Title: Safe use of intraoperative high flow nasal oxygen - a surgical perspective

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Safe use of intraoperative high flow nasal oxygen - a surgical perspective

Intraoperative use of high flow nasal oxygen (HFNO) is a relatively new practice which broadens options available to anaesthetists and surgeons during awake procedures. As with all new medical technologies, clinicians must consider the risks and benefits to ensure safe delivery and appropriate usage of this valuable tool. Primarily, we must consider the increased risk of surgical fires in an oxygen-rich environment. While this issue has been previously addressed in the anaesthetic literature, it is important that surgeons are aware of these risks in order to ensure patient and operator safety.

Intraoperative use of HFNO has been described during endoscopic procedures,¹ dentistry,² caesarean sections with spinal anaesthesia,³ thoracic,^{4,5} otolaryngeal⁶ and neurosurgery.⁷

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HFNO delivers humidified oxygen at up to 60L/min at 37 °C, a significant increase when compared to the maximal tolerated rate via conventional nasal cannulae of 10L/min.² and is better tolerated by patients than high flows via venturi masks or non-invasive ventilation.^{4,8} Alongside the physiological benefits, practical benefits include reduced anaesthetic times¹ and the patient's ability to communicate with the surgeon/anaesthetist throughout the case.⁷

However, HFNO will create a significantly oxidiser-enriched atmosphere, which is defined as any increase in oxygen concentration above room air level (21%) and/or the presence of nitrous oxide.⁹ Although oxygen is not a flammable gas, it is an oxidiser facilitating a combustion. Mehta et al. found that oxygen was the oxidiser in 95% of electrocautery fires reported to the American Society of Anesthesiologists, and 84% of these cases used an open system for oxygen delivery, such as a nasal cannula or mask.⁹

Surgical fires require the presence of the "fire triad": an oxidiser (eg: oxygen or nitrous oxide), an ignition source (eg: diathermy, lasers, fiberoptic light cables), and fuel (eg: surgical drapes, alcohol prep solutions, hair, gauze).⁹

Increasing oxygen concentrations decreases the time to ignition of surgical drapes,¹⁰ and in organic tissue-based models. Roy et al. used a raw chicken model to simulate oropharyngeal fires to demonstrate this concept. Electrocautery ignited a sustained flame in 15-30 seconds in the presence of 100% FiO₂ at flows of 15L/min. This time-to-ignition was extended to 2-3 minutes when in the presence of 50% FiO₂ at 15L/min.¹¹

Seventy-four percent of reported surgical fires implicate pooling of oxygen within the operative space or under surgical drapes.¹² Multiple methods to reduce oxygen pooling have been proposed, including strategic 'tenting' of the operative drapes to create an open space around the patient's head and neck allowing oxygen to sink to the floor.¹³ Simple interventions can be employed to mitigate the risks incurred with the use of HFNO, and to ensure patient and operator safety.

Barnes et al. established that significantly higher oxygen concentrations occurred beneath surgical drapes with each incremental change in oxygen flow rate between 0-4L/min.¹⁴ Regardless of the supplemental oxygen flow rate used, usage of a scavenger system connected to continuous wall suction significantly decreased the oxygen concentration beneath the drapes. Kung et al. demonstrated that the addition of vacuum suctioning in the operative field significantly decreased the time for oxygen concentrations to return to 21% after cessation of oxygen administration compared to tenting alone.¹³

A review of the literature suggests that surgical fires is an extremely rare event, however anecdotal evidence suggests that the true number is higher. Fear of medico-legal ramifications may lead to under-reporting of these events. Of concern are two studies that demonstrated a lack of awareness of the dangers of diathermy in surgical clinicians of all levels.^{15,16} The introduction of mandatory reporting of surgical fires may alert surgeons and trainees to these very real risks.

HFNO can create an oxygen-enriched environment in the operative field and beneath surgical drapes, which may increase the risk of surgical fires. We believe that prevention of

surgical fires depends on clear communication between surgeons, anaesthetists and nursing staff. Surgeons and trainees must recognise this risk and may be required to change their practice if intraoperative HFNO is being used.

