Non-Invasive Ventilation and High-Flow Nasal Cannula Guideline

Non-Invasive Ventilation

Background
Non-invasive ventilation (NIV) is the provision of ventilator support without the use of an invasive artificial airway. NIV may be delivered in two modes – continuous positive airway pressure (CPAP), or bi-level non-invasive positive pressure ventilation (BiPAP). In CPAP, the patient breathes through a pressurized circuit against a resistor which maintains positive pressure during inspiration and expiration. BiPAP combines pressure support ventilation (PSV) with positive end-expiratory pressure (PEEP), and differs from CPAP in that the inspiratory assistance of PSV rests the muscles of respiration. Both modes may reduce the work of breathing and improve alveolar ventilation.

NIV may be used in the outpatient setting, in the Emergency Department, Post-Anaesthetic Care Unit, general floors, and the Intensive Care Unit. In the ICU, NIV is used in 2 scenarios:

1. As a substitute for conventional invasive ventilation in patients with chronic respiratory failure and difficulty in weaning from mechanical ventilation.
2. Preventive NIV in recently extubated patients a high-risk for re-intubation.

NIV should not be used as a rescue therapy – i.e. in patients who have developed respiratory failure with indications for intubation. Those patients should be intubated, as the delay can be associated with a higher mortality rate. In carefully selected patients who have a cause of respiratory failure amenable to rapid resolution (e.g. fluid overload, negative pressure pulmonary oedema), NIV may be used (Esteban, Keenan).

Risks for failure of NIV
pH <7.25
Acute Lung Injury/Acute Respiratory Distress Syndrome
Pneumonia
Severe hypoxaemia
Shock
Metabolic acidosis
Impaired mental status

NIV involves the delivery of pressurized gas via a mask. Common interfaces are nasal masks, full facemasks which cover the nose and mouth, and total facemasks which seal around the perimeter of the face. As excessive air leakage can lead to failure of NIV, mask straps are used.
to secure a seal in the interface between the mask and the patient. Uncooperative or agitated patients are unlikely to tolerate full facemasks, with nasal masks or total facemasks less likely to induce claustrophobia. Patients at risk for aspiration, such as those with copious secretions, impaired swallowing, or vomiting, are poor candidates for NIV. The concern for development of abdominal distension and anastamotic suture line rupture makes recent upper gastrointestinal surgery a relative contra-indication, although there have been studies reporting the successful use of NIV in post-operative patients (Squadrone).

**Indications**
1. Impending respiratory failure – acute condition of anticipated short duration
2. Acute or acute-on-chronic CO₂ retention
3. Post-operative muscle weakness
4. Patient previously on NIV

**Contra-indications**
Respiratory arrest
Haemodynamic instability
Uncontrolled arrhythmias
High risk for aspiration (severe upper gastro-intestinal bleeding, haemoptysis, epistaxis)
Multi-system organ failure
Inability to cooperate
Inability to obtain proper mask fit
Recent facial surgery/trauma or middle ear pathology
Recent upper GI surgery (relative contra-indication)
Bowel obstruction
Intracranial pressure >20 mmHg
Acute sinusitis

**Failure of NIV (consider intubation)**
Respiratory rate >40 bpm
Increasing heart rate
Persistent increased work of breathing
Poor patient/ventilator synchrony
p₉O₂ <60 mmHg or S₉O₂ <90% on F₉O₂ 60%
Decreasing pH or increasing CO₂

*per Respiratory Therapy protocol, NIV is limited to 48 hours duration*
High-Flow Nasal Cannula

Background
Low-flow devices such as nasal cannulae, non-rebreathing masks, and masks with reservoir bags deliver varying levels of F\(\text{I}O_2\) depending on delivery system, mask characteristics, inspiratory flow rate, and patient breathing pattern. Conventional high-flow systems, such as Venturi masks, use a constant flow of oxygen through precisely sized ports. In combination with entrained room air, this allows delivery of a more consistent F\(\text{I}O_2\). These masks are less well-tolerated than nasal cannulae, and the absence of heated and humidified gas flow limits their long-term utility. In addition, as the patient’s respiratory rate increases the amount of entrained room air increases, decreasing the inspired oxygen fraction.

High-flow nasal cannula (HFNC) were developed as an alternative to traditional oxygen delivery systems. HFNC consists of an air/oxygen blender which provides a F\(\text{I}O_2\) of up to nearly 1, independent of flow rate. The gas mixture is passed through an active heater and humidifier to loose-fitting nasal prongs.

The nasal prongs are larger but softer than the standard nasal cannulae. In combination with the heated and humidified gas, this enhances patient comfort and increases tolerance. Humidification of airway mucous facilitates secretion removal, and avoids desiccation and epithelial injury. The high flow rate (up to 60 L/min) minimizes entrainment of room air, allowing reliable provision of set FiO\(\text{I}O_2\) even in a distressed, rapidly breathing patient.

HFNC systems can generate positive expiratory airway pressure, directly correlated to flow rate. For every increase in flow rate of 10 L/min, mean airway pressure increases by approximately 0.69 cm H\(2\)O. The pressure generated by HFNC peaks at end-expiration, but positive pressure is present throughout the respiratory cycle.

HFNC has been used for multiple indications, including hypoxaemic respiratory failure, post-extubation respiratory failure, and cardiogenic pulmonary oedema. At present, however, there are limited high-quality studies evaluating HFNC, and so recommendations regarding the most appropriate clinical setting for the use of HFNC are sparse (Spoletini).
References

