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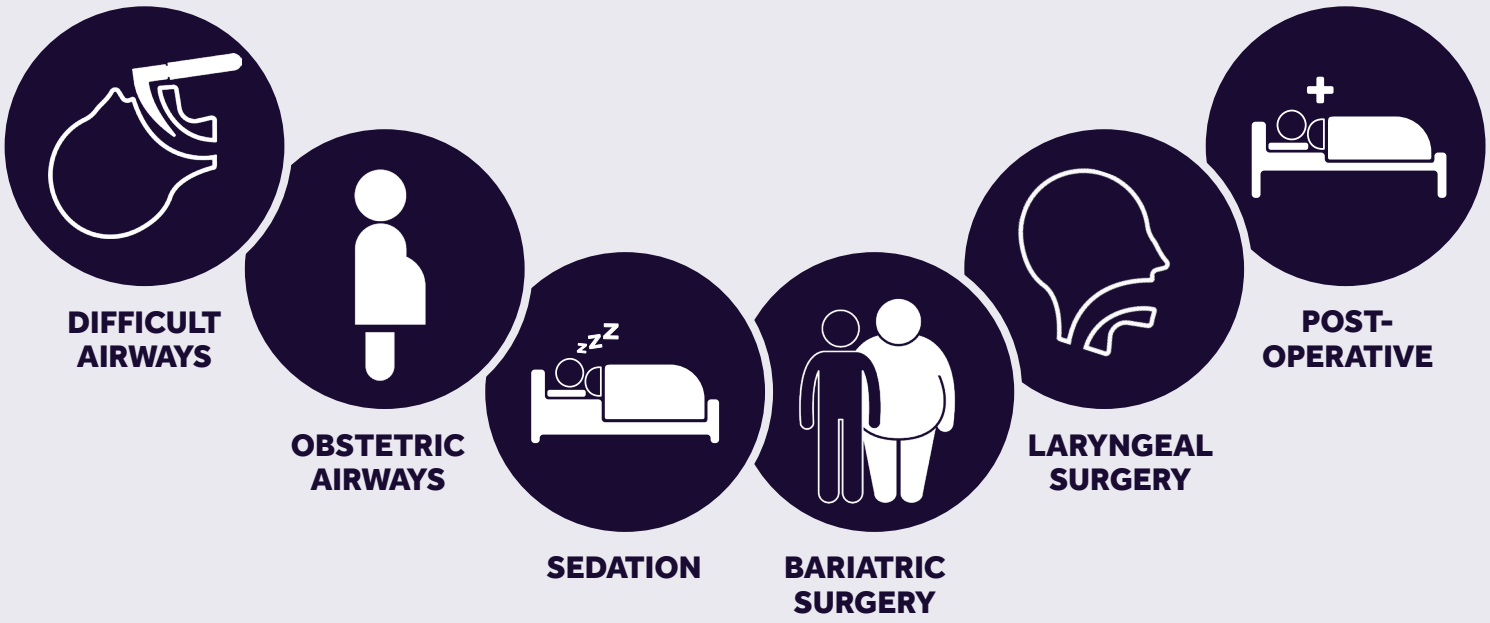

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Contents

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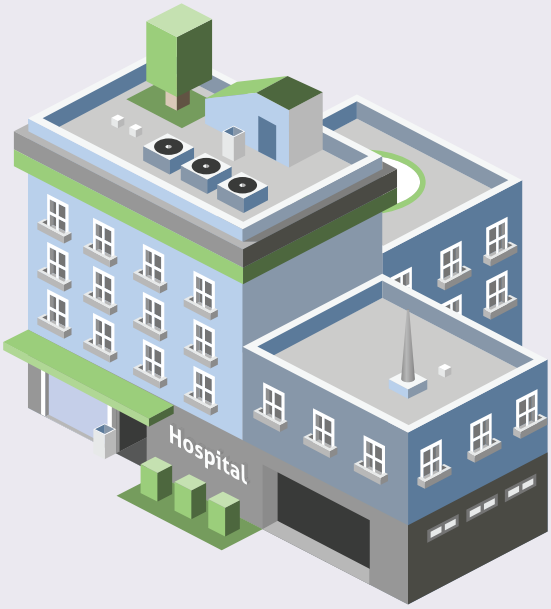

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The role of high flow nasal oxygen therapy in anaesthesia

ABSTRACT

The delivery of oxygen is a key component of anaesthetic practice. High flow nasal oxygen therapy is a relatively new addition to more traditional means of oxygenation which provides heated and humidified flows of controlled oxygen/air mixes achieving rates of up to 120 litres/min. The physiological benefits include nasopharyngeal dead space washout, reduced work of breathing, alveolar recruitment, maintained mucociliary function and the ability to provide apnoeic oxygenation. This article considers the current evidence for high flow nasal oxygen therapy in perioperative anaesthetic care during pre-oxygenation and intubation, management of the difficult airway, oxygenation for shared airway surgery, extubation and postoperative support, obstetric and paediatric anaesthesia.

The ability to deliver oxygen to a patient is a mainstay of anaesthetic practice. Although often uneventful, airway manipulation may be complicated by adverse outcomes with the risk of hypoxia, hypoxic arrest and related sequelae.

The importance of oxygenation at all costs is reflected in the 4th National Audit Project of the Royal College of Anaesthetists (Cook et al, 2011) and in the plethora of Difficult Airway Society guidelines – intubation (Frerk et al, 2015), intubation in critically ill adults (Higgs et al, 2018), extubation (Popat et al, 2012), obstetric (Mushambi et al, 2015) and paediatric (https://www.das.uk.com/files/APA2-UnantDiffTracInt-FINAL.pdf). This primacy of oxygenation has resulted in a paradigm shift in terminology from 'can't intubate can't ventilate' to 'can't intubate can't oxygenate' (Chrimes and Cook, 2017).

High flow nasal oxygen therapy is a system for delivering warm, humidified oxygen and air mixtures at flows up to 120 litres/min. Inspired oxygen concentration (FiO_2) can range from 21% to 100%. The Difficult Airway Society intubation guidelines (Frerk et al, 2015) acknowledge the potential efficacy of high flow nasal oxygen therapy as a tool for preoxygenation and apnoeic oxygenation; however, the authors did not consider there to be enough evidence to specifically endorse its use. Since the publication of these guidelines, high flow nasal oxygen therapy is increasingly regarded as a potential 'game-changer' in airway management with a growing body of opinion and evidence regarding its use in elective and emergency anaesthesia, intensive care and the management of airway emergencies (Nekhendzy, 2017). This attitudinal change is reflected in the most recent Difficult Airway Society guidelines for the management of tracheal intubation in critically ill adults which advocate high flow nasal oxygen therapy as a valid alternative or adjunct to traditional oxygen delivery systems (Higgs et al, 2018).

This narrative review concerns the role of high flow nasal oxygen therapy in perioperative anaesthetic airway management. A detailed review of its role in the emergency room, and adult or paediatric critical care is beyond the scope of this article.

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Components of a high flow nasal oxygen therapy system

High flow nasal oxygen therapy comprises an oxygen/air blender, used to control flow and FiO_2 delivery, a heater-humidifier (conditioning the gas temperature to 37°C and absolute humidity up to 44 mgH_2O/litre) and a delivery system comprising a sterile water reservoir, non-condensing circuit and patient interface system. There are several devices available with flow rates up to 120 litres/min. Administration of high flow nasal oxygen therapy requires a high pressure gas supply of air and oxygen. An example of the system is shown in *Figure 1*.

Physiology

Table 1 summarizes the fluid dynamics and physiology underpinning high flow nasal oxygen therapy.

Indications and contraindications

Historically, the principal use of high flow nasal oxygen therapy has been in neonatology, but more recently its application has extended into adult intensive care and anaesthesia. Specific areas of interest for high flow nasal oxygen therapy in anaesthesia include:

- Difficult airway management
- Pre- and apnoeic oxygenation before intubation
- Rapid sequence induction
- Awake fibreoptic intubation
- Extubation and postoperative support
- Surgical procedures involving the airway
- Obstetric and paediatric anaesthesia.

Currently there are no published guidelines describing contraindications to high flow nasal oxygen therapy. Guidance on the use of non-invasive ventilation is not

directly translatable as there are situations where high flow nasal oxygen therapy can be used effectively where non-invasive ventilation would be contraindicated (e.g. patient apnoea and shared airway surgical procedures). The authors propose contraindications to high flow nasal oxygen therapy in anaesthesia include:

- Agitated, uncooperative or non-consenting patients
- Procedural oxygenation for those with a high aspiration risk
- Complete airway obstruction
- Maxillofacial trauma
- Basal skull fracture.

Pre- and apnoeic oxygenation before intubation

Preoxygenation is the administration of 100% oxygen to a patient before the induction of anaesthesia. It denitrogenates the functional residual capacity creating an oxygen reservoir in the lungs. This provides time, after the onset of apnoea, to secure the airway (e.g. by intubation) before hypoxaemia occurs. Apnoeic oxygenation, in contrast, is the provision of supplemental oxygenation without ventilation at the airway after the induction of anaesthesia. It can be used as an adjunct to preoxygenation to extend a patient's safe apnoea time – the rate of alveolar oxygen absorption being greater than capillary carbon dioxide (CO_2) accumulation results in a pressure gradient generating a mass flow of gas from a patent pharynx to the alveoli. The Difficult Airway Society intubation guidelines recommend the use of standard nasal prongs at flows of 5–15 litres/min for apnoeic oxygenation (Frerk et al, 2015).

While conceptually high flow nasal oxygen therapy might offer advantages over traditional pre- and apnoeic oxygenation techniques, studies (*Table 2*) are ultimately inconclusive and underpowered. Moreover, areas of particular interest are situations where difficult and prolonged intubations are more prevalent, but there is a paucity of data for the provision of high flow nasal oxygen therapy in these scenarios. Nevertheless, despite the lack of robust evidence, high flow nasal oxygen therapy has gained traction and is advocated as being at least comparable to standard nasal oxygen for the intubation of the critically ill patient (Higgs et al, 2018).

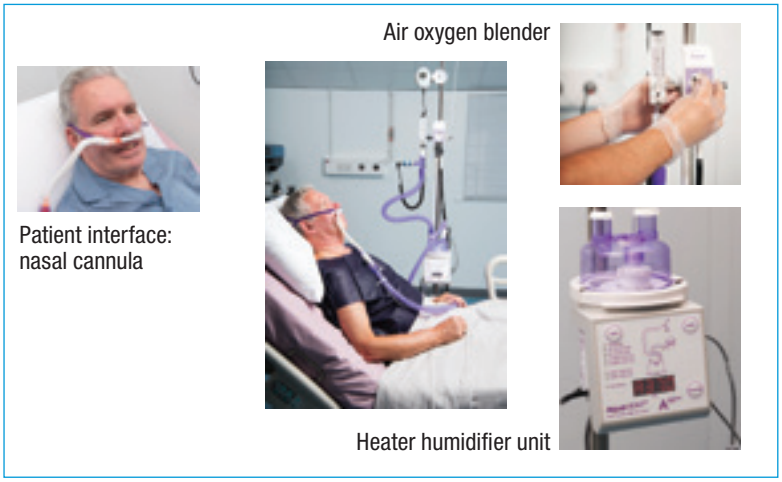

Figure 1. Components of a high flow nasal oxygen therapy system.

