IAEM Paediatric Clinical Guideline

Humidified High Flow Nasal Cannula (HHFNC) oxygen therapy: A guide for use in patients with acute viral bronchiolitis

Version 1.2

September 2024

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To reference this document please reference as:

McNally P, Cox D. Humidified High Flow Nasal Cannula (HHFNC) oxygen therapy: A guide for use in patients with acute viral bronchiolitis. IAEM Guidelines 2024. https://iaem.ie/professional/clinical-guidelines/ (accessed 2nd September 2024).

DISCLAIMER

IAEM recognises that patients, their situations, Emergency Departments and staff all vary. These guidelines cannot cover all clinical scenarios. The ultimate responsibility for the interpretation and application of these guidelines, the use of current information and a patient's overall care and wellbeing resides with the treating clinician.

Revision History

Date	Version	Section	Summary of changes	Author
October 2018	V1.0	All	Final Version	PMcN/DC
April 2019	V1.1	Front cover	Removed guideline number	C. Briant
September 2024	V1.2	All Front cover Contents	Updated formatting Added guideline referencing information Added table of contents	C. Briant C. Briant C. Briant

CONTENTS

GLOSSARY OF TERMS

CBG	Capillary Blood Gas
CXR	Chest X-Ray
ED	Emergency Department
FiO_2	Fraction of Inspired Oxygen
HR	Heart Rate
HHFNC	Humidified High Flow Nasal Cannula
NICU	Neonatal Intensive Care Unit
PICU	Paediatric Intensive Care Unit
PEWS	Paediatric Early Warning Score
PEEP	Peak End Expiratory Pressure
RR	Respiratory Rate
VBG	Venous blood gas

HHFNC oxygen therapy: A guide for use in patients with acute viral bronchiolitis

INTRODUCTION

HHFNC therapy is a relatively new therapy for respiratory distress that offers non-invasive respiratory support through the delivery of high flow, humidified oxygen at various concentrations. Some studies have demonstrated that the appropriate use of HHFNC in infants and children with respiratory distress can reduce the need for invasive ventilation. It is proposed that HHFNC reduces the work of breathing and improved efficacy of ventilation through several mechanisms, many of which are still under investigation:

- Improved mechanics by supplying adequately warmed and humidified gas: Studies have shown that providing gas that is warmed and humidified results in a significant decrease in pulmonary conductance and compliance.
- Reduced inspiratory work of breathing by providing increased airflow: The effect of HHFNC on inspiration is to provide nasopharyngeal gas flows that match or exceed a patient's peak inspiratory flow – this alters the inspiratory resistance and results in decreased work of breathing.
- Reduced metabolic cost of gas conditioning: Delivery of high flow gas without warming or humidification can result in the drying of nasal passages, mucosal injury, impaired secretion clearance and patient discomfort. When oxygen is delivered via HHFNC it is heated to near body temperature and humidified to almost 100% of relative humidity. This then allows the gas to be delivered at high flow rates without causing local damage/irritation. By conditioning the gas to optimal temperature and humidity prior to its delivery the metabolic demand on the body to perform the same tasks is felt to be greatly reduced.
- Washout of nasopharyngeal dead space: The nasopharyngeal dead space contains end expiratory gas at the beginning of inspiration. Whilst this heats and humidifies

inspired air it reduces the efficacy of gas exchange. By washing out this dead space HHFNC improves alveolar ventilation and also facilitates carbon dioxide removal.

- Provision of distending pressure: The nasopharynx also contributes to upper airway resistance. It is hypothesised that HHFNC contributes to reducing upper airway resistance by providing positive pressure that can help to stent the upper airway. It is important to note that the positive pressure produced by HHFNC cannot be quantified or regulated in the same fashion as CPAP as it is affected by flow rate, mouth position (open/closed), patient weight and diameter of nasal cannulae.

At the time of creating this guideline we found that there was not a large volume of high quality evidence upon which to base our recommendations. Whilst HHFNC has become commonplace in the hospital setting over the last few years, there are very few large, multi-centre studies that have furthered our understanding of this new medical treatment. Most available recommendations are still based on extrapolations from observational or physiological studies.