To prevent surgical fires in the usage of HFNO, the following recommendations have been proposed:

- Disclose use of HFNO during time-out
- Use lowest possible oxygen flow and concentration to maintain adequate oxygenation
- Limit use of diathermy in the presence of HFNO
- Considered draping technique and suctioning to prevent oxygen pooling beneath the drapes and in the operative field
- Avoid HFNO if the operative field is above the chest
- Keep water in theatre in case of surgical fire
- Regular fire training for surgeons, anaesthetists and nursing staff
- Mandatory reporting of surgical fires

1. Schumann R, Natov N, Rocuts-Martinez K, Finkelman M, Phan T, Hegde S, et al. High-flow nasal oxygen availability for sedation decreases the use of general anesthesia during endoscopic retrograde cholangiopancreatography and endoscopic ultrasound. *World J Gastroenterol.* 2016;**22**:10398-405.
2. Sago T, Harano N, Chogyoji Y, Nunomaki M, Shiiba S, Watanabe S. A Nasal High-Flow System Prevents Hypoxia in Dental Patients Under Intravenous Sedation. *J Oral Maxillofac Surg.* 2015;**73**:1058-64.
3. Farquharson P, Campbell G, Joss J, McClymont W. Use of Intraoperative Optiflow for Caesarean Section Under Combined Spinal-epidural Anaesthesia in a Patient With End-stage Pulmonary Fibrosis on Long Term Oxygen Treatment. Poster presented at: Obstetric Anaesthesia Brussels; 2017 May 18-19 ; Brussels, Belgium. Available from: https://epostersonline.com/oaa2017/node/483_
4. Jakob W, Lorenzo B, Paolo P, Marcelo GdA. High-flow nasal cannula oxygen therapy in patients undergoing thoracic surgery: current evidence and practice. *Curr Opin Anaesthesiol.* 2019;**1**:44-49.
5. Wang M-L, Hung M-H, Chen J-S, Hsu H-H, Cheng Y-J. Nasal high-flow oxygen therapy improves arterial oxygenation during one-lung ventilation in non-intubated thoracoscopic surgery. *Eur J Cardiothorac Surg* 2018; **53**:1001-6.
6. Onwochei D, El-Boghdadly K, Oakley R, Ahmad I. Intra-oral ignition of monopolar diathermy during transnasal humidified rapid-insufflation ventilatory exchange (THRIVE). *Anaesthesia* 2017; **72**:781-3.

7. Wong JWM, Kong AHS, Lam SY, Woo PYM. High-Flow Nasal Oxygen in Patient With Obstructive Sleep Apnea Undergoing Awake Craniotomy: A Case Report. *A & A Case Reports*. 2017;**9**:353-6.
8. Millette BH, Athanassoglou V, Patel A. High flow nasal oxygen therapy in adult anaesthesia. *Trends in Anaesthesia and Critical Care*. 2018;**18**:29-33.
9. Mehta SP, Bhananker SM, Posner KL, Domino KB. Operating Room Fires: A Closed Claims Analysis. *Perioperative Medicine* 2013; **118**: 1133-9.
10. Wolf GL, Sidebotham GW, Lazard JLP, Charchafli JG. Laser Ignition of Surgical Drape Materials in Air, 50% Oxygen, and 95% Oxygen. *Anesthesiology* 2004; **100**: 1167-71.
11. Roy S, Smith LP. What does it take to start an oropharyngeal fire? Oxygen requirements to start fires in the operating room. *Int J Pediatr Otorhinolaryngol*. 2011;**75**:227-30.
12. ERCI. A Clinician's Guide to Surgical Fires: How They Occur, How to Prevent Them, How to Put Them Out. 2003:5.
13. Kung TA, Kong SW, Aliu O, Azizi J, Kai S, Cederna PS. Effects of vacuum suctioning and strategic drape tenting on oxygen concentration in a simulated surgical field. *J Clin Anesth*. 2016;**28**:56-61.
14. Barnes AM, Frantz RA. Do oxygen-enriched atmospheres exist beneath surgical drapes and contribute to fire hazard potential in the operating room? *AANA Journal*. 2000;**68**:153-61.
15. Clark SC. Are surgeons aware of the dangers of diathermy? *Ann R Coll Surg Engl*. 2002;**84**:369.
16. McQuail PM, McCartney BS, Baker JF, Kenny P. Diathermy awareness among surgeons-An analysis in Ireland. *Ann Med Surg*. 2016;**12**:54-9.

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