High Flow Nasal Cannula Use in Patients Outside of the Intensive Care Unit

Kathy Kalkbrenner, MD
Rosanne Salonia, MD
Kara Denz Fluck, PA-C
What is a Clinical Pathway?

An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective, and consistent patient care.
Objectives of Pathway

• To define the criteria for patients on high flow nasal cannula (HFNC) who may be appropriate to initiate and manage outside of the ICU
• To outline the management for titration and weaning of respiratory support
• To review the feeding and monitoring guidelines for this group of patients
• To identify the circumstances under which a Medical Emergency Team (MET) should be activated
Why is Pathway Necessary?

• To ensure an optimal, consistent approach to the medical management of acute respiratory illness patients who require HFNC therapy
Overview

• High flow oxygen therapy is defined as oxygen delivered at flow rates that meet, or exceed, the inspiratory flow demands of the patient

• At Connecticut Children’s, we utilize the Fisher Paykel Optiflow, and Optiflow Jr. nasal cannula setups for delivery of oxygen via HFNC

• The device can be broken down into four main components
  o Blender
  o Humidifier
  o Circuit
  o Nasal Interface
How Does It Work?

• Standard methods of oxygen therapy provide either no humidity, or passive cooling systems (bubble humidifier). Aside from not being able to provide enough flow, improper heating/humidification can lead to:
  o Inflammation of the airways
  o Impaired mucociliary function
  o Increased caloric expenditure to warm and humidify air manually

• The Optiflow system heats and humidifies all gas passed through the system, while using high enough flow rates to flush out anatomical dead space, subsequently converting it to a reservoir of fresh humidified gas for the next breath
  o Minimizes oxygen dilution
  o Minimizes rebreathing of CO2
  o Minimizes patient caloric expenditure
• HFNC devices have also shown the ability to increase functional residual capacity (FRC), or lung volume at end expiration
  o Normally a function of PEEP
  o Evidence suggests that HFNC devices provide some level of PEEP, but it is not directly set
  o Possible mechanism of action for improved WOB

• A commonly heard reference is that 10LPM of flow will provide around 1cmH2O of PEEP, but is that really true?
  o Many factors need to be considered
    – Patient size
    – Cannula size
    – Mouth open/closed
    – Liter flow

• In short, patients can receive little PEEP, sufficient PEEP, or excessive PEEP depending on these factors, and must be monitored diligently
Blender

• The air-oxygen blender is the control for FiO2 delivery
• The operator, by dialing desired FiO2, controls patient oxygenation
• The blender will have two oxygen flow meters connected to it
  o One flow meter will increase by increments of 10
  o One flow meter will increase by increments of 1
  o Dual flow meters allow for exact titration of desired flow
• The blender, in order to work properly, must have high pressure connections of both air and oxygen to a wall gas source
  o Patient transports can be done with an oxygen tank at 100% FiO2
• Unlike a standard nasal cannula, flow rate does not control oxygenation
  o Because flow typically meets or exceeds demand, air entrainment is not a factor
Humidifier

- The humidifier warms inspired gas, working as an artificial nose for patients on HFNC support.
- Gas is heated to 37 degrees Celsius in the chamber, increasing the temperature to 40 degrees Celsius at the proximal probe:
  - Temperature gradient increases water vapor retention to reduce condensate.
  - Humidity and temperature control/promote secretion hydration, cilia movement, and normal physiologic airway conditions.
- The humidifier should be set to “invasive mode”, despite being a non-invasive device:
  - High flow rates must be humidified to that temperature because the nose is unable to compensate.
- Alarms are usually associated with chamber water level, or probe disconnection.
Circuit

• Pictured is the Optiflow Jr. circuit
  o The Optiflow (large pedi/adult patients) uses a similar set-up, but larger bore tubing
    – Standard ventilator inspiratory limb

• The circuit has 4 main components
  o Tygon, or oxygen tubing, connecting the flow meters to the manifold, which is connected to the “dry” side of the humidifier
  o The high pressure manifold has a high pressure pop-off designed to engage at 40 cmH2O. During normal use there should be no sound or air emitting from it
    – For the Optiflow circuit, the manifold may be replaced with a straight adapter and connector to provide higher flow rates
  o The circuit tubing is single limb, heated wire, and sources from the “wet” side of the humidifier
  o Plastic clip to affix the tubing to bed sheets, or parent clothing while holding

HFNC
Nasal Interface

• The Optiflow Jr cannulas come in various sizes, based on the size of the child
  o Color coded, and the circuit connects at the colored hub

• Cannulas are only rated to deliver set amounts of flow, according to the sizing chart
  o Exceeding flow rate will cause pressure build up in the circuit
  o Respiratory will set up both the device and the cannula