In the Emergency setting available evidence best supports use of HHFNC for infants with bronchiolitis in specific circumstances outlined in indications/contraindications section below. As per NICE guidelines 2015: “Providing oxygen (typically by nasal cannula) is standard care for bronchiolitis. Newly-developed medical devices can now deliver high-flow humidified oxygen that is thought to provide more comfortable and effective delivery of gases while retaining airway humidity. The use of this medical device is becoming widespread without demonstration of additional efficacy. A multicentre RCT comparing high-flow humidified oxygen and standard supplemental oxygen would be of benefit, and should include weaning strategies for high-flow humidified oxygen.”

AIMS

The aim of this document is to provide a guide for the application of HHFNC to patients with acute viral bronchiolitis in the Emergency Department (ED).

PARAMETERS

Target audience: This guide is directed at health-care professionals engaged in the acute care of infants and children presenting in acute respiratory distress due to viral bronchiolitis who may benefit from treatment with HHFNC oxygen. HHFNC is a medically ordered mode of respiratory support and should only be initiated by medical and nursing staff with knowledge and experience in its use.

Patient population: This guideline applies to infants and children presenting to the ED with moderate to severe respiratory distress with a clinical diagnosis of acute viral bronchiolitis who meet the criteria as outlined in initiation section below for treatment with HHFNC.

- Special consideration must be given to neonatal patients with a history of chronic lung disease or other defined lung pathology as well as patients with underlying cardiac defects prior to commencement of HHFNC. (Please see special consideration section)
- Children with significant respiratory distress due to other respiratory conditions not effectively managed with low flow oxygen may benefit from a trial of HHFNC on the advice of the supervising consultant.

Contraindications:

- Respiratory acidosis with pH < 7.25
- Blocked nasal passages e.g. choanal atresia

- Trauma
- Injury to the nasopharynx
- Air leak (e.g. pneumothorax)
- Life threatening hypoxia

Complications: As outlined above HHFNC therapy generates positive pressures in the nasopharynx which cannot be accurately monitored. In a highly compliant system, a small increase in pressure delivers a much higher gas volume, which can lead to the development of pneumothorax secondary to both barotrauma and volutrauma. High flow rates of gas delivery via nasal cannula can result in alveolar over-distension and cause air leak syndromes. Case reports exist of serious air leak syndrome associated with HHFNC therapy. HHFNC is also more labour intensive than conventional low-flow oxygen and requires more resources to utilise. Complications to observe for while using HHFNC are as follows:

- Gastric distension
- Pneumothorax / other air leak
- Local pressure areas
- Blocked HHFNC due to secretion

Figure 1: HHFNC initiation algorithm

INITIAL REVIEW

A patient with acute viral bronchiolitis displays persistent signs of moderate to severe respiratory distress, namely:

- Increased respiratory rate
- SpO_2 < 92%
- Increased respiratory effort

Registrar and senior nurse to review patient within 30 minutes and consider:

- The cause for respiratory distress.
- The need for increased respiratory and/or other organ support.

Increased respiratory support needed and HHFNC considered.

- Obtain CBG/VBG and CXR prior to initiation.
- Inform Paediatric Consultant and nursing management.
- Consider PICU/anaesthetic review if severe distress.

Initiating Treatment:

Are there contraindications to HHFNC?

- Respiratory acidosis with pH < 7.25
- Blocked nasal passages e.g. choanal atresia
- Trauma
- Injury to the nasopharynx
- Air leak (e.g. pneumothorax)
- Life threatening hypoxia

If YES to any of the above, patient needs urgent PICU / anaesthetic referral.

If NO contraindication present: Commence HHFNC according to the guideline below and use Table 1 below to determine appropriate settings for age.

INITIATION

(Please see algorithm for quick reference)

HHFNC may be considered appropriate when a child with acute viral bronchiolitis displays persistent signs of moderate to severe respiratory distress despite conventional therapy e.g. low flow nasal cannula oxygen, normal saline or hypertonic saline nebulisers.

The decision to initiate HHFNC therapy may be made by a paediatric registrar in consultation with the paediatric consultant on call. It is not necessary to make the PICU / anaesthetic team on call aware of all patients commencing on HHFNC. However, commencement of HHFNC does not mitigate the need for PICU / anaesthetic review for children with severe respiratory distress and/or who are rapidly deteriorating or for children who the paediatric registrar on call has specific clinical concerns about.

The clinical nurse manager and/or senior nursing staff (out of hours) must also be informed once HHFNC has been commenced.

