replenished, removing exhaled gas to reduce re-breathing and increase the clearance of carbon dioxide. HFNC needs to remain an 'open system' in order for this to work, nasal cannula should cover no more than half the diameter of the nostril and there is no need to keep the patient's mouth closed

Evidence for HHFNC Oxygen therapy:
Most of the evidence supporting the use of HHFNC Oxygen Therapy in infants and children relates to bronchiolitis[1, 2]. However, there is now emerging evidence of benefit in acute respiratory distress and/or hypoxia following extubation [3,4], acute severe asthma [5,6] and pneumonia [7].

1. Bronchiolitis: A systematic review and meta-analysis found reduction in treatment failure children with bronchiolitis who received HHFNC oxygen compared to standard oxygen therapy. However, no significant differences between HHFNC and CPAP were noted in terms of treatment failure [8]. A number of RCTs have consistently shown no differences in duration of oxygen therapy and/or need for intensive care transfer [1,2] .
2. Post-extubation respiratory failure: Retrospective observational studies and RCT evidence have found improvement in clinical parameters such as respiratory rate, heart rate and atelectasis compared to standard oxygen therapy. There was a lower rate of extubation failure in the HHFNC oxygen sub-group [3,4]
3. Acute asthma: Improvements in pulmonary score and respiratory rate were evident in the HHFNC group compared to the standard oxygen treatment groups based on observational studies and RCT [5,6]
4. Pneumonia: A randomised RCT comparing HHFNC oxygen, CPAP and low flow oxygen did not show differences in treatment failure between HHFNC oxygen. However this study was terminated early due to higher mortality in the low flow oxygen group [7].

High Flow has advantages over other forms of oxygen delivery. It is more comfortable for the patient than low-flow oxygen therapy as the gases are heated and humidified. It allows greater access to the patient than head box oxygen therapy. Evidence extrapolated from RCTs in infants with bronchiolitis have provided information about flow rates when using HHFNC oxygen, which is usually 1-2 litres/kg. However, using flows of 3L/kg was associated with increasing patient discomfort [9].

HHFNC oxygen has also been used as an alternative to Continuous Positive Airway Pressure (CPAP) in premature neonates, but as the system is not sealed and does

not have an expiratory valve, it is not as an 'alternative' to CPAP in older babies and children, rather should be considered an adjunct to prevent escalation to needing non-invasive or invasive ventilation.

Indications for HHFNC Oxygen Therapy in LCH wards:

Consider using HHFNC oxygen in patients with features of moderate/severe respiratory illness

- Moderate respiratory distress (recessions, nasal flaring, head bobbing, tachypnoea)
- Features of moderate to severe bronchiolitic illness (see below)
- Child with respiratory illness with features of severe disease and PEWS >4
- Acute hypoxia and/or raised carbon dioxide
- As a step down therapy after HDU/PICU admission

Contraindications to HHFNC Oxygen Therapy:

Absolute -

- Suspected Pneumothorax or basal skull fracture
- Nasal Obstruction/Upper airway abnormalities (Choanal atresia)

Relative -

- Apnoea: if child having apnoeic episodes should be managed in HDU not ward environment
- Recent oesophageal or gastric surgery (proceed with caution)

Potential complications to HHFNC Oxygen therapy:

- Isolated case reports of pneumothorax in children receiving HHFNC Oxygen
- Trauma to the nasal mucosa (less common than CPAP)
- Gastrointestinal distension (NG on free drainage may be appropriate)

Assessment of Bronchiolitis Severity:

Please refer to: LCH **Bronchiolitis UHL Childrens Guideline** (D11/2020) 'and NICE guidance 'Bronchiolitis in Children: diagnosis and management '

Bronchiolitis severity can be categorised into 3: moderate, severe and life threatening disease

Moderate disease
Sats < 92% in air + ↑HR, ↑RR, respiratory distress, poor feeding