• Optiflow Cannulas come in small, medium, and large sizes, and can deliver up to 60LPM of flow

<table>
<thead>
<tr>
<th>F&amp;P OPTIFLOW JUNIOR NASAL CANNULA</th>
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<tbody>
<tr>
<td>PRODUCT SIZE</td>
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<tr>
<td>Premature</td>
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<tr>
<td>Infant</td>
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<td>Pediatric</td>
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</table>
Nasal Interface Application

- Optiflow Jr. Cannulas are applied by removing the tab from the back of pads, and applying them to the child’s face
  - Warming in hands first = easier application
  - Does not need to go over the ears/under chin like standard cannula
    - Flexible coils allow for over the head application, and the cannula can be tightened (loosely) to secure around the back of the patient’s head

- Optiflow should be placed in the nares, with the strap going over the top of the patient’s head, and tightened to an appropriate level for proper securement

- Nares should not be fully occluded!!
  - May cause excessive airway pressures
  - May cause difficulty exhaling
  - May cause septal breakdown
Remember

- Clinical Pathway for HFNC Use Outside of the ICU can be found on the Connecticut Children’s Clinical Pathways internet page
- Don’t hesitate to contact respiratory if questions, issues, or concerns arise regarding:
  - Alarms
  - Settings
  - Circuit Setup
  - Humidifier Setup
  - Need for replacement parts (wiggle pads/cannula)
Deep Suctioning

- Nasotracheal or deep suctioning is defined as suctioning past the posterior pharynx and through the vocal cords into the trachea.
- Nasotracheal suctioning is necessary when a patient is unable to effectively mobilize pulmonary secretions and does not have an artificial airway.
Open suction kit or catheter using aseptic technique. Do not allow the suction catheter to touch any nonsterile surfaces.

Secure catheter to tubing aseptically. Coat distal 2-3 inches of catheter with water-soluble lubricant (K-Y Jelly/Lubricant).

Estimate depth of insertion based on the distance from the patient’s nose to the base of the earlobe and then down to the thyroid cartilage as a guide.

Remove oxygen delivery device with non-dominant hand. Without applying suction, and using the dominant thumb and forefinger, gently but quickly insert the sterile catheter into either naris during inhalation with a slight downward slant.

Remember that the epiglottis is open during inspiration and facilitates insertion of the catheter into the trachea.
• Do not force the catheter. Try the other naris if insertion meets resistance or is difficult to insert.

• Apply intermittent suction by placing and releasing non-dominant thumb over the vent of catheter. Slowly withdraw the catheter while rotating it in a circular motion with suction on for as long as 10-15 seconds.

• Assess the need to repeat suctioning procedure. Allow adequate time between suction passes for ventilation and oxygenation. Keep oxygen readily available in case the patient exhibits signs of hypoxemia. Administer oxygen to the patient between suctioning attempts.

• When the pharynx and trachea are cleared of secretions, perform oral suctioning to clear the mouth of secretions. Do not suction the nose or trachea after suctioning the mouth.

• Deep suctioning may cause trauma and/or edema to the mucosa. Discontinue deep suctioning if bleeding occurs, until discussed with the physician/practitioner.
How To Find HFNC Data in Epic

### Oxygen Therapy

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<th>Value 1</th>
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<th>Value 3</th>
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### Procedures

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<td>Location - orientation</td>
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<td>Associated Signs/Symptoms</td>
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This is the High Flow Nasal Cannula Use in Patients Outside of the Intensive Care Unit Clinical Pathway.

We will be reviewing each component in the following slides.

CLINICAL PATHWAY: High Flow Nasal Cannula Use in Patients Outside of the Intensive Care Unit

Initiation criteria:
- High Flow Nasal Cannula (HFNC) support initiated for de novo hypoxicemic patients
- Maintenance flow rate 25-30 liters per minute (LPM) depending on the HFNC device capabilities
- Maintenance P/F > 100 or maintain NIV of NCPAP

Conclusion Criteria:
- Patients meeting criteria for nasal cannula support are excluded from this pathway and need be admitted to the PICU.
- Consider PICU consultation prior to initiating HFNC support in other high-risk scenarios (e.g., intubation, sepsis, respiratory arrest)

When supported with HFNC in the PICU:
- The patient will be monitored for HFNC support and other high-risk scenarios (e.g., intubation, sepsis, respiratory arrest)
- Consider PICU consultation prior to initiating HFNC support in other high-risk scenarios (e.g., intubation, sepsis, respiratory arrest)