For the initiation of HHFNC in patients with underlying congenital cardiac defects or ex-premature infants with chronic lung disease or other defined respiratory pathology, please see special considerations.

COMMENCING THERAPY

- Baseline CXR and CBG or VBG must be obtained
- An NGT must be inserted and aspirated as outlined below.
- The high flow system should be commenced at the settings according to Table 1 below.

ESCALATION

HHFNC therapy should be escalated as outlined in Table 1 below, at or before 2 hours, following paediatric registrar review if:

- Respiratory distress / hypoxaemia persist
- SpO_2 persistently < 92%.
- Any increase in the respiratory component of the PEWS from the initial baseline.
- Where PEWS is not in use, the equivalent is persistent increased respiratory rate for age with no improvement in respiratory effort.

If the HHFNC is escalated appropriately according to the age of the patient they should display signs of stabilisation two hours following initiation or escalation of HHFNC therapy in line with the table below.

If there is no improvement despite escalation as per the table the patient can be considered to have failed HHFNC and PICU / anaesthetics review is warranted and admission to PICU should be considered for alternative respiratory support.

Table 1. Guide for initiation and escalation of HHFNC Therapy

	0 – 1 month	1 – 12 months	1 – 4 years	5 years and above
Initial settings	2L/kg/min with FiO_2 of 40%	8L per minute with FiO_2 of 40%	10L per minute and FiO_2 of 40%	12L per minute and FiO_2 of 40%
First escalation of therapy*	Increase flow rate by a further 2L per minute	Increase flow rate to 10L per minute	Increase flow rate to 12L per minute	Increase flow rate to 16L per minute
Second escalation of therapy*	Increase FiO_2 to 50% if SpO_2 < 92%	Increase FiO_2 to 50% if SpO_2 < 92%	Increase FiO_2 to 50% if SpO_2 < 92%	Increase FiO_2 to 50% if SpO_2 < 92%
Third escalation of therapy*	Increase FiO_2 as needed to maintain SpO_2 > 92% with referral to PICU	Increase FiO_2 as needed to maintain SpO_2 > 92% with referral to PICU	Increase flow rate to 15L per minute	Increase flow to 20L per minute
Fourth escalation of therapy*	N/A	N/A	Increase FiO_2 as needed to maintain SpO_2 > 92% with referral toPICU	Increase FiO_2 as needed to maintain SpO_2 > 92% with referral to PICU
Maximum Flow**	10L/min	10 L/min	15 L/min	20 L/min

** Flow rate can be escalated above the maximum rate for age at the discretion of a Paediatric Intensivist*

SIGNS OF STABILISATION

Within two hours clinical signs of stabilisation should be seen and can be measured according to the following parameters:

- FiO_2 required to maintain SpO_2 in the target range should decrease to <40%.
- Heart rate should reduce by 20% or be within the normal range for age.
- Respiratory rate should reduce by 20% or be within the normal range for age.

- Clinical signs of respiratory distress should improve (e.g. recessions, nasal flaring, tracheal tug).
- Consider a repeat CBG/VBG

ACUTE DETERIORATION ON HHFNC

Urgent medical review required if any of the following occur:

- Sudden worsening of respiratory distress and/or SpO_2 - urgent CXR should be performed to exclude a pneumothorax.
- Recurrent / frequent apnoea and or bradycardia.
- Persistent hypoxaemia despite adequate escalation of FiO_2 / Flow.
- Sudden deterioration in patient's overall condition.

NURSING CARE OF PATIENT ON HHFNC

All nursing staff must work within the scope of their professional practice; it is their responsibility to know the limits of their practice relating to the care of a child requiring HHFNC and to seek advice from a senior nursing colleague and/or medical staff to ensure the best outcome for the patient.

- When fitting the nasal cannula there should always be a visible gap around the cannula when fitted in the nares.
- Confirm that nasal cannula remains in the correct position and that there are no pressure areas.
- Gentle suction may be needed to keep nostrils patent.
- Oral and nasal care should be performed 4 hourly, to ensure that nostrils do not occlude.

An NGT must be inserted prior to commencement of HHFNC to minimise abdominal distension.