Rapid sequence induction

Rapid sequence induction of anaesthesia is used to prevent aspiration of gastric contents in patients who are inadequately fasted, have impaired gastric emptying or are known to have a history of gastric reflux. It is commonly used during emergency surgery. Conceptually pre- and

Table 1. High flow nasal oxygen therapy proposed physiological effects and mechanisms of action

Physiological effect	Mechanism of action
Nasopharyngeal dead space washout	High flow nasal oxygen therapy generates a reservoir of oxygen within the nasopharyngeal cavity dead space – this results in less rebreathing of carbon dioxide (Dysart et al, 2009). There is consequently a reduction in arterial carbon dioxide concentration, respiratory effort becomes more efficient and thoraco-abdominal synchrony improves (Nillius et al, 2013)
Reduced work of breathing	High flow nasal oxygen therapy delivers heated gases with 100% relative humidity – this preconditioning means there is less metabolic demand placed on the patient to warm or humidify the gases by normal physiological mechanisms. Moreover, the high flow rates are at least equal to peak inspiratory flow – this minimizes the nasopharyngeal inspiratory resistance and decreases resistive breathing effort (Dysart et al, 2009)
Alveolar recruitment or positive end expiratory pressure effect	High flow nasal oxygen therapy is associated with the generation of positive airway pressure and the end-expiratory lung volume is greater with high flow nasal oxygen therapy than with low flow oxygen therapy. Positive pressure improves alveolar recruitment and reduces ventilation–perfusion mismatch. The positive pressure generated by high flow nasal oxygen therapy depends on: ■ flow rate ■ whether the mouth is closed or open ■ the size of the nasal cannula in relation to the nostrils and the geometry of the upper airways (Groves and Tobin, 2007; Parke et al, 2009)
Accurate inspired oxygen fraction	High gas flow rates increase the accuracy of the inspired oxygen fraction because the amounts of ambient air entrained are comparatively minimal (Sim et al, 2008)
Maintained mucociliary function	The humidified and warmed gas delivered to the patient reduces the viscosity of secretions and thus can facilitate and enhance mucociliary clearance. A reduction in the dryness of the upper airways generally improves comfort for patients (Dysart et al, 2009)

Table 2. Pre- and apnoeic oxygenation before intubation

Reference	Study type	Study design	Population	Main results and observations
Miguel-Montanes et al (2015)	Non-randomized prospective 'quasi-experimental' single centre study	Comparison of 3 minutes preoxygenation via a 15-litre non-rebreathing reservoir face mask to 60 litres/min high flow nasal oxygen therapy	101 adult patients with hypoxaemia requiring intubation on intensive care unit	■ Pulse oximetry oxygen saturation (SpO_2) higher in the high flow nasal oxygen therapy group at the end of both preoxygenation and intubation (100 *vs* 94%) ■ Fewer oxygen desaturations (<80%) with high flow nasal oxygen therapy ■ No arrhythmias or cardiac arrests observed in the high flow nasal oxygen therapy
Semler et al (2016)	Single centre randomized control trial	Preoxygenation with non-rebreathe facemask, bi-level positive airway pressure, bag valve mask or standard nasal cannulae. Then a comparison of apnoeic oxygenation with high flow nasal oxygen therapy at inspired oxygen fraction 100% and 15 litres/min during laryngoscopy to no peri-laryngoscopy supplemental oxygen therapy	150 adult patients on intensive care unit (46 further patients were excluded because of the urgency of the procedure or anticipated difficult airways)	■ No statistical difference in lowest SpO_2 (92 *vs* 90%) ■ Only five patients not intubated first time ■ 12 patients critically desaturated <80% with high flow nasal oxygen therapy *vs* 18 who received no apnoeic oxygenation
Vourc'h et al (2015)	Multicentre randomized control trial	Comparison of high flow nasal oxygen therapy to high flow face mask oxygenation during preoxygenation and apnoeic oxygenation	119 adult intensive care unit patients with hypoxaemic respiratory failure	■ No statistical difference in lowest SpO_2 (91.5 *vs* 89.5%) ■ No difference in first pass intubation ■ No difference in intubation adverse events, critical desaturation <80% or mortality

apnoeic oxygenation with high flow nasal oxygen therapy may provide additional time for airway manipulation during rapid sequence induction, which may be of use in both predicted and the unanticipated difficult airway.

However, the literature specifically examining the use of high flow nasal oxygen therapy during rapid sequence induction is limited. For example, a survey (Sajayan et al, 2016) explored the practice of rapid sequence induction in the UK and revealed that only 6% of respondents routinely use peri-laryngoscopy apnoeic oxygen techniques, although the authors did not differentiate between standard nasal oxygen (via nasal cannula at variable flow rates) and high flow nasal oxygen therapy. Furthermore, a randomized control trial by Mir et al (2017) of 40 patients, with an average body mass index of 26 kg/m^2, compared high flow nasal oxygen therapy to face mask preoxygenation and demonstrated no significant differences after rapid sequence induction between the two groups in terms of oxygen saturation (SpO_2), partial pressure of oxygen (PaO_2) and carbon dioxide ($PaCO_2$) in arterial blood, or pH. Despite comparable intubation grades between the groups, they reported a statistically significant increased mean apnoea time until intubation in the high flow nasal oxygen therapy group of 248 *vs* 123 seconds. The authors postulated that this was because the unblinded operator undertook a more considered laryngoscopy rather than suggesting that high flow nasal oxygen therapy prolonged the time taken to secure the airway. Notably, the authors did not provide apnoeic oxygenation by standard nasal cannula in the control group during laryngoscopy.

Awake fibreoptic intubation

Awake fibreoptic intubation is a core skill in the management of known or predicted difficult airways, and the 4th National Audit Project of the Royal College of Anaesthetists mandated that hospitals must be able to provide it (Cook et al, 2011). There is currently no gold standard technique of procedural oxygenation despite evidence that the use of high flow nasal oxygen therapy can improve oxygenation and mitigate desaturation during awake fibreoptic intubation.

In a prospective observational study Badiger et al (2015) used high flow nasal oxygen therapy during awake fibreoptic intubation in 50 patients. They had no difficulty intubating nasally despite the presence of the nasal cannulae and reported no desaturation or hypercapnia.

In a further prospective observational cohort study of 600 patients undergoing awake fibreoptic intubation (El-Boghdadly et al, 2017), high flow nasal oxygen therapy was used in 49% of all cases, although as the study progressed over time its use increased to almost 100%. Both the incidence of complications (9.2% *vs* 12.7%) and desaturations (1% *vs* 2%) were reduced in the high flow nasal oxygen therapy group without reaching statistical significance. However, the authors observed an increased incidence of over-sedation in the high flow nasal oxygen therapy group (3.4% *vs* 1%) which could be a result of increased confidence in maintaining oxygenation by the operator allowing for a deeper plane of sedation. Despite the lack of statistically significant benefit, the authors reported that high flow nasal oxygen therapy is now the standard oxygenation strategy for awake fibreoptic

intubation in their institute. This is consistent with the recommendation of oxygenation for awake intubation with 'for example, high flow nasal oxygen therapy' made by Higgs et al (2018).

Extubation and postoperative support

Pre-oxygenation before extubation is considered standard practice, particularly in the high-risk patient. Postoperative respiratory embarrassment and hypoxaemia are clinically and financially burdensome, increasing morbidity, mortality and length of stay (Miskovic and Lumb, 2017).

High flow nasal oxygen therapy can be used immediately post-extubation to provide oxygenation as an alternative to conventional face mask methods. However, published research is dominated by the use of high flow nasal oxygen therapy for extubation on the intensive care unit (as reviewed by Papazian et al, 2016) and may not be directly translatable to anaesthesia.

Nevertheless, high flow nasal oxygen therapy interfaces are reported as being better tolerated than face masks with fewer pressure-related skin lesions, and having improved oxygenation and other physiological parameters with at least a comparable requirement for re-intubation compared to alternatives (Stéphan et al, 2015; Hernández et al, 2016).

However, there is scope for further work in this area as patient outcome data remain sparse. At best, the evidence suggests that high flow nasal oxygen therapy is not inferior to standard oxygen delivery methods and theoretically may confer some advantages.

Surgical procedures involving the airway

Prolonged apnoeic oxygenation with high flow nasal oxygen therapy has shown promise during maintenance of anaesthesia for shared airway procedures, including laryngo-tracheal surgery and fibreoptic bronchoscopy. An educational article claimed that high flow nasal oxygen therapy has the potential advantage of avoiding the risks associated with jet ventilation and can provide superior gas exchange to low flow techniques (Pearson and McGuire, 2017). However, in the absence of ventilation one of the limitations of apnoeic oxygenation with high flow nasal oxygen therapy is that it leads to an increase in $PaCO_2$ and respiratory acidosis (Nekhendzy, 2017).

Patel and Nouraei (2015) published a well-conducted case series: the original THRIVE (transnasal humidified rapid-insufflation ventilatory exchange) study which demonstrated extended apnoea times using high flow nasal oxygen therapy in patients with difficult airways receiving general anaesthesia for hypopharyngeal or laryngotracheal surgery. Patients were pre-oxygenated using high flow nasal oxygen therapy and then apnoeic oxygenation was provided for an extended period until either the airway was secured, jet ventilation was commenced or spontaneous ventilation returned. They achieved apnoea times of 5–65 minutes with no oxygen desaturations greater than 90% and reported mean rates of end tidal carbon dioxide ($ETCO_2$) rises of 0.15 kPa/min.

> **"High flow nasal oxygen therapy can be used immediately post-extubation to provide oxygenation as an alternative to conventional face-mask methods"**

Subsequent not dissimilar studies, summarized in *Table 3*, achieved comparable apnoea times with high flow nasal oxygen therapy with To et al (2017) concurring with Patel and Nouraei (2015) that patients with a high body mass index may be more predisposed to rapid desaturation with high flow nasal oxygen therapy than patients with a normal body mass index. They recommended careful planning to minimize surgical time in obese patients and those with complex stenosis.

These studies also explored CO_2 accumulation in greater detail with Gustafsson et al (2017) reporting comparable rates to Patel and Nouraei (2015) of mean $ETCO_2$ rise (at 0.12 kPa/min). However, their rate of mean $PaCO_2$ rise was disproportionately greater at 0.24 kPa/min. This finding is broadly consistent with data provided by Lyons and Callaghan (2017) showing a mean $ETCO_2$ rise of 0.17 kPa/min compared to a mean rise in $PvCO_2$ (partial pressure of carbon dioxide in venous blood) of 0.21 kPa/min. This suggests that anaesthetists should be aware that capnography at the end of the procedure underestimates carbon dioxide accumulation in blood.

Interestingly, in contrast to the aforementioned studies, a retrospective observational study by Booth et al (2017) examined the use of high flow nasal oxygen therapy while maintaining spontaneous ventilation. This included 26 adult patients with airway compromise or respiratory distress (16 stridulous, 10 dyspnoeic) undergoing airway surgery. Anaesthesia was induced and maintained in a protocolised fashion using a propofol infusion (Marsh TCI model) and patients were allowed to breath for themselves. Median oxygen saturations were 100% (range 97–100%) during induction, with spontaneous ventilation maintained in all patients and there were no episodes of complete airway obstruction. They achieved a median duration of spontaneous ventilation of 44 minutes (range 18–100 minutes) including the staged induction period (ranging from 14 to 26 minutes). They measured the $ETCO_2$ at the end of the period of spontaneous ventilation using a supraglottic airway or endotracheal tube and compared this to baseline levels recorded via a face mask at the start. Over this period, there was an $ETCO_2$ rise of 0.03 kPa/min which is unsurprisingly less than that reported with apnoeic techniques. Moreover, they achieved an extended use time of 56 minutes in seven patients with a body mass index >35 kg/m^2. This contrasts with the shorter apnoea times that Patel and Nouraei (2015) achieved in THRIVE and may reflect the significance of spontaneous ventilation with high flow nasal oxygen therapy particularly in the obese population.