Sweat:
- HFNC is a method of delivering humidified gas to the patient, which is warmed to a temperature of 37°C and humidified to 100% relative humidity
- The patient is typically monitored in a medical setting, such as a hospital or clinic, and the HFNC device is typically located in the patient's room
- HFNC support is typically provided on a medical ward, where the patient is being monitored by nurses and doctors
- HFNC support is typically provided for a prolonged period, such as several days or weeks

Monitoring:
- HFNC is a method of delivering humidified gas to the patient, which is warmed to a temperature of 37°C and humidified to 100% relative humidity
- The patient is typically monitored in a medical setting, such as a hospital or clinic, and the HFNC device is typically located in the patient's room
- HFNC support is typically provided on a medical ward, where the patient is being monitored by nurses and doctors
- HFNC support is typically provided for a prolonged period, such as several days or weeks

Feeding:
- HFNC is a method of delivering humidified gas to the patient, which is warmed to a temperature of 37°C and humidified to 100% relative humidity
- The patient is typically monitored in a medical setting, such as a hospital or clinic, and the HFNC device is typically located in the patient's room
- HFNC support is typically provided on a medical ward, where the patient is being monitored by nurses and doctors
- HFNC support is typically provided for a prolonged period, such as several days or weeks

Contact:
- For any questions or concerns, please contact the PICU team.
- PICU can be contacted at 123-456-7890.
- For urgent matters, please dial 911 or your local emergency services.

Note: This document is for informational purposes only and does not replace clinical judgment.
Inclusion Criteria:
- High Flow Nasal Cannula (HFNC) support indicated for acute respiratory illness
- Maximum flow rate ≤3 LPM/kg (max 45 LPM)
- Maximum FiO2 of 50% to maintain SpO2 of ≥92%

Exclusion Criteria:
- Patients receiving continuous albuterol who also require HFNC support are excluded from this pathway and must be admitted to the PICU.
- Consider PICU consultation when initiating HFNC support in other high risk populations (e.g., intermittent apnea, significant neuromuscular weakness).

HFNC support can be initiated outside of the ICU for an acute respiratory illness, as long as the following are adhered to:

- Maximum flow rate ≤3 LPM/kg (max 45 LPM).
- **Note:** Any flow rate that is over 45 LPM must be approved by the attending physician.
- Maximum FiO2 of 50% to maintain SpO2 of ≥92%
Those initiated on HFNC typically respond clinically within 1 hr of initiating therapy.

Lack of improvement in respiratory status despite HFNC warrants ICU consultation.
- Supplemental oxygen (FiO2) should be titrated to maintain a minimum SpO2 of 92%
- Physicians, APPs, Nurses, and RTs may titrate O2
- Oxygen should be weaned first before any flow changes

GOAL:
- Maintain SpO2 of 92%

WEANING:
- Oxygen should be weaned for SpO2>92%

Physicians, Advanced Practice Providers, Nurses, and Respiratory Therapists may titrate O2
**Initiation/Titration of Flow:**

- Initial flow rates of 2 LPM/kg are recommended, with increases to a max of 3 LPM/kg (max 45 LPM) PRN.
- Any patient with significant WOB despite 3 LPM/kg should be evaluated by the ICU.
- RT, physicians or APPs may decrease or increase flow as clinically indicated at bedside.

**Weaning Flow:**

- Weaning should be initiated when WOB improves and stable HR/RR.
- Once a patient has stable HR/RR/WOB at 4 LPM, transition to a conventional nasal cannula or RA.

**Initiation/Titration:**

- Initial flow rates of 2 LPM/kg are recommended. The flow rate may be increased based on the patient’s work of breathing to a maximum of 3 LPM/kg (max 45 LPM).
- Flow rates above 45 LPM require discussion with/approval by the attending physician.
- Patients with significant work of breathing despite this level of support warrant evaluation by the PICU team.
- Respiratory therapists, physicians, and advanced practice providers may increase the flow as needed.

**Weaning:**

- Wean decreases in flow when:
  - WOB is improved; HR/RR may be elevated for age but are stable.
  - Assess for readiness to wean at regular intervals (at least once/shift).

**Weaning Strategy:**

- For patients with mild-moderate WOB, decrease flow by 50-100% and observe for changes in work of breathing and vital signs. If after several minutes the patient remains comfortable, update the HFNC orders (if RT weans, page resident to update order accordingly) and communicate changes to the bedside nurse.
- Respiratory therapists, physicians, and advanced practice providers may perform bedside weaning of flow.
Treatments and feeds should be clustered as much as possible to allow for the patient to have periods of rest.

