وزارة الصحة
Ministry of Health

Adult High-Flow Oxygen Therapy Protocol

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1. Background

Acute respiratory failure is one of the most common causes of Intensive Care Unit (ICU) admission. Mechanical ventilation is a common intervention for 61% of acute respiratory failure. Other common condition that requires mechanical ventilation includes a decreased level of consciousness, respiratory failure, and post-operative failure of Extubation.
Tracheal intubation and mechanical ventilation are not without risk and adverse outcomes as barotrauma, hemodynamic instabilities, ventilator-associated events, and pneumonia. It usually requires an ICU bed and a high nurse-to-patient ratio.
High Flow Nasal Cannula (HFNC) is a non-invasive respiratory support. It can deliver a mix of air and oxygen with an inspired oxygen fraction (FiO2) ranging between 0.21 and 1.0 at a flow rate of up to 60 L/minute. The physiological benefits of HFNC are improved oxygenation, decreased anatomical dead space, decreased metabolic demand of breathing, decreased production of carbon dioxide, superior comfort, and improved work of breathing, positive nasopharyngeal and tracheal airway pressure, and better secretion clearance.
HFNC can be used in different clinical settings, including emergency departments, intensive care units, outpatient, and procedural settings. It has been gaining popularity, probably due to how easy it is to use, its high tolerability, and the possibility of applying it outside the ICU setting.

2. Purpose

To establish a standardized, evidence-based procedure for the safe and effective administration of High Flow Oxygen Therapy (HFOT) for eligible patients. This protocol applies to all trained clinical staff (Physicians, Respiratory Therapists, Registered Nurses involved in the initiation, monitoring, and weaning of HFOT

3. Definitions

HFOT: is a treatment that delivers a heated (37°C) and humidified mixture of oxygen and air at high flow rates (10-60 liters per minute) through a specialized nasal cannula. This approach provides a continuous positive airway pressure (CPAP) effect, which improves lung recruitment and oxygenation.

Fraction of Inspired Oxygen (FiO_2): The concentration of oxygen delivered, expressed as a percentage (21%-100%).
Flow Rate: The velocity of the gas mixture, measured in liters per minute (L/min).
Peak Inspiratory Flow (PIF): The maximum flow rate generated by a patient during inspiration. HFOT aims to match or exceed this.
Positive End-Expiratory Pressure (PEEP) Effect: The washout of anatomical dead space and generation of a small level of positive airway pressure (typically 2-5 cm H_2O) due to the high flow.
The ROX Index is a validated bedside tool used to predict the likelihood that a patient will respond successfully to High-Flow Oxygen Therapy (HFOT/HFNC). It incorporates three readily available clinical parameters—oxygen saturation (SpO_2), respiratory rate (RR), and fraction of inspired oxygen (FiO_2)—into a single numerical value.

4. Physiological Mechanisms of Action

HFOT provides therapeutic benefits through several key mechanisms:

1. Reduction of Anatomical Dead Space: The high flow rate flushes out the CO_2-rich gas in the nasopharynx at the end of expiration, improving ventilatory efficiency and reducing the work of breathing.
2. **HFOT** ensures that flow rates are sufficient to match or exceed the patient's peak inspiratory flow. This effectively eliminates the entrainment of room air, guaranteeing that the fraction of inspired oxygen (FiO_2) delivered is the actual FiO_2 that the patient receives.
3. Generation of Low-Level PEEP: The resistance to the high flow generates a positive pharyngeal pressure, which can stents open the alveoli, reduce atelectasis, and counteract intrinsic PEEP (auto-PEEP) in obstructive lung disease.
4. Improved Secretion Clearance: Full active humidification to 100% Relative Humidity at body temperature (44 mg H_2O/L) prevents mucosal drying, improves ciliary function, and aids in the mobilization of thick secretions.
5. Reduction of Work of Breathing: By meeting the patient's inspiratory flow demand and improving compliance through the PEEP effect, the work of the respiratory muscles is significantly decreased.