- The NGT should be aspirated every 2 – 4 hours.
- Once patient has stabilised on high flow they should be assessed as to whether or not they can feed (either PO or via NGT) by medical staff. Comfort feeds orally may be tolerated but most patients will require NGT feeding.
- If infants have not clinically stabilised and therapy is being escalated they should be commenced on maintenance IV fluids.

Minimal handling.

PATIENT MONITORING

- Continuous monitoring of SpO_2 and HR via pulse oximetry with hourly recording.
- In the first two hours of therapy monitor the patient every 15 minutes for a response in the following parameters: RR, HR, SpO_2, respiratory distress and work of breathing.
- Observations must be documented clearly and include the flow of oxygen (L/min), the FiO_2 and the humidifier temperature.

WEANING THERAPY

Consideration of weaning of HHFNC can be made when the patient is no longer felt to be in moderate-severe respiratory distress. Weaning can be performed as outlined below:

- First wean FiO_2 to 40%.

- Monitor and document SpO_2, RR, HR and respiratory distress (if any) after each change in FiO_2.
- Inform senior nursing and medical staff if there is any deterioration in respiratory/cardiovascular status – therapy may need to be increased.
- Once the child is stable and using an FiO_2 of < 40%, standard low flow nasal cannula oxygen can be used, there is no need to wean flow rate (Flow rate can be weaned at the discretion of the supervising Consultant if felt to be warranted).

SPECIAL CONSIDERATIONS

Cardiology: Certain patients with congenital cardiac defects may be suitable candidates for HHFNC therapy. This can only be commenced in this population following discussion with the consultant paediatric cardiologist on-call after any other necessary investigations/treatments required have been performed. Consideration should also be given to informing the PICU team on call.

Target SpO_2 levels will be patient specific in this population and must be clearly documented prior to initiation of therapy. Over-oxygenation can be a risk in patients with underlying cyanotic defects so maximum SpO_2 levels tolerated must also be determined with review of HHFNC if this is exceeded (Usually target range for SpO2 of 75–85% in cyanotic cardiac disease with balanced circulation).

HHFNC oxygen can only be used on Cardiac patients who are on the Children's Heart Centre or in PICU as an experienced nurse is required.

- FiO_2 is commenced at 0.21 (21%)
- Flow is titrated by weight as with any other patient
- If FiO_2 between 0.21 and 0.3 (30%) is required patient should again be discussed with Cardiology team and be reviewed by PICU

- If FiO_2 greater than 0.3 (30%) required patient should be reviewed by PICU.

Neonatology: There is good evidence for the use of HHFNC therapy being used as a primary form of non-invasive respiratory support or as a weaning tool post invasive or non-invasive ventilation for preterm infants being cared for on a neonatal intensive care unit (NICU). Outside of this setting, HHFNC therapy is often used as a means of respiratory support on the wards to infants with chronic lung disease of prematurity that have persistent hypoxaemia. The initiation of HHFNC therapy in this setting should be only be done in consultation with the consultant neonatologist on call.

The commencement, monitoring and weaning of HHFNC therapy in the ED in this setting is not covered by this guideline and if there are signs of clinical deterioration in a patient who has been previously stable and maintained on HHFNC on the wards, then the consultant neonatologist on call should be aware of their clinical status. In these circumstances, early escalation of care and referral to the PICU team on call should be considered. It is important to note that these patients may have abnormal blood gases at baseline and it is the change from baseline that should be noted.

If an ex-premature infant with a history of chronic lung disease of prematurity or other significant respiratory pathology and/or cardiac lesion e.g. VSD / PDA and/or on low flow home oxygen therapy, present to the ED with symptoms of acute viral bronchiolitis and HHFNC therapy is being considered as a treatment option, then the consultant neonatologist on call should be informed of their presentation. For these infants, the protocol for initiation of HHFNC therapy can be followed as per this guideline with the caveat that this is a vulnerable patient population and that early escalation of care and referral to the PICU team on call should be considered.

USEFUL LINKS

1. Standard Operating Procedure for HHFNC
2. http://www.pmh.health.wa.gov.au/development/manuals/clinical_practice_guidelines/documents/CPG_HumidifiedHighFlowNasalCannulaTherapyForChildren.pdf
3. http://www.rch.org.au/picu/about_us/High_Flow_Nasal_Prong_HFNP_oxygen_guideline/
4. http://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Oxygen_delivery/
5. http://www.nice.org.uk/guidance/ng9/evidence/full-guideline-60851053