Table 3. Studies using high flow nasal oxygen therapy as an apnoeic oxygenation technique for surgical procedures involving the airway

Reference	Study type	Study design	Population	Main results and observations
Patel and Nouraei (2015)	Single centre prospective case series	■ Preoxygenation with high flow nasal oxygen therapy 100% O_2 at 70 litres/min for 10 minutes ■ Apnoeic oxygenation at 70 litres/min until the airway was secured, jet ventilation commenced, or spontaneous ventilation resumed	■ 25 patients ■ Hypopharyngeal or laryngotracheal surgery ■ 12 obese patients ■ Body mass index range 18–52 kg/m^2 ■ ASA 1–4 (median 3) ■ Nine stridulous patients ■ Predicted difficult airways – median Mallampati grade 3	■ Mean apnoea times 17 minutes ■ No SpO_2 desaturations <90% ■ Rate mean $ETCO_2$ increase 0.15 kPa/min ■ Mean $ETCO_2$ 7.8 kPa ■ Median intubation grade was 3
Gustafsson et al (2017)	Single centre prospective randomized trial	■ Preoxygenation with high flow nasal oxygen therapy 100% O_2 at 40 litres/min for at least 3 minutes ■ Apnoeic oxygenation at flows of 70 litres/min	■ 30 patients ■ Laryngoscopic surgical procedures ■ Body mass index <30 kg/m^2 ■ ASA 1–2	■ Mean apnoea time 22.5 minutes ■ No SpO_2 desaturations <91% ■ Rate $PaCO_2$ increase 0.24 kPa/min ■ Rate mean $ETCO_2$ increase 0.12 kPa/min ■ End procedure mean $ETCO_2$ 7.4 kPa ■ Mean pH decline 7.44 to 7.14 over 30 minutes ■ No malignant arrhythmias
Lyons and Callaghan (2017)	Single centre prospective case series	■ Preoxygenation with high flow nasal oxygen therapy 100% O_2 at 80 litres/min for 3 minutes ■ Apnoeic oxygenation at flows of 80 litres/min ■ Supraglottic airway device placed at end of procedure	■ 28 patients ■ Laryngotracheal surgical procedures ■ Median Mallampati grade 1 ■ Mean body mass index 24.8 kg/m^2	■ Median apnoea times 19 minutes ■ Four patients desaturated to SpO_2 85–90% with one improving with increased flows of 120 litres/min ■ Rate mean $PvCO_2$ increase 0.21 kPa/min ■ Rate mean $ETCO_2$ increase 0.17 kPa/min ■ End procedure mean $ETCO_2$ 8.47 kPa ■ Mean venous pH 7.23 (at 15 minutes)
To et al (2017)	Single centre case series	■ Preoxygenation with high flow nasal oxygen therapy ■ Apnoeic oxygenation at flows of 70 litres/min	■ 17 patients with subglottic stenosis	■ Median apnoea time 18 minutes ■ Rate $ETCO_2$ increase 0.17 kPa/min ■ End procedure median $ETCO_2$ 7.4 kPa ■ Two patients desaturated to 80% after 25 minutes apnoea – one with a body mass index of 35 kg/m^2 and difficult surgical access ■ Surgeons reported improved surgical access

ASA = American Society of Anesthiologists class; $ETCO_2$ = end tidal carbon dioxide; $PaCO_2$ = partial pressure of carbon dioxide in arterial blood; $PvCO_2$ = partial pressure of carbon dioxide in venous blood; SpO_2 = pulse oximetry oxygen saturation

Obstetric anaesthesia

Difficult intubation is more frequent in the obstetric population with failed intubation rates quoted as high as 1 in 390 (Kinsella et al, 2015). The gravid uterus results in a reduced functional residual capacity and increased metabolic rate, thus predisposing the mother to rapid desaturation and hypoxaemia.

The joint Obstetric Anaesthetists Association and Difficult Airway Society obstetric intubation guidelines (Mushambi et al, 2015) state that nasal oxygen should be considered at 5 litres/min during pre-oxygenation. At the time of publication high flow nasal oxygen therapy was recognized as an option but not openly advocated because of a clear lack of evidence in the obstetric population – this remains the case.

Paediatric anaesthesia

Children are less able to tolerate apnoea than adults, experiencing a greater rapidity in oxygen desaturation and hypoxaemia because of the higher basal metabolic rates of oxygen consumption, reduced functional residual capacity and a higher closing capacity (Jagannathan and Burjek, 2017).

Unanticipated difficulty managing a paediatric airway can result in adverse outcomes and oxygen desaturation during attempted intubation can result in the need to revert to face mask ventilation. Both repeated instrumentations to facilitate intubation and paediatric face mask ventilation are associated with airway complications (Fiadjoe et al, 2016).

In paediatrics, high flow nasal oxygen therapy has been used for many years in paediatric intensive care for awake, spontaneously breathing children with respiratory failure and for ventilator weaning, typically using flows of 2 litres/kg/min and 1 litre/kg/min for neonates and infants respectively (Milési et al, 2014). However, the use of high flow nasal oxygen therapy during anaesthesia is less well established.

Humphreys et al (2017a) conducted a study on 48 healthy children (0–10 years old) presenting for elective surgery. After induction of anaesthesia and onset of apnoea all patients had 3 minutes of face mask ventilation using 100% oxygen. The control arm had supplementary oxygen removed and a jaw thrust applied only; the intervention arm received a weight-guided flow rate of 1–2 litres/kg/min of high flow nasal oxygen therapy at 100% FiO_2. Time taken to desaturate to 92% was measured. The intervention group SpO_2 was maintained at 97% or more with apnoea times more than twice those expected by age: 192 seconds in the <6-month age group, up to 430 seconds in the 6–10-year-old group. Transcutaneous CO_2 clearance in both groups demonstrated similar rates of CO_2 accumulation at 2.4 mmHg/min.

Riva et al (2018) compared apnoea times using high flow nasal oxygen therapy at 2 litres/kg/min (30% or 100% FiO_2) to low flow nasal cannula oxygen at 0.2 litres/kg/min. They randomized 60 healthy children (aged <6 years) after the induction of anaesthesia and onset of apnoea. Their apnoea times were recorded until either desaturation to 95%, transcutaneous CO_2 >65 mmHg or 10 minutes duration. High flow nasal oxygen therapy at 30% FiO_2 achieved shorter apnoea times than 100% FiO_2 because the patients desaturated to 95%, whereas the endpoint in the 100% FiO_2 groups was primarily the result of transcutaneous CO_2 rises. There was no statistical difference between the low flow nasal cannula and high flow nasal oxygen therapy 100% FiO_2 groups with median apnoea times of 6.9 and 7.6 minutes respectively. No patients in the 100% FiO_2 high flow nasal oxygen therapy arm desaturated to <95% and more achieved apnoea times of 10 minutes than the low flow group. Their mean rate of transcutaneous CO_2 increase was 4.13 mmHg/min. The greater rate of CO_2 accumulation than that seen by Humphreys et al (2017a) may reflect the increased basal metabolic rate in the younger cohort. It is clear there is a greater rate of CO_2 accumulation than in adult studies (Patel and Nouraei, 2015; Gustafsson et al, 2017).

A further series by Humphreys et al (2017b) successfully demonstrated the use of 100% FiO_2 age-adjusted flow high flow nasal oxygen therapy in 20 children aged 5 days to 11 years for a variety of indications including airway surgery, flexible bronchoscopy, predicted difficult airway and comorbid apnoea risk. Across the series, the average SpO_2 was 96% and the lowest was 77%. One patient required rescue oxygenation.

KEY POINTS

- High flow nasal oxygen therapy provides humidified and heated controlled inspired oxygen/air mixtures and is an alternative to traditional means of perioperative oxygenation.
- While there is growing evidence in the literature highlighting its potential utility there are no published guidelines describing its indications and contraindications.
- Despite there being no large randomized control trials there is an increasing body of opinion advocating its use – particularly during intubation of the critically ill, for awake fibreoptic intubation, and oxygenation during short surgical procedures involving the airway.

Conclusions

Despite there being no large multicentre randomized control trials high flow nasal oxygen therapy appears to have established a toehold in anaesthetic practice with numerous publications highlighting its feasibility, practicality and safety. The most convincing evidence of its advantage over alternative techniques is the provision of apnoeic oxygenation during short surgical or other shared airway procedures. However, the full utility, indications and contraindications of high flow nasal oxygen therapy are not yet completely understood with little in the literature detailing its current usage in day-to-day practice.

Difficult Airway Society tracheal intubation guidelines advocate the use of high flow nasal oxygen therapy as an alternative to conventional oxygenation techniques at best (Higgs et al, 2018). This reflects the current evidence base being limited to small studies, with many exhibiting control group bias, that may not be transferable to all patient groups.

Although best clinical practice is ideally informed by robust randomized control trials, it may prove difficult to achieve in all cases – as it seems implausible to conduct such studies, for example, with the unanticipated difficult airway. In that scenario the evidence base is more likely to come from the scrutiny of databases and registers. It is still early days in the development of high flow nasal oxygen therapy within anaesthesia and time will tell whether it gains further traction and establishes its use in routine practice. **BJHM**

Figure 1 *is reproduced with permission of Armstrong Medical Ltd. Conflict of interest: Dr D Kotwinski, Dr L Paton and Dr R Langford received an honorarium payment from Armstrong Medical Ltd for writing a user guide for the peri-operative insufflatory nasal therapy airway system.'*

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WAMM

2019 World Airway Management Meeting

Clinical Abstracts from WAMM 2019

In November 2019, Armstrong Medical was a principal sponsors of the World Airway Management Meeting (WAMM); a combined congress for the annual scientific meetings for the Difficult Airway Society (DAS), The Society for Airway Management (SAM) and the European Airway Management Society.

Held in Amsterdam, this international event welcomed over 1,800 physicians, trainees and specialists from around the world, representing over 80 countries. The programme brought together product innovation and clinical experience from the leading experts in the field.

WAMM 2019 surpassed our expectations and we were extremely pleased with the response we received globally for POINT® following the event.
We are proud to share with you the following five abstracts presented at WAMM referencing POINT®.

Measurement above the carina of FiO2 and Positive Pressure changes using different HFNO rates

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Introduction

High Flow Humidified Oxygen has been described in the medical literature as effective to provide apnoeic oxygenation in different scenarios, from intensive care to difficult airway, laryngeal surgery to paediatrics.

There is some concern about the risk of fire in oxygen enriched surgical fields.

Using a cadaver we aimed to measure the pressure obtained, the percentage of oxygen achieved and the time it takes to increase and decrease the oxygen concentration above the carina with different high flow rates.

Methods

A fresh frozen cadaver was used to measure the FiO2 and the PEEP above the carina by means of a double lumen percutaneous catheter inserted trans tracheal and positioned under fibre-optic vision.

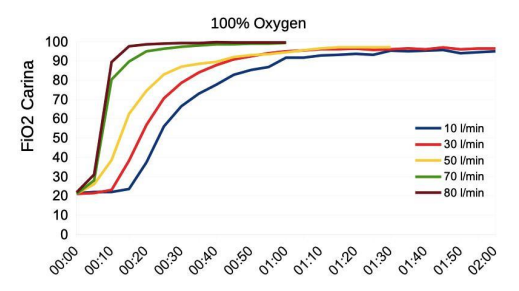
The airway was cleaned and the cadaver ventilated with air and a baseline of 21% inspiratory oxygen obtained.

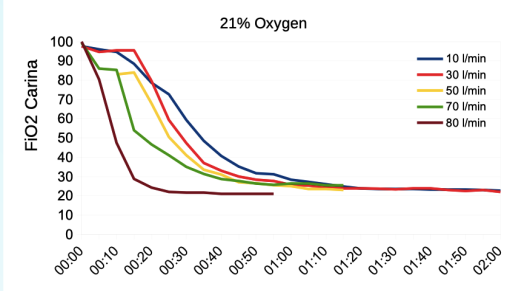
With the airway patent (jaw trust) and the mouth closed. 100% oxygen was administered through nasal High Flow Humidified Oxygen at 10, 30, 50, 70 and 80 L·min−1. Pressure and FiO2 were measured until stabilised above 95%.

Once the increase of oxygen reached a plateau, and while the same flow 21% oxygen was given, pressure and FiO2 measured again until FiO2 stabilised below 24% with the aim to time how long it would take to decrease the risk of combustion.

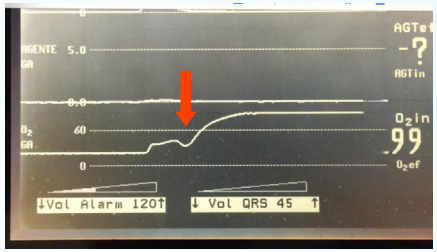
Results

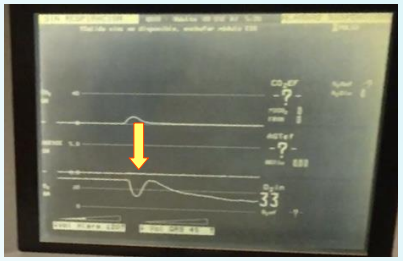
PEEP at the different flow rate was constant as long as the mouth was kept closed. Values obtained: 10 L·min-1 PEEP 0,5. 30 L·min-1 PEEP 2, 50 L·min-1 PEEP 4. 70 L·min-1 PEEP 6. 80 L·min-1 PEEP 7.5 mmH2O.





HFNO increased FiO2 in the carina, the time needed to provide more than 90% oxygen depends on the flow rate from 96 seconds at 10 L·min^{-1} to 15 seconds with 70 L·min^{-1}.Time needed to reduce the FiO2 below 30% varies from 55 to 23 seconds.