5. Indications for HFO Therapy

HFOT is indicated for the management of acute hypoxemic respiratory failure in adults, where it may prevent the need for invasive mechanical ventilation.

a) Hypoxemic Respiratory Failure: Evidence of severe hypoxemia, typically defined as: SpO2 < 90% despite standard oxygen therapy or ABG PaO2 < 60 mmHg, for example:

   i. Strong evidence supports using HFOT
      1. Pneumonia
      2. Prevention of Intubation: In patients with progressive respiratory distress (ARDS), high-flow oxygen can be used as a bridge to avoid invasive ventilation.
      3. Covid-19
      4. Post-Extubation Support: Patients recovering from surgery, especially those at risk for respiratory complications, may benefit from high-flow oxygen therapy.

   ii. Conditional or limited evidence: In certain situations—and only under the supervision of a pulmonologist or intensivist within an ICU setting—HFOT may be considered, although robust supporting evidence is currently lacking.
      1. COPD hypercapnic failure (HFNC is non-standard vs NIV)
      2. Acute asthma (very limited evidence)

Acute Heart Failure / Pulmonary Edema | The PEEP effect can reduce left ventricular afterload and improve oxygenation.

b) Rox index:

Predictor for HFOT:

i. The benefits of the ROX Index include its non-invasive nature, quick and easy calculations, and utility in resource-limited or high-census settings. It standardizes decision-making across teams. However, it is crucial to recognize that the ROX Index should not be used as a stand-alone decision-making tool; clinical assessment remains essential.

ii. Additionally, it does not directly measure ventilation or CO_2 clearance and has not been validated for primary hypercapnic respiratory failure, such as COPD exacerbation.

iii. It incorporates three readily available clinical parameters—oxygen saturation (SpO_2), respiratory rate (RR), and fraction of inspired oxygen (FiO_2)—into a single numerical value.

Formula: $$\textbf{ROX Index} = \frac{SpO_2/FiO_2}{\text{Respiratory Rate}}$$

Recommended Monitoring Schedule: Evidence-based practice suggests calculating ROX at:

I. Baseline (before HFOT)
II. 1–2 hours after initiation
III. 6 hours
IV. 12 hours
V. Then at least every 6–8 hours, or more frequently if unstable
VI. Trend is more important than a single value.

Interpretation Thresholds: Guidelines recommend integrating early prediction tools such as

1. ROX Index ($SpO_2/FiO_2 \div RR$) at 2, 6, 12 hours
2. ROX < 3.85 → high risk of HFNC failure
3. ROX 3.85–4.88 → intermediate
4. ROX > 4.88 → low risk for failure

Indicators that HFOT is Working (ROX ↑)

- Improving ROX over time
- Rising SpO_2/FiO_2 ratio
- Falling respiratory rate
- Stabilizing work of breathing

Indicators of Possible HFOT Failure (ROX ↓)

- ROX worsening over serial measurements
- Increasing FiO_2 requirement
- Persistent tachypnea (RR > 30–35/min)

Clinical deterioration (altered mentation, fatigue, hemodynamic instability)

6. Procedure

1. **Selection of the proper cannula size**

High-flow nasal cannulas come in various sizes to accommodate infants, children, and adults. The intended use determines the size selection, as well as the internal diameter of the prongs, which influences oxygen flow delivery. Selecting the correct size of the high-flow nasal cannula (HFNC) is crucial for ensuring effective oxygen delivery and patient comfort.

a) Sizing Based on Patient Age

- **Adult Patients:**
  - Adult Cannulas: Generally, for individuals aged 13 years and older, with distinct adult sizes (small, medium, large) based on the nasopharyngeal anatomy.
  - Consider the patient's overall size and weight when selecting; larger adults may require a larger cannula size for optimal fit and effective oxygen delivery.