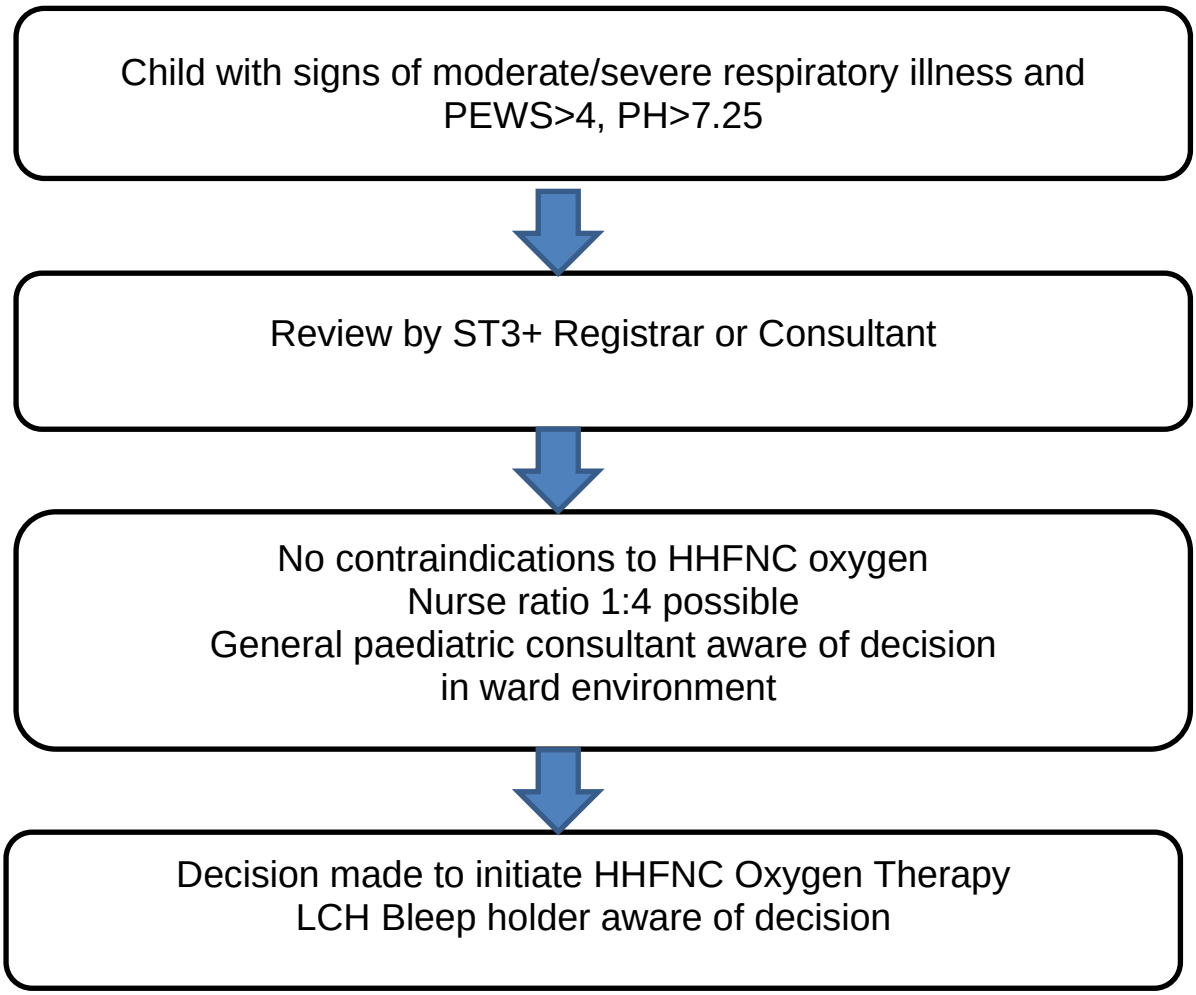
Severe disease
FiO2 > 0.5 to maintain Sats > 92%, ↑HR, ↑RR, severe recession, , frequent apnoea's (>2/h) but not needing bagging