Some “dips” on the FiO2 measurement where noted when pressure was lost, when the grip from the jaw trust was lost (red arrow) or when the FiO2 was changed and therefore the HFNO switched from the Oxygen to the Air canister (yellow arrow).

Conclusions

As described in the literature, HFNO provides PEEP with the mouth closed directly related to the flow rate.

HFNO is effective in providing apnoeic oxygenation. The time needed to surpass 90% oxygen varies from 96 seconds at 10 L·min-1 to 15 seconds with 70 L·min-1.

It is equally effective in washing out oxygen from the airway to a level that can be safe to perform intra-luminal electro-cauterization without the risk of combustion whilst maintaining the benefit of continuous positive pressure.

If we consider the delay caused by the gas analyser, the changes provided at 70 and 80 L·min-1 are nearly instantaneous.

Any pressure change caused an immediate but temporary shift ,most likely due to gas re-distribution from the death space.

Caution has to be applied when interpreting this data as it was obtained from a single subject, with the mouth closed.

Acknoledgments

Department of Human Anatomy and Embryology. Faculty of Medicine and Odontology. Valencia University .who granted permission and facilities to perform the measurements.

Martin Vecino SL (Distributor Armstrong Medical Spain) provided Armstron FD140 flow driver, oxygen and air cylinders.

Use of high flow nasal oxygen to facilitate emergency awake surgical tracheostomy

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Bedford Hospital NHS Trust, UK; 1) Trainee Anaesthetist 2) Consultant Anaesthetist 3) Ear, Nose & Throat Surgeon

Case report

- 81-year-old female
- PMH: heavy smoker (60 pack year history), otherwise well & independent
- HPC: 1 year increased hoarseness of voice
- Presented to ED with increasing respiratory distress
- O/E: obvious **stridor**, low SpO_2
- FNE: **large left supraglottic mass** (figure 1) causing near complete obstruction on each inspiration
- Management options discussed with patient & family:
  - 1. **awake surgical tracheostomy**
  - 2. supportive/palliative care
- Consented for surgical tracheostomy under LA

HIGH RISK of endotracheal intubation complication/failure, even with use of awake fibreoptic intubation or microlaryngeal tube

Perioperative airway management

- Perioperative airway management
- Preoperative SpO_2: 69% on 15 L/min Heliox
- Sitting position due to critical airway
- Preoxygenation: F_IO_2 0.75 at 60 L/min via a high flow nasal cannula (HFNC) system (Peri-Operative Insufflatory Nasal Therapy with AquaNASE®, Armstrong Medical, figure 2)

Immediate relief of respiratory distress & improvement in SpO_2

- Spontaneous ventilation with HFNC oxygenation **maintained adequate SpO_2** of 86-90% (except brief desaturation to 75% when trachea breached, figure 3)
- Size 7 Portex® cuffed tracheostomy tube inserted

Follow-up

- ITU for postoperative monitoring
- Cuff deflated after 24h without incident
- Further Ix: CT neck/chest, GA laryngoscopy & biopsy
- Discharged with further management as an outpatient

Figure 1: View of laryngeal mass on flexible nasendoscopy

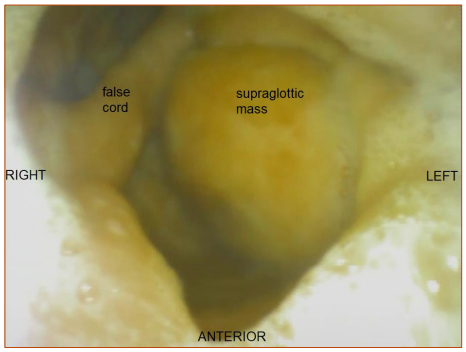


Figure 2: AquaNASE® nasal cannula & POINT system

Discussion

HFNC oxygenation for emergency awake tracheostomy has been described once previously.[1]

Ventilatory techniques for upper airway surgery:[2]
- spontaneous ventilation with topical anaesthesia ± sedation
- spontaneous ventilation with GA
- intermittent positive pressure ventilation through microlaryngeal tube
- low frequency jet ventilation
- high frequency jet ventilation

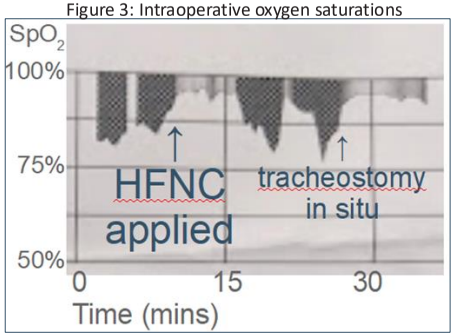
Indications for HFNC therapy in adults:[3]
- treatment of acute respiratory failure
- management of difficult airways
- improvement of gas exchange post-abdominal/cardiac surgery
- post-extubation & immediate pre-intubation periods on intensive care
- facilitation of bronchoscopy

National Confidential Enquiry into Patient Outcome and Death (NCEPOD) recommendation: in **critical airway stenosis** an **experienced otolaryngologist** should perform **tracheostomy** under **local anaesthesia**, maintaining airway patency until control is established.[2]

Physiological benefits of HFNC delivery systems:[3]

HFNC feature	Physiological effects
Warm humidified gas	Reduced airway surface dehydration Improved secretion clearance Decreased atelectasis
Gas flow up to 60 L/min	CO_2 washout Reduction in anatomical dead space Provides an oxygen reservoir Allows F_IO_2 close to 1.0 to be delivered
Positive end expiratory pressure	Increased end-expiratory lung volume Alveolar recruitment

Figure 3: Intraoperative oxygen saturations



In our case HFNC proved invaluable in:
- **treating hypoxia and respiratory distress**, surpassing conventional methods of non-invasive ventilation and Heliox
- **increasing oxygen reserve**, preventing life-threatening perioperative desaturation
- **maintaining perioperative spontaneous ventilation**, without causing patient distress or restricting surgical access

Conclusion

We present the use of HFNC as a highly effective means of resuscitation and ensuring oxygenation during emergency awake surgical tracheostomy.

We are grateful to the patient for consenting to the presentation of her case.

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Preoxygenation with high flow nasal cannula vs face mask in morbidly obese patients

Conclusion

In morbidly obese patients, high flow nasal cannula (HFNC) provided preoxygenation comparable to face mask. HFNC may prolong time to desaturation during laryngoscopy.

Introduction

HFNC delivers heated, humidified, high flow oxygen through the nose and provides positive airway pressure which may be beneficial for preoxygenation in morbidly obese patients.

Further, HFNC may prolong apnea tolerance due to apneic oxygenation during laryngoscopy in this patient population.

Aims

The primary aim of this study was to compare preoxygenation with HFNC to standard management with face mask in morbidly obese patients. Also, we aimed to observe apneic oxygenation with HFNC during intubation.

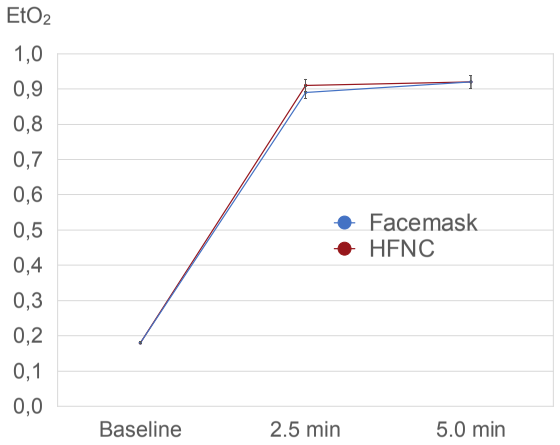

Fig. 1 *EtO_2 during preoxygenation*

Methods

In this single center, randomised, controlled, open-labelled study, patients with BMI ≥ 35 kg/m² were assigned to receive 5.0 min of preoxygenation with 100% O_2 by face mask with a PEEP of 7 cmH_2O (n=8) or HFNC (Fig. 2) with a flow of 70 L/min (n=11).

After anesthesia induction, oxygenation was maintained with face mask ventilation or apneic oxygenation with HFNC in the two groups respectively.

Results

- No difference in EtO_2 during preoxygenation – all patients in both groups reached an EtO_2 of ≥ 0.8 and 0.9 within 2,5 and 5.0 min respectively (Fig.1).
- No difference in PaO_2 during preoxygenation. Mean PaO_2 after 5.0 min was 65.1 ± 7.2 vs 66.4 ± 7.9 kPa in the HFNC and face mask group respectively.
- In the HFNC group, mean apnea time was 206 ± 28 s and mean PaO_2 was 37.8 ± 11.5 kPa after endotracheal tube confirmation. No patient desaturated below a SpO_2 of 100%.

Fig. 2 *Typical patient positioning and equipment set up in the HFNC group.*

Department of Anaesthesia & Head and Neck Surgery

Efficacy of High Flow Nasal Oxygen in Head and Neck surgery: a prospective audit

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University Hospitals of Derby and Burton NHS Foundation Trust

Introduction

Techniques based on apnoeic oxygenation via aventilatory mass flow (AMF) have come into prominence in recent years. The current iteration of apnoeic oxygenation uses high-flow nasal oxygenation (HFNO) also termed THRIVE[1] (transnasal humidified rapid insufflation ventilatory exchange). The physiology is based on the creation of a supraglottic vortex as oxygen enters the nose at 70-90L/min and exits through the mouth which constantly replenishes oxygen and prevents entrainment of room air. HFNO also exerts a positive expiratory pressure facilitating apnoeic oxygenation. These processes maintain an oxygen concentration gradient to the alveoli and allow a degree of clearance of CO_2[2].

There are few reports of use of THRIVE during use of laser in transoral laser surgery. We wanted to assess the impact of the recent introduction of THRIVE on our day case ENT list. Specifically, whether this technique had an advantage over traditional anaesthetic methods in terms of surgical operating conditions.

Methods

Using the POINT (Peri-Operative Insufflatory Nasal Therapy, Armstrong Medical) system, we prospectively audited the use of HFNO in 20 head and neck cases at our hospital between October 2018 and May 2019. The audit was conducted on the same biweekly operative list, with the same surgeon, anaesthetist and theatre team. The case mix of patients included diagnostic rigid scopes and both laryngeal and tracheal surgery using the CO_2 laser.

At the morning briefing, we discussed as a team, the steps and processes required. It was agreed the patient would be anaesthetised in theatre and with surgical team ready to manage the airway once the patient was anaesthetised.

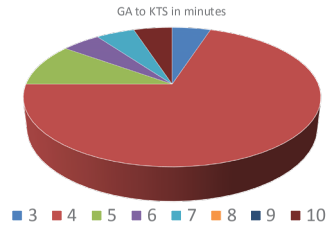
The POINT apparatus, used as the sole method of oxygen delivery, was applied to the patient as soon as they arrived in theatre with a concentration of 100% oxygen at a flow rate of 30L/min to start and increased to 70 L within a minute for a minimum of ten minutes.

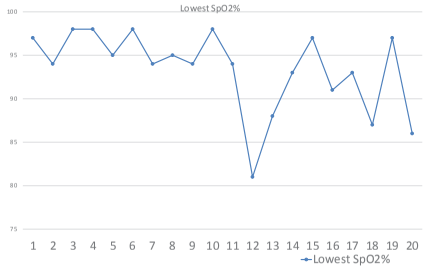
Thereafter, induction of anaesthesia was performed using an intravenous technique of propofol, remifentanil and rocuronium. Total intravenous anaesthesia was used to maintain anaesthesia and all patients had depth of anaesthesia monitoring applied. A jaw thrust was maintained at all times, in order to keep the airway patent. This was initially by the anaesthetist and thereafter by the surgeon prior to insertion of a suspension laryngoscope.

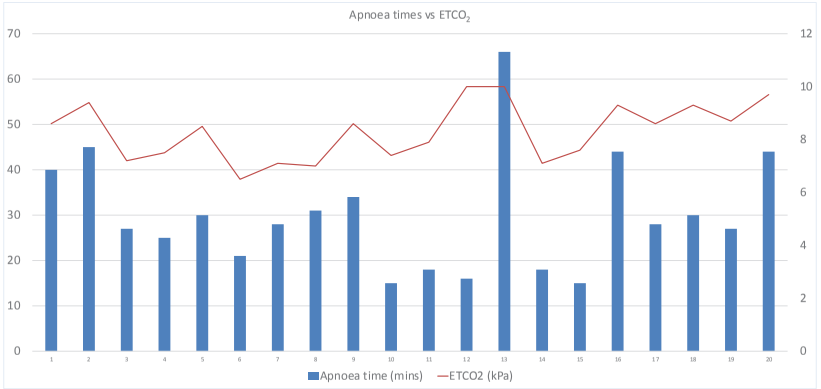
If the patient's oxygen saturations dropped below 92%, an Aintree catheter was inserted by the surgeon and the patient was transiently ventilated until oxygen saturations were > 95% after which it was removed.