b) Measuring for Proper Fit

- **Assess Nasal Anatomy:**
  - Examine the patient's nostrils, noting any anatomical considerations such as the width and depth of the nasal passages.
  - The prongs should comfortably fit into the patient's nostrils without causing pain or excessive pressure.
- **Trial Fit:**
  - If feasible, perform a trial fit of different sizes of nasal cannulas. Choose the size that best meets the patient's comfort and oxygen delivery needs.
  - The cannula should allow for adequate airflow without excessive obstruction or leakage, and the patient should feel comfortable with the device in place.

c) Considerations for the Selection Process

I. **Patient Comfort:**

Ensure that the cannula is comfortable for extended wear.

Oxygen Flow Requirements:

The size of the cannula may affect the maximal flow rate delivered. Confirm that the selected size is compatible with the flow rates needed for high-flow therapy.

II. **Manufacturer Guidelines:**

Always refer to the manufacturer's sizing charts and guidelines for specific recommendations based on the brand of nasal cannula used, as sizing may differ among products.

d) **Preparation:**

i. **Nasal Cannula Placement:**

1. Insert the nasal prongs into the patient's nostrils gently, ensuring a snug fit while minimizing discomfort.
2. The position of the prongs should allow for free airflow, check for any obstruction.

ii. Equipment Check; Ensure Availability of Required Equipment

1. HFOT Device: (high-Flow Nasal Cannula (HFNC)
    a. Specific, Sized HFNC Nasal Cannula (see fitting section).
2. Single-Use Breathing Circuit: Heated inspiratory limb with integrated temperature probe.
3. Humidifier (if utilizing HFNC).
4. Single-Use Humidification Chamber.
5. Sterile or Distilled Water.
6. Oxygen and Air Source (wall outlet or blender).
7. Pulse Oximeter.
8. Emergency Equipment: Suction, bag-valve-mask, and intubation equipment must be readily available.
9. Flow meter and pressure relief valve.

7. Initiating Therapy: Step-by-Step Protocol

Patient Assessment and Preparation

1. Verify the physician's order for HFOT.
2. Review the Indication for HFO
3. Obtain baseline vital signs: respiratory rate, heart rate, blood pressure, temperature, recent ABG if available, and oxygen saturation (SpO2).
4. Conduct a thorough clinical evaluation, work of breathing (accessory muscle use, respiratory rate), level of consciousness, and ability to protect the airway, including review of the patient's medical history, comorbidities, and medications
5. Ensure the therapy is ordered by a qualified healthcare provider, specifying high-flow oxygen delivery.
6. Patient and Family Education: Explain the procedure, benefits, and sensations (warm, humidified air) to the patient and family to ensure cooperation.

Equipment Preparation

1. Place the HFOT device on a secure stand near the patient.
2. Fill the humidification chamber with sterile/distilled water to the indicated line.
3. Connect the breathing circuit to the device and the humidification chamber.
4. Connect the circuit to the gas source (oxygen/air blender).
5. Power on the device. It will perform a self-check.
6. Prime the circuit by setting initial parameters (see Step 3) and allowing it to reach the target temperature (typically 37°C). This takes 2-5 minutes.

8. Setup and Administration

Initiation

- Ensure all equipment is functioning properly and the appropriate device is selected based on patient needs.

- Position the patient in a comfortable upright position to facilitate breathing:

Primary Position:

Semi-Fowler's (Head of Bed elevated 30-45°) or High Fowler's (45-90°). This position maximizes lung expansion by lowering the diaphragm, reducing pressure from the abdomen on the chest, and improving ventilation-perfusion (V/Q) matching. It is essential for optimizing the PEEP effect generated by HFOT.

Alternative Position:

Lateral Decubitus (on the side).It can be used for patient comfort and to prevent pressure injuries. The PEEP effect and gas exchange are still maintained, though potentially less effectively than in an upright position.