Consider the following respiratory treatments based on clinical condition:
- Aerosolized hypertonic saline
- Chest physiotherapy
- Deep suctioning

*Recommend cluster care of CPT, Nebs, and suctioning to allow for periods of rest
• Patients will be “WATCHER” status until flow rates are being weaned

• PEWS scores should be documented per policy
  • Note that PEWS scores may be greater than 7 due to flow rates rather than clinical deterioration

WHEN TO CALL A MET:
• Team member or family concern about the patient’s clinical status
• Oxygen demand exceeds 50% FiO2
• More than moderate work of breathing on 3LPM/kg (max 45LPM)
• PEWS > 10 after an hour on maximum flow of 3LPM/kg (max 45LPM)
• Initiate feeds when there is an improved WOB
• IV hydration may be preferable based on patient
It is important to closely monitor a patient's clinical status while on the floors and requiring HFNC support.

A MET activation is indicated in the following situations:

- Staff and/or family concern for patient's clinical status
- Oxygen demand exceeds 50% FiO2
- More than moderate WOB on 3 LPM/kg (max 45 LPM)
- PEWS > 10 after an hour on max flow of 3 LPM/kg (max 45 LPM)

**WHEN TO CALL A MET:**
- Team member or family concern about the patient’s clinical status
- Oxygen demand exceeds 50% FiO2
- More than moderate work of breathing on 3LPM/kg (max 45LPM)
- PEWS > 10 after an hour on maximum flow of 3LPM/kg (max 45LPM)
Patients may be ready for discharge when:

- Stable on room air 90-92% or greater for more than 4 hours
- Tolerating PO intake without need for IVF or NGT support
- Caregiver education complete
- Appropriate follow up in place

DISCHARGE CRITERIA:

- SpO2 in room air 90-92% for greater than 4 hours
- Tolerating PO intake/no need for IV fluids or NGT support
- Age appropriate RR with comfortable WOB
- Caregiver education complete
- Appropriate follow up in place
Provider Roles

Respiratory Therapist (RT):
- In charge of HFNC equipment set-up
- Every 4 hour checks on patient, administers nebulizer treatments, chest physiotherapy and deep suctioning
- May decrease or increase flow as clinically indicated and communicate with provider team and RN
- May adjust oxygen (FiO2) for SpO2 of >92% and communicate with RN
- Communicate with house staff every 4 hours about patient’s status and any potential changes to care plan
- Responsible for documentation of HFNC in EPIC

Nursing Staff:
- May wean oxygen (FiO2) if patient is clinically stable
- Administer chest physiotherapy and/or deep suctioning as needed for the patient if RT is unavailable
- Communicate with house staff and RT about patient’s status and potential changes to care plan
- Document any changes in FiO2 that they or the providers make on rounds and during the day

Providers (attending physician, advanced practice providers and house staff):
- Assess patient with RT and RN at least every 4 hours and communicate clearly about care plan
- May decrease or increase flow as clinically indicated, put in orders pertaining to flow changes and communicate with RT and RN
- May adjust FiO2 and communicate with RN to document change
Review of Key Points

• This pathway is for acute respiratory illness patients who require HFNC outside of the ICU

• Continue patients on WATCHER status until flow rates are being decreased

• Cluster respiratory treatments and feeding if possible

• Have a low threshold to call a MET if a patient is clinically worsening and has the need for escalated care
Use of Order Set

- Please make sure to use the order set associated with this pathway to ensure pathway adherence
- Preselected items in the order set include Initiate Pathway and MET activations
Quality Metrics

- Percentage of patients with use of HFNC order set
- Average number of days on HFNC (PICU)
- Average number of days on HFNC (Med/Surg)
- Percentage of patients requiring increase in respiratory support on med/surg units (increased flow rates)
- Percentage of patients with MET activations who had HFNC initiated on med/surg floors
- Percentage of patients requiring transfer to the PICU
- Average length of stay
Pathway Contacts

• Kathy Kalkbrenner, MD
  o Pediatric Hospital Medicine

• Rosanne Salonia, MD
  o Pediatric Intensive Care

• Kara Denz Fluck, PA-C
  o Pediatric Hospital Medicine
References


The Clinical Pathways Program at Connecticut Children’s aims to improve the quality of care our patients receive, across both ambulatory and acute care settings. We have implemented a standardized process for clinical pathway development and maintenance to ensure meaningful improvements to patient care as well as systematic continual improvement. Development of a clinical pathway includes a multidisciplinary team, which may include doctors, advanced practitioners, nurses, pharmacists, other specialists, and even patients/families. Each clinical pathway has a flow algorithm, an educational module for end-user education, associated order set(s) in the electronic medical record, and quality metrics that are evaluated regularly to measure the pathway’s effectiveness. Additionally, clinical pathways are reviewed annually and updated to ensure alignment with the most up to date evidence. These pathways serve as a guide for providers and do not replace clinical judgment.