During laser cases, the oxygen concentration was transiently decreased to 21% whilst the laser was in use. At the end of the procedure, sugammadex 2mg/kg was administered and a supraglottic airway was inserted. Once adequate spontaneous breathing had been established, the patient was transferred to recovery.

Variables measured included total anaesthetic time, apnoea time, operative time, turnaround time and end of procedure end tidal CO_2 ($ETCO_2$). The only exclusion criteria was a body mass index (BMI) > 30. This audit complied with local clinical governance guidelines and ethics.







Results

Of the 20 cases audited, 50% had surgeries involving the CO2 laser. Pre-oxygenation time ranged from 10 to 12 minutes. Apnoea time ranged from 15 to 45 minutes, with one outlier case totalling 66 minutes. In five cases, the patient's oxygen saturations dropped to below 92% and an Aintree catheter was inserted. The Aintree catheter was then removed and surgery continued in all apart from one patient who required intubation and ventilation. No complications were recorded and no procedure was abandoned. End of procedure $ETCO_2$ levels were all equal to or less than 10kPa. The time from induction of general anaesthesia to time of surgical start time ranged from 3 minutes to 10 minutes with a mean time of 4.5 minutes. Time from administration of sugammadex to the patient leaving theatre ranged from 4 to 17 minutes with a median time of 7 minutes and 75% of cases leaving within 8 minutes. Again, 17 minutes appeared to be an outlier and apnoea time in this instance was 66 minutes.

Conclusions

Tubeless trans-oral laser surgery has the potential to improve surgical outcomes by:

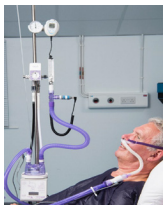
- Allowing improved access to areas such the vocal process and posterior commissure which are usually obscured by the endotracheal tube.
- Reduced movement of target tissue, less blood spray and a smokeless operative field.

Increased productivity and capacity on the operating list due to

- The patient is anaesthetised in theatre which eliminates the need for transfer of patient from anaesthetic room.
- No requirement for the patient to be extubated; the patient can be taken to recovery breathing spontaneously with a supraglottic device.
- Reduced surgical time secondary to improved access and quality of operating conditions
- No repeat procedures required for incomplete biopsies in any of the patients and the surgeon feels this is probably due to improved view of the larynx.

For future use

- Requires training of all theatre staff and team to be aware of procedure and equipment to ensure a safe and smooth running of the list.
- Patient selection – not tested in in patients with BMI>30.
- Although we did not see any problems with the use of laser, the case numbers are small.



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EXCEPTIONAL Care Together

POINT® Case Reports

Improving safety, patient outcomes and service delivery in Special Care Dentistry (SCD) using high flow nasal oxygen. School of Dentistry, DPU Royal Victoria Hospital Belfast

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Anne Stevens,
Consultant in Special Care Dentistry
Kathryn McKenna
StR SCD in Special Care Dentistry
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Summary of presentation by Dr Molloy at Armstrong Medical POINT® in Practice Seminar, Coleraine Northern Ireland October 2018.

SCD is the provision and delivery of oral healthcare to patients with a wide range of disabilities. Patients tend to not access healthcare, have increased comorbidities and worse outcomes
General anaesthesia (GA) may be needed to facilitate patient co-operation rather than facilitate the surgical procedure, and in these circumstances it is often a complex undertaking that requires careful consideration.

Recent guidelines recommend use of IV sedation wherever possible to avoid the problems associated with GA, and supplemental oxygen is usually required in these procedures 6
Use of High Flow Nasal Oxygen Therapy (HFNOT) improves oxygenation, creates positive airway pressure effects, and improves patient comfort whilst allowing deeper levels of sedation to be used without causing hypoxia 7
Use of POINT High Flow system allows air blending and reduction in FiO_2 so that patients are not exposed to prolonged sedation with 100% O_2 and can be used to good effect in difficult patients, obese patients and known difficult airways

Effects on practice: increase in number of patients being treated as day cases and use of IV sedation, with a reduction in the number of GAs being given and unplanned admissions post procedure. Use of POINT® and IV sedation is now the preferred choice in higher risk cases

Take home message: use of POINT® in SCD allows deeper sedation to be used more safely and frequently in complex and high risk patients.

HFNOT with IV sedation - Impact on SCD service

We observed:

- Reduced inpatient referral
- Decrease waiting times overall
- Improved access to care patient
- Improved outcomes for patients

Summary written by Dr Alister Glossip, Sheffield Teaching Hospitals

Any technique resulting in the loss of consciousness is defined as general anaesthesia, and in the UK deep sedation requires the same level of care. General anaesthesia is not permitted in the primary dental care setting in the UK.

http://www.sdcep.org.uk/wp-content/uploads/2018/07/SDCEP-Conscious-Sedation-Guidance.pdf Conscious sedation in dentistry. Third Edition. June 2017

For more information contact:
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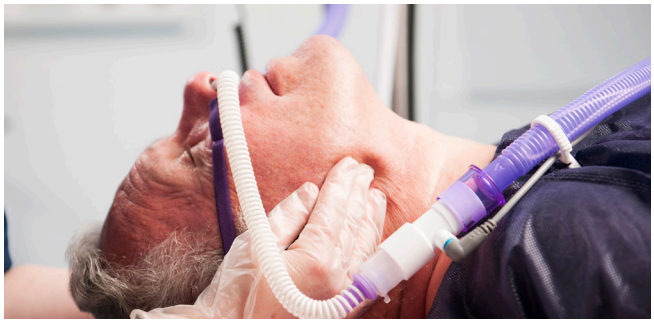
POINT® High Flow Oxygen support during bronchoscopy



"POINT® has enabled the provision of more complex procedures under deep sedation."

Dr Rachel O'Farrell is a Consultant Anaesthesiologist, working across a variety of clinical areas within the hospital setting. A proportion of her clinical practice involves the provision of deep sedation for patients requiring bronchoscopy. "The location of the endoscopy suite is classed as a remote, or satellite facility. The provision of deep sedation in such satellite endoscopy units, remote from a suite of theatres, has been the subject of several British and Irish studies. All studies regarding such facilities indicate an increase in Serious Adverse Incidents (SAIs) comparative to procedures undertaken within a dedicated theatre suite".

The bronchoscopy suite treats a specific cohort of patients, many with advanced chronic airway conditions, undergoing a fibreoptic bronchoscopy for optimal visualization of the affected airway. This procedure enables the clinician to perform bronchial lavage with or without an associated biopsy.

There are several potential problems associated with performing a bronchoscopy:

- This patient cohort, by the nature of their underlying pathophysiology, is deemed high risk in relation to deep sedation and anaesthesia.
- Partial occlusion of the patients' airway after introduction of the bronchoscope.
- Sharing of the airway with the operator, who is introducing the scope into the patient lungs, in conjunction with the introduction of fluid and saline as well as the suctioning of secretions, etc.
- A large percentage of patients undergoing bronchoscopy for investigation of breathing difficulties, have a high body mass index (BMI) and thus have a baseline higher metabolic oxygen requirement, secondary to their premorbid state. These patients have an increased propensity for a precipitous drop in oxygen saturations during deep sedation.
- All of these factors combined, deem the patient undergoing bronchoscopy to be at risk of developing persistent desaturations during the procedure, which has a significant clinical impact for the patient and results in intraprocedural delay.

"These patients benefit from heated and humidified High Flow Oxygen therapy. We use the Armstrong Medical POINT® (Peri-Operative Insufflatory Nasal Therapy) device. The POINT® device blends medical air and oxygen to provide High Flow via a specifically designed nasal cannula interface."

"Since the introduction of the POINT® system, we have observed several benefits:

- **Increased quality and safety of procedural provision to patients undergoing bronchoscopy.**
- **Reduction in post-procedure complication rates such as hypoxaemia and/or altered haemodynamics.**
- **Patients identified as having a high body mass index have received a positive clinical impact in the delivery of clinical care.**
- **Improved recovery times post-procedure, ensuring that patients are returned to their receiving ward or department quicker.**
- **POINT® has enabled the provision of more complex procedures under deep sedation."**

Improved Surgical Access & Operating Times for Laryngeal & Tracheal Surgery

Armstrong Medical POINT® High Flow with adjustable Oxygen concentration 21-100%.

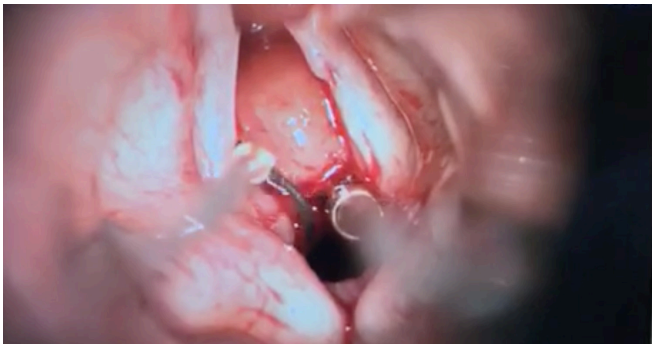
"Tubeless anaesthesia for laryngeal surgery has revolutionised our practise. It has led to improved operative conditions facilitating better surgical outcomes, reducing operative times whilst not impacting on patient safety.

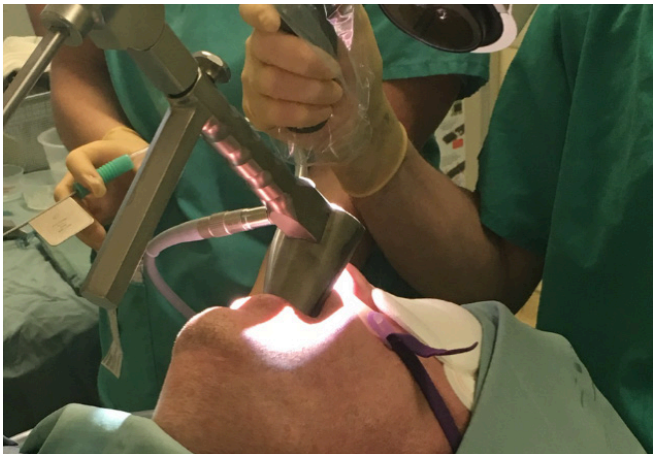
We used the POINT® (Peri-Operative Insufflatory Nasal Therapy) system which allows the delivery of humidified HFNO at flow rates of up to 80L/min and FiO_2 of 0.21-1.0 as the sole method of oxygen ventilation.

We carried out 27 cases of microlaryngoscopy in addition to, an intervention such as a biopsy, tumour debulking or injection thyroplasty and one case of balloon dilation of subglottic stenosis. The median apnoea time where surgery was permitted was 19 minutes with a range of 9-37 minutes.

We believe this technique is the way forward in the future for certain types of laryngeal and tracheal surgery.**"**

Kavanagh F, Callaghan M, Young O. Tubeless Anaesthesia for Laryngeal and Tracheal Surgery: A Surgeon's Perspective. ENT & Audiology News 27;4:57-62.