Position to AVOID:

Supine (Flat on Back). In a supine position, the abdominal contents push against the diaphragm, restricting lung expansion (reduced functional residual capacity). This can worsen atelectasis and hypoxemia, counteracting the benefits of HFOT. It also significantly increases the risk of aspiration.

7. Select the appropriately sized nasal cannula. The prongs should fit comfortably in the nares without excessive leakage. (See section – nasal canula)
8. Gently insert the nasal prongs into the patient's nostrils, making sure they fit snugly and comfortably. Finally, secure the cannula with the adjustable head strap.
9. Adjust the cannula to avoid pressure sores, especially around the ears and nose.
10. Connect the HFNC device to the oxygen source and ensure the humidifier is filled with sterile water as per the manufacturer's instructions.
11. FiO_2: Start at a level to achieve $SpO_2 \geq 92\%$ (or per disease-specific target, e.g., 88-92% for COPD). Often started at 40-60%.
12. Flow Rate:
    a. Set the desired oxygen flow rate, typically between 10-60 L/min, based on patient requirements and tolerance (30-40 L/min for most adults).
    b. Titrate up rapidly to 50-60 L/min if the work of breathing is high.
    c. For pre-oxygenation, start at 50-70 L/min.
13. Temperature: Set to (37°C) (body temperature). For patient comfort, it may be reduced to 34-37°C if the patient complains of excessive heat.
14. Adjust the FiO2 settings to achieve the target oxygen saturation (usually $SpO2 \geq 90\%$).
15. Turn on the device and begin high-flow oxygen delivery.
16. When increasing support is needed, move flow up first, then Oxygen.
17. When reducing support, move Oxygen down first, then flow.
18. The flow rate should be increased if:
    a. Respiratory rate fails to improve,
    b. Oxygenation fails to adequately improve,
    c. Breathing remains labored.

As required to reduce oxygen down to 0.21 and keep humidified air going.

9. Monitoring

A. Continuous Monitoring:

- SpO2 levels every 15-30 minutes initially or as clinically indicated.
- Vital signs at least every hour, SpO_2, and Heart Rate.
- Obtain an ABG within 1-2 hours of initiation or after significant parameter changes to assess PaO_2, $PaCO_2$, and pH.
- Respiratory Rate and Work of Breathing.
- Patient Comfort and Tolerance.
- Titration Goals: Adjust settings every 5-15 minutes until the patient is stabilized.
- Titrate FiO_2 first to maintain target SpO_2.
- Titrate Flow Rate to manage work of breathing and dyspnoea. Higher flows (up to 60 L/min) provide more PEEP and dead space washout.
- Perform a full clinical assessment, including vital signs, at least every 4 hours.

b. Failure Criteria (Escalate to ICU/Consider Intubation):

i. ROX index less than 3.85
ii. Respiratory acidosis with pH < 7.25.
iii. Hemodynamic instability (e.g., SBP < 90 mmHg).
iv. Depressed mental status (GCS < 8).

10. Precautions and Contraindications

Patient Tolerance:

1. Evaluate the patient for any signs of discomfort or intolerance, such as nasal irritation, pressure sores, or anxiety.
2. f intolerable, consider reassessment of the delivery method.

Precautions:

1. COPD patient with hypercapnia: Use HFO carefully in patients with COPD; carefully monitor for hypercapnia or potential respiratory depression.
2. Barotrauma: Be aware of the risk of barotrauma in patients with underlying lung pathology (e.g., bullous lung disease).

Humidification:

1. Ensure proper humidification is provided with high-flow systems to prevent airway dryness, irritation and maintain mucosal integrity.
2. Adjust the temperature of the inspired gas to a comfortable range (37°C is commonly used) to enhance mucosal comfort.
3. Patient Comfort: Regularly check for signs of discomfort or intolerance with the mask or cannula; adjust settings as necessary to ensure patient compliance.

