

Title: Standard Operating Procedure for the Use of Non-Humidified High Flow Nasal Oxygen in Anesthesia

Introduction:

High flow nasal oxygen (HFNO) is a descriptive term for a range of oxygen delivery systems able to carry flow rates of up to 100L/min to the patient via nasal cannula.(1) Our equipment comprises a high rate flow meter capable of delivering 70L/min, which can be connected to the Mindray anesthesia machine or wall outlet. It works in conjunction with our existing nasal cannula or alternate cannula that are supplied with the flowmeter. The circuit is not heated or humidified and cannot blend air into the gas flow which makes it suitable for short term use only.

The benefits of such a system are its ability to carry close to 100% oxygen even with elevated inspiratory flow rates, and by washing out carbon dioxide from the anatomical dead space creates an additional oxygen reservoir. The high flow rates generate PEEP which leads to alveolar recruitment, reduced work of breathing and increased end expiratory lung volumes(2). Finally, the continuous insufflation can facilitate carbon dioxide removal and limit the expected rise in arterial carbon dioxide levels during apnea.(3)

Indications for use:

1. Optimisation of pre-oxygenation prior to induction of general anesthesia
2. As an adjunct to maintain oxygenation and improve carbon dioxide removal when managing the induction of an *anticipated* difficult airway
3. Instituted prior to extubation to reduce risk of immediate respiratory complications in the OR
4. With awake fiberoptic or videolaryngoscopic intubation, particularly for those with existing hypoxia, respiratory failure or critical airway stenosis.

Cautions and contraindications:(1)

Absolute Contraindications

- High fire risk procedures including use of lasers or diathermy in close proximity to the airway
- Significant untreated tension pneumothorax
- Known or suspected skull base fracture, or the presence of a communication between the nasal cavity and intracranial space
- Complete nasal obstruction
- Recent functional endoscopic sinus surgery
- Active epistaxis
- Prolonged pre-operative or post-operative use without humidification
- Airway disruption including laryngeal fracture or tracheal rupture

Relative Contraindications

- Partial nasal obstruction
- Contagious pulmonary infections such as active tuberculosis
- Any contraindication to hyperoxia such as bleomycin usage
- If indicated for a suspected or known COVID patient, then it should be used in conjunction with appropriate PPE
- In conjunction with positive pressure ventilation via face mask (see below)

Bag mask ventilation should not be necessary after induction and prior to laryngoscopy. Apnea is well tolerated without desaturation and additional positive pressure ventilation with the mask risks gastric insufflation. This is especially true if high flows are used via the nasal cannula and if the APL valve is set to pressures greater than 5 cmH₂O.

Details and description of device:

1. Nasal cannula & oxygen tubing
 - a. **Specific** for delivery of high flows
 - b. Supplied nasal cannula: **both** nasal outlets deliver O₂
 - c. Standard nasal cannula: 1 outlet delivers O₂, 1 outlet samples, is acceptable.
2. High flow meter O₂ delivery system:
 - a. Capable of delivering flows up to 70L/min
3. Disposal of equipment:
 - a. Nasal cannula and tubing are **one-time use** and must be disposed appropriately after each case
 - b. Flow meters are re-usable and require standard cleaning

Preparation for use:

1. **PPE during use of HFNO**
 - a. N95, surgical face mask, eye protection, scrub cap
2. **Preparation of OR**
 - a. Oxygen flow meter:
 - i. Ensure secure connection with outlet on the wall, or there is an O₂ flowmeter outlet on the side of the Mindray that can be used
 - ii. Inspect flowmeter for visible cracks
 - iii. Ensure flow gauge is able to dial up to maximum of 70L/min and deliver O₂, without an audible leak
 - b. Confirm correct oxygen tubing & nasal cannula for delivery of high flow
 - c. Connect oxygen tubing to high flow meter
3. **Monitoring**
 - a. Standard ASA monitoring should be applied to the patient prior to induction or as per extubation

Usage in specific indications:

1. **Preoxygenation and induction of anesthesia** including an anticipated difficult airway
 - a. Prior to induction:
 - i. Apply HFNO nasal cannula to the patient and begin flow at 10L/min
 - ii. Pre-oxygenate by placing facemask securely over the patient's nose and mouth, as tolerated, with nasal cannula still in place
 - iii. Ensure APL valve is open
 - iv. Confirm readiness for induction of anesthesia as normal, e.g.: target EtO₂
 - b. Induction:
 - i. Administer induction agents
 - ii. Upon loss of consciousness, flows can then be increased to a maximum of 40L/min
 - iii. Positive pressure ventilation/bag mask ventilation should **NOT** be performed during this time. Apnea will be well tolerated due to the high flow nasal oxygen.
 - iv. Maintain high flow settings (max 40L/min) during laryngoscopy
 - v. Perform intubation and confirm placement of ETT as normal
 - c. Immediately after intubation:
 - i. Turn off HFNO and consider leaving cannula in place (for peri-extubation use)
2. **Extubation planning** for known, difficult airways or for patients with a high risk of airway collapse or desaturation soon after extubation.
 - a. During **emergence**: restart flows through nasal cannula, maximum 40L/min
 - b. During **extubation**: keep high flows running through nasal cannula
 - c. **After** extubation: keep high flows running through nasal cannula, wean down flows as able.

- i. Application of the face mask should not be necessary, and positive pressure ventilation risks gastric distension while high flows are being delivered through the nasal cannula.
 - ii. Wean down flow and assess airway patency prior to moving patient. If unable to wean below 25L/min, then transferring to PACU using HFNO is NOT possible on the transport cylinder.
 - d. Transferring to PACU
 - i. Maximum setting on O2 transport cylinders is 25L/min
 - ii. Ensure enough O2 is in the cylinder (size E cylinder: max capacity 680L)
- 3. Awake fiberoptic intubations for the anticipated difficult airway, including the prevention of hypoxia in cases of critical airway narrowing**
- a. Prior to induction
 - i. Perform topicalization as normal
 - ii. Apply HFNO nasal cannula to the patient and begin flow at 10L/min
 - iii. Consider increasing flow rate slowly to a maximum of 40L/min, as tolerated by patient. Sedation or analgesia may be required in this setting.
 - b. Intubation:
 - i. Perform fiberoptic intubation and confirm placement of ETT as usual
 - c. Immediately after intubation:
 - i. Turn off HFNO and consider leaving cannula in place (for peri-extubation use)

References & Resources:

1. Cooper J, Griffiths B, Ehrenwerth J. Safe Use of High-Flow Nasal Oxygen (Hfno) With Special Reference to Difficult Airway Management and Fire Risk. APFS NewsI - Off J Anaesth Patient Saf Found. 2018;33(2):33–68.
2. Ashraf-Kashani N, Kumar R. High-flow nasal oxygen therapy. BJA Educ [Internet]. 2017;17(2):63–7. Available from: <http://dx.doi.org/10.1093/bjaed/mkw041>
3. Gleason JM, Christian BR, Barton ED. Nasal cannula apneic oxygenation prevents desaturation during endotracheal intubation: An integrative literature review. West J Emerg Med. 2018;19(2):403–11.