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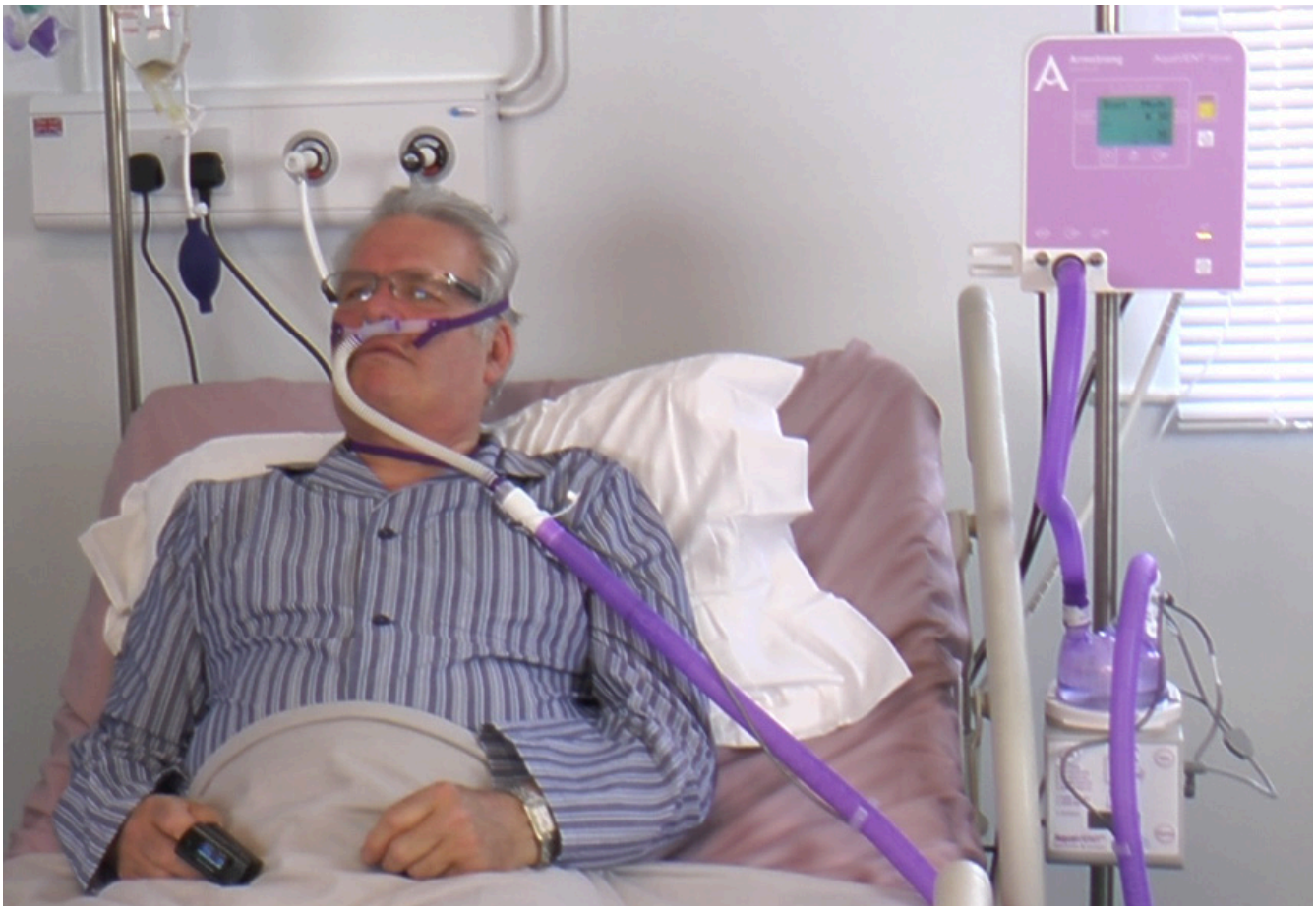
Cardiac & Thoracic post-operative respiratory support with the FD140



Liverpool Heart & Chest Hospital is a major UK center for cardiothoracic surgery, cardiology and respiratory medicine. With a catchment area of 2.8m people, a 30-bed Critical Care Unit, 12 consultants and 200 plus nursing staff receiving 2400 sternotomy patients per year.

Dr James Greenwood, Consultant in Respiratory and Critical Care Medicine, fellow of the Royal College of Physicians (London), Fellow of the Faculty of Intensive Care Medicine and Member of the British Thoracic Society.

"The vast majority of patients that come through our critical care unit have had major cardiac or thoracic surgery, these patients will have lots of respiratory co-morbidity. With a very high instance of smoking in the part of the world where I work these patients are vulnerable to post-op respiratory complications."

The Benefits of Nasal High flow

Nasal High Flow Oxygen therapy is promising in its ability to overcome some of the most common post-operative complications, very good at humidifying the airway, delivering a reasonable fraction of inspired oxygen and delivering a little bit of pressure to the lower airway to help open up the airways and keep them open, particularly those patients whose lungs have collapsed down during cardiac bypass surgery. The evidence is that Nasal High Flow is very well tolerated, patients find it comfortable and the studies show a real potential to improve length of stay and reduce critical care co morbidity.

Previous 12 Month Consumable Cost	
Product	**Annual Usage**
CPAP Mask	440
Head Strap	440
CPAP Circuit	769
CPAP Hood	145
Total Consumable Cost	**£28,486**

Implementing Nasal High flow

We had been looking to introduce Nasal High Flow Therapy to our units for several years but for a variety of reasons not been able to move it forward. We then had an opportunity to move forward on Nasal High Flow as we needed to replace some of the hardware currently used to deliver more advanced Respiratory support.

The FD140 ticks all the boxes, it is easy and intuitive for the nursing staff to set up and use, quick to turnaround for medical engineering, and most importantly it's very well tolerated and comfortable for patients. An additional benefit is the ability to easily step up to CPAP or wean down to ward level respiratory support.

THE FD140 patient experience

If I select my patients correctly I know that Nasal high flow therapy will be better tolerated than what we used previously and reduce the need to step up to CPAP.

However, when CPAP is required, with the FD140 the step up and changeover to CPAP with the same device is very easy.

If you can reduce length of stay, then economically that's a big benefit for the Unit. Since the introduction of the FD140 as part of a package of changes in our unit, we have seen initial encouraging signs that a reduction in mean LOS may be occurring in patients requiring advanced respiratory support.

Minimising things like CPAP hood usage is also economically beneficial. The Universal face mask seems to be very well tolerated and the patients are very comfortable.

Since implementing in our department we have seen a reduction in hood usage by more than 95% which would equate to almost £18,000 savings on consumable costs per year.

At Liverpool Heart and Chest, we have introduced 22 FD140 systems and universally my colleagues and I are very happy. The experience has confirmed that delivering combined Nasal High Flow and CPAP with the FD140 has both financial and patient benefits.

Although initial results are promising we await publication of further data regards reduction in length of stay.

2015-16 data

- 885 patients received higher level respiratory care (87% cardiac, 9% thoracic)
- Total therapy days 2057, average 2.32 per patient
- Total length of stay 5763 days, average 5.61 per patient

The Cost benefits of reducing ICU length of stay (LOS)

Level 2 bed c. £900 per day

- Reduce LOS by 0.5 days in half the patients, save £198K
- Reduce LOS by 1 day in half the patients save £396K.

POINT® in Practice Seminar

Armstrong Medical POINT® Seminar Summary, 11th & 12th October 2018

Apnoeic POINTed oxygenation & high flow

Dr Saracoglu

Tubeless operations in upper airway surgery using STRIVE – HI

Dr Shallik

Improving safety, patient outcomes and service delivery in Special Care Dentistry (SCD) using High Flow Nasal Oxygen

Dr Molloy

High flow nasal oxygenation during awake craniotomy

Dr Kelly

To watch all the presentations from our POINT® in Practice Seminar visit armstrongmedical.net or

Scan the QR code

What's the POINT? Why, When and How - the nuts and bolts of High Flow Nasal Oxygen in Anaesthesia Care

Dr Mannion

Perioperative Insufflatory Nasal Therapy (POINT®) in laryngeal surgery

Dr Lopez

Intraoperative High Flow Oxygen Therapy in Bariatric Surgery: A new hope.

Dr Rezola

Use of High Flow Nasal Oxygen Therapy (HFNOT) in immediate post op recovery

Dr Ekambaram

Armstrong Medical POINT® Seminar Summary Notes 11th & 12th October 2018

Background and glossary of commonly used terms.

- **HFNOT**: high flow nasal oxygen therapy, involving delivery of high flow oxygen (>60L/min) to patients via the nasal route
- **HFNC**: high flow nasal cannulae, a specific cushioned nasal interface used for the delivery of high flow nasal oxygen to patients.
- **Apnoeic oxygenation**: continued provision of oxygen to the alveoli in the absence of ventilation. It is used in anaesthesia to extend the 'safe apnoea time' beyond that which can be achieved by preoxygenation alone.
- **POINT®**: perioperative insufflatory nasal therapy, which encompasses delivery of high flow nasal oxygen throughout the perioperative period. When used pre and intraoperatively, it utilises the benefits of HFNC to generate flow dependent, non-rhythmic ventilatory exchange due to mass flow of O_2 and CO_2 .
- **STRIVE-HI**: spontaneous respiration using intravenous and nasal high flow oxygen. An anaesthetic technique which provides a tubeless surgical field but does not rely upon apnoeic oxygenation as the patient still breathes spontaneously under anaesthesia.
- **THRIVE**: transnasal humidified rapid insufflation ventilatory exchange. A physiological mechanism for oxygenating and ventilating patients who are under general anaesthesia and who have diminished or absent respiratory effort, created using high flow nasal oxygen delivered by nasal cannulae.

Apnoeic POINTed oxygenation and high flow - Professor Kemal Togla Saracogla.

- Oxygen uptake is variable and defined by the Fick principle; oxygen (O_2) storage is limited to the Functional Residual Capacity (FRC) of the lung which is 2100 to 2500 mls in adults.
- Breathing room air, the FRC contains approximately 240mls O_2 which will be used up after 1 minute of apnoea; if effectively preoxygenated the FRC will hold up to 1650mls O_2 which will support an apnoea time of 6.5 to 7 minutes.
- Safe apnoea time is the duration of apnoea without desaturation occurring and may be up to 7 or 8 minutes in healthy adults; markedly reduced in critical illness, children, obesity and pregnancy.
- Apnoeic oxygen has been described in a number of studies and is the result of aventilatory mass flow creating a negative pressure gradient for oxygen in the absence of ventilation. This sustains oxygen saturations and, as CO_2 is produced less rapidly and buffered, build up is less of an issue[1].
- Apnoeic oxygenation techniques recommended by Difficult Airway Society[2] where there is a high risk of difficult airway or desaturation although no preference for mode of delivery is specified.
- Low flow devices may be used but deliver cold, dry air and have variable performance; high flow oxygen provides better humidification, better patient comfort and less entrainment of room air.
- HFNOT has numerous other advantages including: expired CO_2 washout, reduction in dead space, higher FiO_2 delivery, increased humidity and secretion clearance, reduced work of breathing, improved patient comfort and flow generated PEEP.
- As well as its use in preoxygenation and prolonging apnoea times, HFNOT may be used for treatment of hypoxic respiratory failure, postoperative hypoxia, support of procedural sedation, difficult airway management. There are also case reports of successful use in awake fiberoptic intubation (AFOI) and before and after Bariatric surgery.
- Research is ongoing to examine use in emergency and prehospital settings, Obstetric care, post extubation populations and its effects on atelectasis as measured by lung ultrasound.

Take home message: HFNOT can be used to augment oxygen uptake in apnoeic patients and prolong the apnoea time, and has the potential to provide benefits in a number of other clinical settings.

What's the POINT? Why, When and How - the nuts and bolts of High Flow Nasal Oxygen in Anaesthesia Care - Dr Stephen Mannion.

- POINT® may be used intraoperatively at higher flow rates (>60L/min) to improve dead space oxygen content, generate low level PEEP (4 to 7 cmH_2O) and flush out expired gases leading to reduced minute volume (MV) and work of breathing.
- Delivery of high flow nasal oxygen for anaesthesia use requires an oxygen blender, delivery system and a heat and humidification unit.
- THRIVE study has driven use in anaesthesia: demonstrated beneficial effects of HFNOT in prolonging apnoea times under anaesthesia without problematic hypercarbia, and has led to more widespread use [3].
- Indications: prolonged apnoeic oxygenation (AFOI, difficult airway), airway surgery (tubeless field), selected surgical patients where invasive ventilation is undesirable.
- Delivery: TIVA (total intravenous anaesthesia) anaesthetic, standard monitoring, head up position, 70L/min flows with jaw thrust, good relationship with surgeon, short surgical procedures, well organised and engaged theatre team.
- Used to good effect in cases of patients with severe COPD or very recent lobectomy surgery where intubation and positive pressure ventilation would be hazardous.
- Experimental data suggests that use of lower flow rates (40L/min) reduces the beneficial effects and length of apnoea time.

Take home message: benefits of HFNOT on oxygenation and CO_2 clearance are more pronounced at higher flow rates (ie. 70L/min) and may be reduced if lower flows are used.

Tubeless operations in upper airway surgery using STRIVE – HI - Dr Nabil Shallik.