Contraindications:

1. Impaired Consciousness / Inability to Protect Airway (high risk of aspiration)
2. Facial Trauma/Burns/Surgery, preventing proper seal of the nasal cannula
3. Basilar Skull Fracture / CSF Leak
4. Profound Hypercapnia ($PaCO_2$ > 65 mmHg) with respiratory acidosis (pH < 7.25). Requires close monitoring
5. Hemodynamic Instability, severe refractory shock with low cardiac output
6. Recent Upper Airway or Esophageal Surgery
7. Patients requiring invasive mechanical ventilation due to significant respiratory failure that high-flow therapy cannot adequately address.
8. Copious, thick Secretions (may require concurrent suctioning)
9. Known or Suspected Pneumothorax without a chest drain

11. Infection Control

i. Follow strict infection control protocols, including regular equipment cleaning and filter replacements as per manufacturer recommendations.

12. Delivery Settings

A. Proper location:

a. High-Acuity Settings (Standard of Care)

i. Intensive Care Unit (ICU): The primary and most appropriate setting for initiating HFOT in unstable patients with moderate to severe respiratory failure.

ii. Emergency Department (ED): For initial stabilization, pre-oxygenation, and management of acute respiratory failure prior to ICU transfer.

iii. Post-Anaesthesia Care Unit (PACU): For managing post-operative respiratory depression, atelectasis, or hypoxemia immediately after surgery.

b. Intermediate-Acuity Settings (Conditional Use):

i. Intermediate Care/Step-Down Units: Suitable for stable patients already established on HFOT who are being weaned, or for patients with mild respiratory failure who are closely monitored. The unit must have:

a. A nurse-to-patient ratio no greater than 1:3.
b. Continuous pulse oximetry and telemetry.
c. Immediate access to respiratory therapy.
d. Clear "failure criteria" and an escalation plan to the ICU.

c. Medical-Surgical Wards (with a Specific Protocol): Use is highly restricted.

i. May be considered for (Do-Not-Resuscitate) (DNR) patients for comfort care or for very mild, stable hypoxemia that has not responded to conventional oxygen. Requires:

a. A specific, hospital-approved protocol for use in the wards.
b. A specific, hospital-approved protocol for use in the wards.
c. Extensive staff education on troubleshooting and failure signs.
d. Rapid Response Team activation criteria.

13. Weaning Off High-Flow Therapy

b. **Assessment for Weaning:**

i. Before gradual weaning, assess improvement in clinical status and resolution of underlying causes necessitating HFO.

c. **Weaning Strategy:**

i. First, gradually reduce the FiO_2 to $\leq 40\%$ while maintaining SpO_2 target
ii. Then, gradually reduce the Flow Rate in increments of 5-10 L/min every 1-2 hours, as tolerated
iii. When the patient is stable on low settings (e.g., FiO_2 30-40%, Flow 20-30 L/min), switch to a conventional nasal cannula or simple face mask.
iv. Perform a final clinical assessment on the low-flow oxygen device before discontinuing oxygen entirely

14. Minimal Operational Requirements

Location	Monitoring	Nurse Ratio	Who may initiate
ICU	Continuous	1:1–1:2	Intensivist
Step-down	Telemetry	1:3	Hospitalist + RT
Ward	**Not recommended** unless explicit policy	1:4+	Rare/DNR only

Contraindicated Settings

d. General Medical-Surgical Wards* without a specific HFOT protocol and monitoring capabilities.
e. Long-Term Care Facilities without acute care monitoring.
f. During intra-hospital transport, unless managed by a critical care transport team with a portable HFOT device and continuous monitoring. Transport is a high-risk period.

Staff Responsibilities:

Physician / Intensivist / Hospitalist:

I. Makes the ultimate decision to initiate HFOT based on clinical indication.
II. Prescribes the initial parameters (FiO_2, Flow).
III. Manages the underlying medical condition.
IV. Makes decisions regarding modification of therapy (e.g., intubation) or shifting to comfort care.