Life-threatening disease
Sats < 88% despite high flow oxygen, respiratory acidosis (ph<7.25) despite CPAP / BiPAP, marked recession, exhaustion, grunting, apnoea needing bagging or frequent with desaturations

Monitoring:

In all cases monitor heart rate, respiratory rate, continuous oxygen saturations and regular Paediatric Early Warning Scores.
Blood gas measurement and serum biochemistry at presentation

Initiation of HHFNC Oxygen therapy- Decision Algorithm:



Transport considerations

HHFNC is increasingly started in ED for patients with moderate to severe respiratory distress secondary to a range of respiratory considerations. Once commenced safe transport to the wards needs to be considered including:

- Portable continuous monitoring
- Consideration of staff e.g. nurse, medical staff, porters
- Respiratory support using either portable vapotherm or anaesthetic bag with PEEP
- Emergency equipment required in the event portable vapotherm fails during transport
- Consideration of which ward is appropriate taking into account acuity

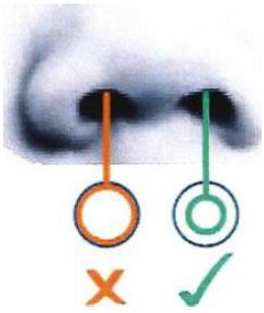
Please refer to the separate ED guideline titled 'Humidified High Flow Nasal Cannula Oxygen Therapy in ED' when commencing HHFNC in ED.

Initiation of HHFNC Oxygen therapy:

Select appropriate sized nasal prongs

Figure 1: Sizing the Cannula

Choice of nasal cannula is based on the diameter of the child's nostril and not on age or weight of child. The nasal cannula chosen to administer high flow should cover no more than half the diameter of the nostril.



Infant nasal cannulas can only be used with low flow cartridges using Vapotherm svstem

Set initial flow rate

Target flow rate is 2l/kg/min

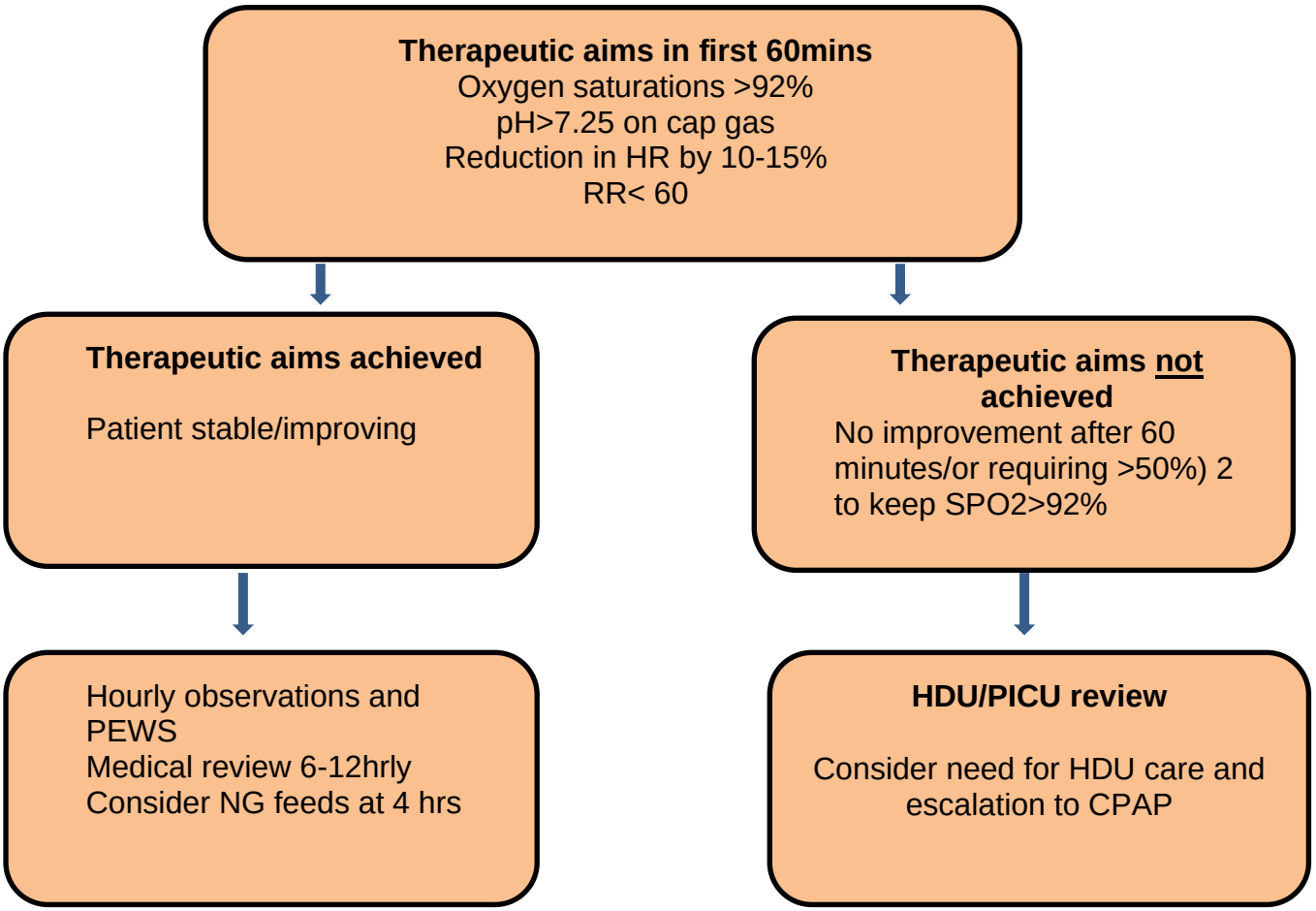
(Vapotherm has two cartridges: low flow set for neonates/infants with flow range of 1-8l/min, and high flow set with flow range of 5-40l/min)