- STRIVE HI is spontaneous respiration using intravenous and nasal high flow oxygen; does not rely on apnoeic oxygenation as the patient is still breathing spontaneously[4].
- Used for tubeless laryngeal surgery in 40 adult and 15 paediatric cases of up to 40 minutes duration
- Benefits: improved surgical field (no ETT in place), allows dynamic airway assessment, reduced barotrauma, reduced atmospheric pollution, better oxygenation in difficult airways, hypercarbia reduced compared to apnoeic techniques (eg. THRIVE).
- Limitations: Hypercarbia, duration of surgery limited (approx. 40 minutes max), less suitable in obese patients or in presence of airway bleeding, infection and obstruction.
- Complications: laryngospasm, aspiration of tumour, blood and fumes, hypoxia, hypercarbia, airway fires with laser / diathermy use, critical gastric distension (in paediatric cases).
- Technique: application of HFNC at 60L/min flow. Anaesthesia with a propofol infusion (incremental doses to avoid apnoea) and either low dose or bolus remifentanil. Also topical application of 4% lignocaine and 0.5% phenylephrine to cords and tumour (reduces remifentanil requirement). If laser being used limit FiO_2 to 0.4 maximium to reduce likelihood of airway fire.
- The technique is modified slightly in paediatric cases to propofol and dexmedetomidine infusions with reduction in HFNOT flows according to patient weight[5].
- In all cases full monitoring (SpO_2, ECG, NIBP) is used plus bispectral index (BIS) depth of anaesthesia and transcutaneous CO_2 monitoring.

Take home message: STRIVE-HI is a promising new technique that facilitates tubeless laryngeal surgery in spontaneously breathing patients, although more research into the scope its use is needed.

Perioperative Insufflatory Nasal Therapy (POINT®) in laryngeal surgery - Dr Isabel Garcia Lopez.

- Laryngeal surgery utilises either an open or endoscopic approach; the endoscopic approach is also referred to as microlaryngeal surgery (MLS).
- MLS involves operating in a small anatomical space and is often intricate and precise in nature.
- Surgical preference is for anaesthetised and paralysed patients; however this is achieved at the expense of an endotracheal tube (ETT) in the airway which can significantly compromise surgical exposure.
- Not having an ETT present provides far better surgical exposure, especially with larger lesions.
- POINT® may be used to provide oxygenation using HFNC; with the addition of a TIVA anaesthetic and paralysis an ideal surgical field can be provided.
- Used in various short surgical procedures including: surgical examinations / EUA, injection laryngoplasties, biopsies, simple phonomicrosurgical procedures (ie. polypectomies), vocal cord injections, patients with otherwise poor surgical exposure.
- Benefits: better surgical exposure and more space to operate in.
- Limitations: limited operating time, which can in turn cause additional stress to the operator.

Take home message: POINT® may be used to provide improved surgical conditions in carefully selected patients undergoing short laryngeal procedures.

Improving safety, patient outcomes and service delivery in Special Care Dentistry (SCD) using High Flow Nasal Oxygen - Dr Mary Molloy.

- SCD is the provision and delivery of oral healthcare to patients with a wide range of disabilities. Patients tend to not access healthcare, have increased comorbidities and worse outcomes.
- General anaesthesia (GA) may be needed to facilitate patient co-operation rather than facilitate the surgical procedure, and in these circumstances it is often a complex undertaking that requires careful consideration.
- Recent guidelines recommend use of IV sedation wherever possible to avoid the problems associated with GA, and supplemental oxygen is usually required in these procedures[6].
- Use of HFNOT improves oxygenation, creates positive airway pressure effects, and improves patient comfort whilst allowing deeper levels of sedation to be used without causing hypoxia[7].
- Use of POINT® allows air blending and reduction in FiO_2 so that patients are not exposed to prolonged sedation with 100% O_2 and can be used to good effect in difficult patients, obese patients and known difficult airways.
- Effects on practice: increase in number of patients being treated as day cases and use of IV sedation, with a reduction in the number of GAs being given and unplanned admissions post procedure. Use of POINT® and IV sedation is now the preferred choice in higher risk cases.

Take home message: use of POINT® in SCD allows deeper sedation to be used more safely and frequently in complex and high risk patients.

Intraoperative High Flow Oxygen Therapy in Bariatric Surgery: A new hope. Dr E Salas Rezola.

- Obese patients present a number of perioperative challenges: increased comorbidities, problematic positioning, regional anaesthesia difficult and increased likelihood of difficult airway.
- Desaturation on induction of anaesthesia is a significant problem due to: reduced FRC, increased shunt, increased atelectasis, higher basal metabolic rate and oxygen consumption. Therefore effective preoxygenation in the obese is vital for safe conduct of anaesthesia.
- NIV has been used to augment preoxygenation in the obese, although only modest improvements in apnoea times were achieved and problems with leaks, tolerance, and loss of effect when patient becomes apnoeic are frequently encountered[8].
- HFNOT is attractive in this patient group as it provides flow related pressure and PEEP, reversal of atelectasis, improved end expiratory lung volume and nasopharyngeal deadspace washout.
- Some of the benefits continue to improve oxygenation whilst patients are apnoeic so HFNOT is helpful at preventing desaturations following induction of anaesthesia in the obese.
- May also have beneficial effects post extubation so can be used at the end of bariatric surgery; HFNC provide better comfort and oxygenation than venturi masks and also improve oxygenation and reduce progression to needing NIV or invasive ventilation[9].
- Protocol for use: patients with BMI > 35 undergoing intubation, 100% O_2 via HFNC for 2 mins at 50L/min, then 5 mins at 70L/min then increase to 80L/min following anaesthesia. Only hand ventilate if SpO_2 < 92%.
- Good results seen in morbidly obese patients with apnoea times up to 6 minutes and reduced gastric insufflation seen.

Take home message: HFNOT may have an important role in reducing prolonging the apnoea time and preventing desaturations in morbidly obese patients.

High flow nasal oxygenation during awake craniotomy - Dr Catriona Kelly.

- Awake craniotomy is a surgical technique used for removal of epileptic foci, excision of tumours and treatment of movement disorders.
- Previously patients would be anaesthetized and then woken for the critical point of surgery; more recently there has been a move to "fully awake" surgery to allow closer monitoring of the effects of surgery on higher cerebral function.
- Fully awake has the potential benefits of functional preservation and faster recovery with shorter hospital length of stay, however there is a risk of incomplete resections and also intraoperative obstructive apneas and seizures.
- Careful patient selection and assessment and good MDT working are the keys to success.
- Technique: sedation with midazolam bolus then dexmedetomidine, additional fentanyl and paracetamol analgaesia and use of local anaesthetic blocks. Dexmedetomidine is associated with fewer respiratory complications than sedation with propofol and remifentanil[10].
- HFNOT at lowest possible FiO_2 used once patient sedated to maintain oxygenation and counteract any effects of sedatives and analgaesics on oxygenation. Also allows rapid conversion to THRIVE delivery in the event of apneas, airway emergencies or conversion to GA.
- Complications include obstructive apnoeas and seizures, which are treated with topical ice cold saline, benzodiazepines and conversion to GA if needed – HFNC useful in all of the situations.

Take home message: HFNC are a useful adjunct in a highly specialised area of awake Neurosurgery, supporting rapid conversion to a GA in the event of apneas, seizures or airway emergencies.

Use of High Flow Nasal Oxygen Therapy (HFNOT) in immediate post op recovery Dr Ramesh Ekambaram.

- HFNOT has been used to good effect in the postoperative management of major head and neck cases with significant cardiovascular and respiratory comorbidities.
- An attractive technique in these patients as upper airway and facial swelling and frequent presence of tracheostomies make NIV use difficult; it also has the logistical benefits of being available in theatre recovery and adaptable to delivery via a tracheostomy.
- Physiological benefits of HFNOT are well known and many seem appear to be suited to treating and attenuating the problems seen after major surgery (ie. PEEP, humification, tolerance).
- There is an established evidence base for HFNOT use in related areas of practice such as post extubation, hypoxic respiratory failure, preoxygenation before intubation.
- The evidence base for HFNOT in postoperative patients is however less convincing and still evolving. Several studies in Cardiac surgery demonstrate few benefits when compared to standard oxygen therapy[11] although HFNOT was found to be noninferior to BiPAP when used in this patient group[12].
- HFNOT was also found to offer no benefits compared to oxygen therapy following abdominal surgery, where the evidence for NIV and CPAP use is strong.
- A lack of convincing evidence in postoperative patients may be due to poor patient selection, with HFNOT better suited to cases with less severe hypoxia and atelectasis (such as ENT) than post abdominal and cardiac surgery, where CPAP may be a better option.

Take home message: although HFNOT has shown great promise in a number of areas the evidence for use post operatively is lacking. Further studies are needed to define its precise role in this patient population.

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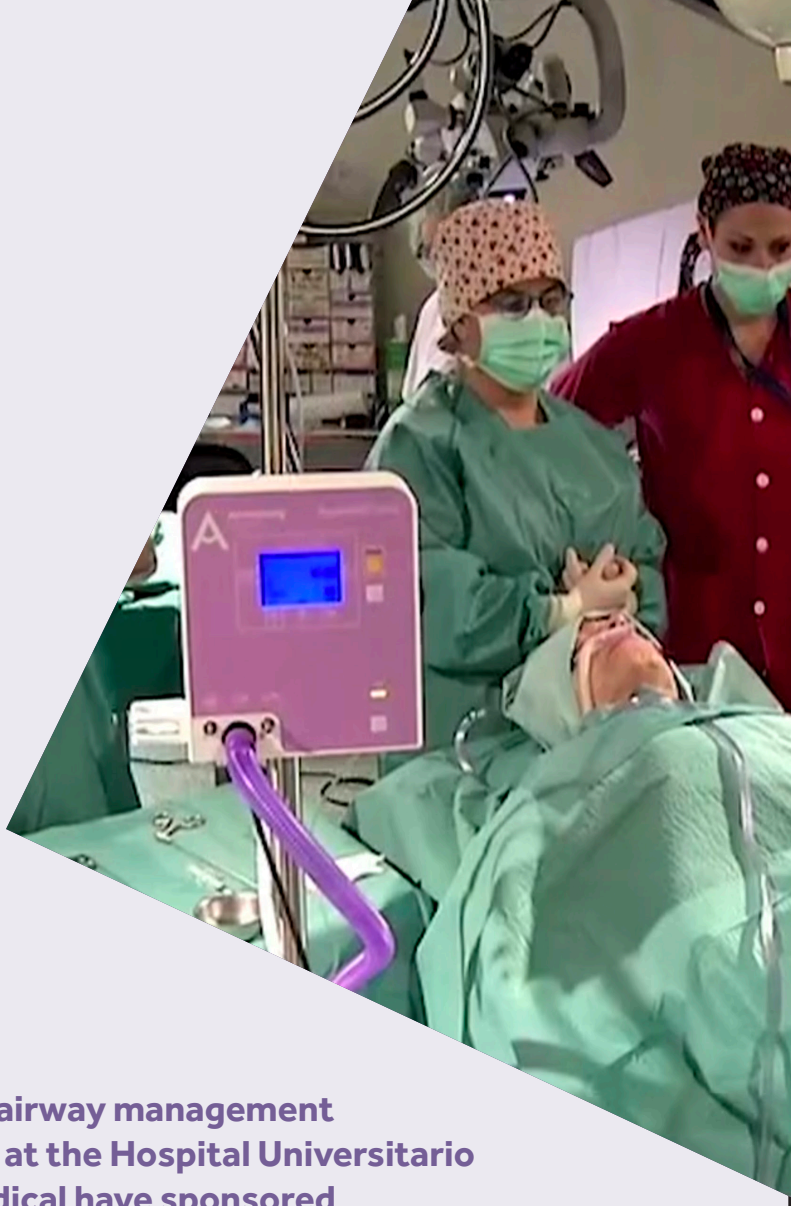
SimuVAD



SimuVAD is a live simulation course for airway management students. This annual event takes place at the Hospital Universitario La Paz, in Madrid, Spain. Armstrong Medical have sponsored SimuVAD since 2016.