Respiratory Therapist (RT):

i. Initiation & Setup
ii. Assembles and tests the HFOT device and circuit.
iii. Selects the appropriate nasal cannula size.
iv. Initiates therapy as per order/protocol.
v. Management & Titration:
    1. Titrates FiO_2 and flow within a prescribed range based on patient response and ABG results.
    2. Troubleshoots device alarms and circuit issues (e.g., condensation).
    3. Performs clinical assessments of respiratory status.
    4. Weaning: Executes the weaning protocol and transitions to low-flow oxygen.

Registered Nurse (RN):

i. Continuous Monitoring:Monitors and documents vital signs, SpO_2, and work of breathing.
ii. Assesses patient comfort, anxiety, and tolerance of the interface
iii. Manages patient hygiene and skin integrity under the nasal cannula/strap.
iv. Communication & Safety:Communicates changes in patient status to the RT and physician.
v. Ensures the patient is in an optimal position (Semi-Fowler's/Fowler's).
vi. Provides patient and family education on the purpose and sensations of therapy.

Documentation:

i. Date and time of initiation.
ii. Initial and subsequent settings (FiO_2, Flow, Temperature).
iii. Patient's response (Vital Signs, SpO_2, Work of Breathing, Comfort).
iv. ABG results (if obtained).
v. Titrations made and clinical rationale.
vi. Patient education provided.
vii. Weaning progress and discontinuation

Figure 1

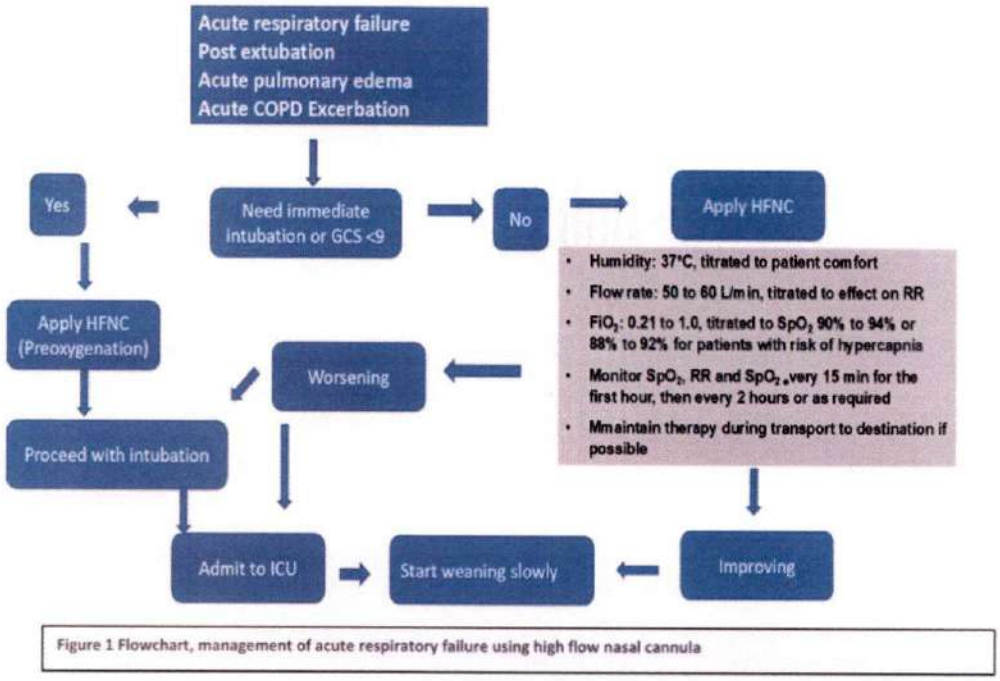

Figure 1 Flowchart, management of acute respiratory failure using high flow nasal cannula

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