Set initial FIO2
Start at 40% FIO2 and titrate to response
Aim for O2 saturations 92-95%

On-going Monitoring and Management of patient on HHFNC Oxygen Therapy:

- Patient requires continuous oxygen saturation monitoring
- PEWS score/observations should be recorded at 0, 30 and 60 minutes, and hourly thereafter
- Hourly observations to include;
    - Documented cannula position
    - Presence/absence gastric distension (consider NG tube on free drainage if signs)

- Medical review by ST3+ Registrar or Consultant at 60 minutes to identify if child responded to treatment



Features of life threatening illness
Hypoxia (Sats < 88% despite high flow oxygen/ CPAP)
Respiratory acidosis (pH < 7.25) despite HHFNC O2
Exhaustion, grunting, marked recession
Apnoea needing bagging or frequent apneoas with desaturations
Any of these features require urgent escalation to PICU

On-going management of child who responds to high flow:

Monitoring:

Continuous oxygen Saturations

Hourly observations including documentation of PEWS Score, cannula position and gastric distension

Commence feeding if stable at 4 hours

Capillary blood gases and CXR are not routinely indicated

Daily medical review and documentation of need to continue HHFNC oxygen therapy

Bedside Care:

Check nasal prong position hourly (at a minimum);

Dislodgement may be a cause for decreased effectivity of the support.

Ensure that a leak is present (nasal prongs should be 1/2 of the diameter of the nostrils) as obstruction of nasal passages create high pressure and may lead to barotrauma (especially neonates)

Check pressure areas to nares. Nasal cannula should be wide enough not to "pinch" the nasal septum

Saturation probe site change 2 - 4 hourly

Perform oral and nasal care to prevent crusting of secretions

Perform effective nasopharyngeal suction as clinically indicated

Check humidifier water level hourly

Feeding:

Review for feeding after stability achieved (usually after 4-6 hours)

Most infants will require NG feeding. Introduce feeds slowly and consider small/frequent feeds bolus feeds initially @2/3 full feeds

If the patient is not tolerating enteral feeding or isn't responding continue IV fluids @2/3 maintenance (0.9% Sodium chloride (plus Glucose as required)) initially.

Weaning:

Wean oxygen before flow. Aim to reach FiO2 25% or less prior to weaning the flow.

Wean oxygen to lowest amount that keeps SPO2 >92%

In bronchiolitis in infants, once the FiO2 is 25% or lower, a suggested approach may be to wean flow by 0.5L/min every 4hrs. For babies with bronchiolitis, weaning from HHFNC oxygen therapy typically occurs over 24hrs. Once child stable and flow <2l/min consider discontinuation of HHFNC oxygen therapy, or change to low flow nasal cannula oxygen therapy if required.

For other indications and in older children, wean the flow as tolerated, depending on the child-specific factors and the weight. Once vapotherm is down at to 0.5L/kg/min, consider stopping it.

Vapotherm device set up and trouble shooting

Equipment:

Vapotherm unit with air compressor

(Only on PICU and HDU can Vapotherm units with black air hose can be used as 'wall air supply' available)

Sterile water

Disposable patient circuit (high flow [5-40l/min] or low flow [1-8l/min])

Nasal Cannula

Nasal cannula are colour coded (as picture below)
(Premature and Solo cannula are not supplied in LCH)
Neonatal and Infant cannulas can only be used with the low flow patient circuit

Cannula Sizes	Cannula Flow Range	Tip OD
Premature	1-8 L/min	1.5 mm
Neonatal	1-8 L/min	1.5 mm
SOLO (single prong)	1-8 L/min	1.9 mm
Infant	1-8 L/min	1.9 mm
Intermediate Infant	1-8 L/min	1.9 mm
Pediatric Small	1-20 L/min	1.9 mm
Pediatric/Adult Small	5-40 L/min	2.7 mm
Adult	5-40 L/min	4.8 mm

Setup

Please refer to Vapotherm Precision Flow Operating Instruction Manual PDF
https://vapotherm.com/resources/support/precision-flow-reference/

Administration of Nebulisers:

Further studies are needed to determine the optimal way of administering nebulised medications during the use of HHFNC oxygen. Current methods include reducing flow to < 5L/min during administration of the nebuliser and/or incorporating the nebuliser via the HHFNC oxygen circuit. There is evidence of increased comfort scores when using an incorporated circuit, however this needs to be balanced against aerosolization of the drug resulting in reduced drug delivery and altered clinical response. When there is diagnostic uncertainty (e.g. Bronchiolitis versus Bronchoconstriction), the need for nebulisation must be balance against the potential risk of deterioration with the removal of HHFNC.

There is limited evidence for the use of in line mesh vibration nebuliser adaptor; drug delivery may be reduced with increasing flow rates and smaller cannula sizes.

3. Education and Training

Medical staff and nursing staff will undergo regular training on the use of vapotherm during departmental teaching sessions.

4. Monitoring Compliance

None

5. Supporting References

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6. Key Words

Oxygen Therapy, Nebuliser, Vapotherm, Bronchiolitis

The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

Contact and review details	
Guideline Lead (Name and Title) Vinayak Rai - Consultant Paediatrician	**Executive Lead** Chief Nurse

Details of Changes made during review:
June 2023
Scope of guidance updated and clarified.
Updated the evidence behind HHFNC therapy
The following indications amended/added;

- Moderate respiratory distress (recessions, nasal flaring, head bobbing, tachypnoea)
- Features of moderate to severe bronchiolitic illness (see below)
- Child with respiratory illness with features of severe disease and PEWS >4
- Acute hypoxia and/or raised carbon dioxide

Added transport considerations section
Updated weaning advice to include –

- Aim to reach FiO2 25% or less prior to weaning the flow. to weaning advice.
- For other indications (other than bronchiolitis) and in older children, wean the flow as tolerated, depending on the child-specific factors and the weight. Once vapotherm is down at to 0.5L/kg/min, consider stopping it.

Updated nebuliser section