SimuVAD is endorsed by the following organisations:

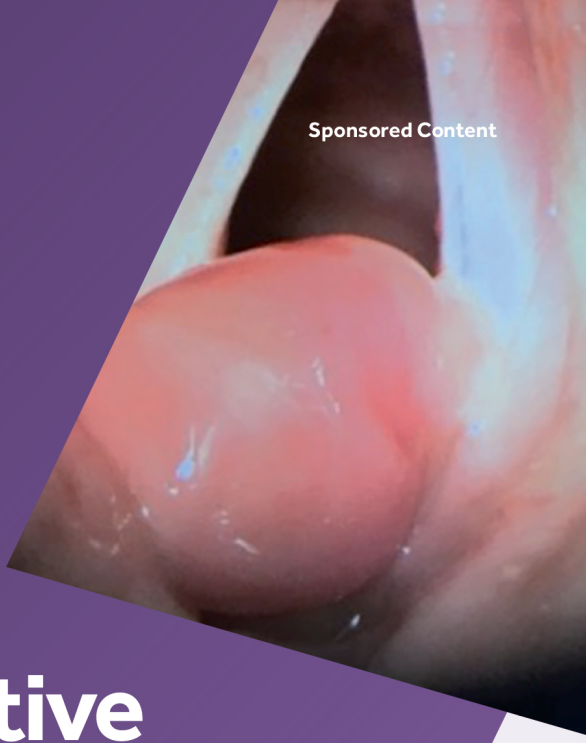
- SEDAR (Spanish Society of Anesthesiology, Resuscitation and Pain Therapy),
- EAMS (European Airway Management Society),
- SAM (the Society for Airway Management),
- DAS (Difficult Airway Society of the United Kingdom),
- CLASA (Latin American Confederation of Anesthesia Societies) and ESPCOP (European Society for Perioperative Care of the Obese Patient).

During the course, anaesthesia procedures are transmitted to a live audience, enabling interaction between Drs and students.

In video below you can view a demonstration of POINT® being used for maintaining apneic oxygenation during a laryngeal procedure.

To watch the live POINT® demo from SimuVAD

Scan the QR code



Tubeless Anaesthesia for Laryngeal and Tracheal Surgery:

A Surgeon's Perspective

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Conventionally one of the key issues with laryngeal surgery has been access.

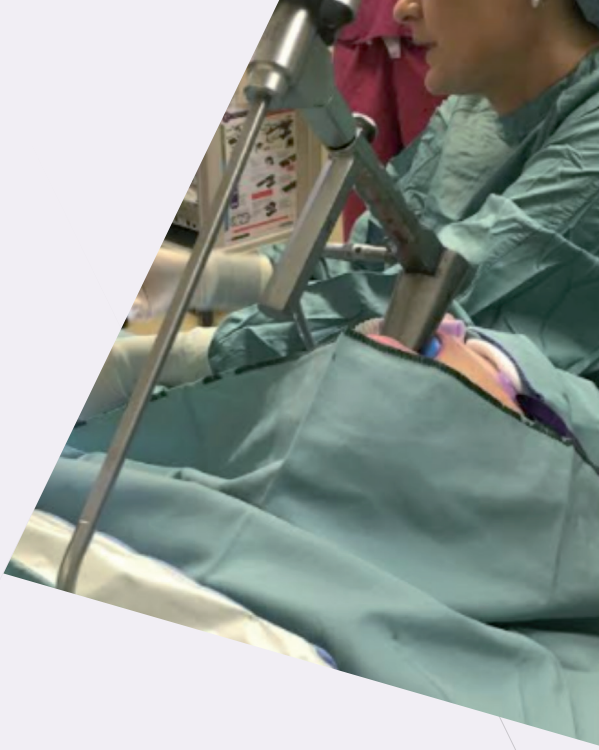
Access is always a key issue in laryngeal surgery. Ideally the operative field would be one in which all the portions of the glottis are in full view.

Traditionally, the posterior aspect of the glottis is occluded by using microlarygnoscopy tubes and techniques to overcome this, all have their limitations. For example, jet ventilation has the attendant risks of barotrauma while repeated extubations have the potential for both hypoxia and airway injury, and spontaneous respiration without tracheal intubation which may lead to inadequate depth of anaesthesia and awareness with the use of inhaled anaesthesia.

In our institution in close cooperation with our anaesthesia colleagues we have trialled a technique of tubeless anaesthesia with the use of high-flow nasal oxygen.

In this article we share some of the background to this technique and our practical experience of its use in a single centre University setting.

Armstrong Medical



"Historically there has been a reluctance to administer oxygen at high-flow rates due to its drying effects on the nasal and oropharyngeal mucosa."

High-flow oxygen has come into prominence in clinical practise in recent years and having demonstrated its use in acute respiratory failure, acute cardiac failure and in preventing post operative atelactasis.

There is an emerging role for this technique in the perioperative and critical care environment. Recent evidence demonstrates that high-flow nasal oxygen facilitates oxygenation and ventilation of both the spontaneous breathing and apnoeic patient.

The physiology of HFNO is complex but can be distilled into a few concepts: it causes nasopharyngeal dead space washout, reduces the work of breathing, exerts a positive expiratory pressure effect and allows apnoeic oxygenation.

We postulated that laryngeal and tracheal surgery could be performed in apnoeic patients using HFNO as the sole mechanism for oxygenation and ventiliation.

Our group carried out a case series demonstrating that laryngeal and tracheal surgery can be safely and successfully performed in apnoeic patients using HFNO as the sole mechanism for oxygenation and ventilation.

Full ethical approval for the study was obtained and 28 patients were recruited.

We used the POINT (Peri-Operative Insufflatory Nasal Therapy) system which allows the delivery of humidified HFNO at flow rates of up to 80L/min and FiO_2 of 0.21-1.0 as the sole method of oxygen ventiliation.

The systems utilises AquaVENT heater humidifier which provides airway temperature settings 34-39 degrees. The median apnoea time where surgery was permitted was 19 minutes with a range of 9-37 minutes. We carried out 27 cases of microlaryngoscopy in addition to, an intervention such as a biopsy, tumour debulking or injection thyroplasty and one case of balloon dilation of subglottic stenosis. No cases in our series required the use of bag mask ventilation or jet ventilation.

Satisfactory oxygenation was achieved in all patients to allow tubeless surgery and there were no cases whereby surgery had to be abandoned because of safety concerns.

There were 4 cases of desaturation 3 of which occurred towards to the end of procedure when the supraglottic device was inserted to reventiliate the patients.

One episode resolved with the temporary removal of the suspension laryngoscope, jaw thrust and an increase in the oxygen flow rate. All the episodes lasted less than 2 minutes and at no point did saturations fall below 85%. When our group first started utilising this technique we published a case report on the use of the system to excise a post intubation granuloma in the posterior glottis.

This innovative technique allows improved access for surgery which we postulate will lead to shorter operative times, better patient outcomes and more productive use of theatre time.

The technique is very broadly applicable to a variety of procedures including microlaryngoscopy and biopsy, tumour debulking, excision of retention cysts, papillomas, polyps and cordotomies.

The benefits of this technique for our practise cannot be over stated. Improved access and has led to an increase in referrals from other institutions in our region that have had issues with access in the past.

We did not report any cases of patients being unable to tolerate the high-flows as a result of discomfort, nasal mucosa irritation or pneumothorax further demonstrating the high tolerability of the therapy.

Currently there have been no published guidelines of the absolute contraindications to high-flow nasal oxygen. We do not use HFNO for laser surgery in our institution. This risk of airway fire with high concentrations of oxygen at high-flows may be reduced by the absence of a tracheal tube or jet ventilation catheter as a fuel source, but whether the tissues themselves might ignite remains uncertain. The use of the HFNO with 30% oxygen has been reported in 12 spontaneously breathing patients undergoing laser airway surgery.

The technique is not used in patients deemed by our anaesthetic colleagues to have a significant risk of aspiration and impending or complete airway obstruction. Decision making with our anaesthesia colleagues is joint and this has been key to ensure satisfactory patient outcome.

One of the key determinants of our successful use of this technique is the close relationship we have with our anaesthetic and nursing colleagues. Regular staff training has ensured successful implementation and has been enhanced by our use of high fidelity simulation.

We use this technique in one operating room in our department and with the same staff every week ensuring a smooth procedure. Good communication and understanding between the surgeon and anaesthetist is essential and alternative plans were always in place in the event of inadequate technique.

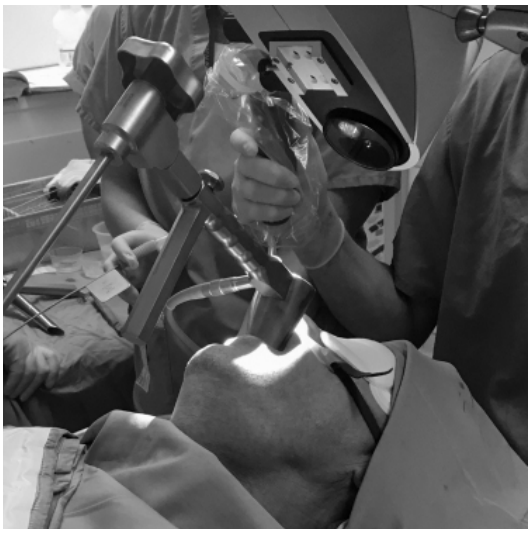
Tubeless anaesthesia for laryngeal surgery has revolutionalised our practise. It has lead to improved operative conditions faciliating better surgical outcomes, reducing shorter operative times whilst not impacting on patient safety. We believe this technique is the way forward in the future for certain types of laryngeal and tracheal surgery and can be successfully implemented with good engagement of all members of the perioperative team.

The POINT® system for high-flow nasal oxygen

Peri-Operative Insufflatory Nasal Therapy (POINT) by Armstrong Medical has the following characteristics:

- **Flow range: 20–120L/min**
- **High-flow nasal oxygen: 20–80L/min**
- **Face mask continuous positive airway pressure: >80L/min**
- **Oxygen concentration: 21–100% FiO2**

Mr Shaji Mansuri & Dr Arun Nair from the University Hospitals of Derby & Burton discuss implementing the THRIVE technique in clinical practice.



Mr Shaji Mansuri MBChB MSc FRCS (ORL),
Consultant Otolaryngologist and Head & Neck Surgeon, University Hospitals of Derby and Burton.

Dr Arun Nair MBBS FRCA,
Consultant Anaesthetist, University Hospitals of Derby and Burton.

How did you first become aware of the THRIVE technique for laryngeal surgery?

Dr Nair: I attended the "Difficult Airway Society" meeting where I was interested in a presentation delivered by Dr A Patel on THRIVE. This was based on an earlier article published by Dr Patel and Mr R Noureai. I could see how this would be a very useful tool in our own practice. I followed this up with a visit to the Royal National Throat, Nose and Ear Hospital, Gray's Inn Road, London and observed Dr Patel using THRIVE. I had further discussion with some of our other anaesthetic colleagues who had experience in the technique elsewhere in the East Midlands and became aware of the POINT® system.

What benefits does this technique bring to your clinical practice?

Dr Nair: The technique is a useful tool that can help in many situations and is not just confined to head and neck/laryngology. The effective pre-oxygenation provides valuable extra time in anticipated difficult airways and emergency situations in all surgical and anaesthetic specialities.

Mr Mansuri: In our own practice, it is particularly useful in providing an unobstructed view and operative field in laryngeal and tracheal surgery. As the POINT® system allows us to reduce the FiO_2, this is particularly key in Trans-Oral Laser surgery. We are also finding there is the potential of improving our "turnaround time" which will improve our efficiency and productivity.

What procedures benefit most & why?

Mr Mansuri: To date we have utilised the technique for diagnostic panendoscopy, microlaryngoscpy and tracheal surgeries. For the latter procedures, the unobstructed view, particularly of the posterior commissure and entire tracheal circumference is invaluable. This is particularly so in surgeries where the CO_2 laser was being used. Prior to THRIVE our practice was to use size 4 microlaryngoscopy tubes, which would still obscure lesions on the vocal process, arytenoid and distal airway.

Dr Nair: It is also a very useful device for awake fibre optic intubation of a difficult airway. The other uses are for preoxygenation prior to inducing anaesthesia in bariatric patients, patients with difficult airway and in extremely sick patients.

What are the limitations?

Dr Nair: As this is only an oxygenation tool and does not provide any ventilation, our procedures are time limited to approximately 45 minutes. Also patient selection is important and currently we are limiting this to patients with a BMI <30.

Why did you choose the POINT® High Flow system?

Dr Nair: After looking at the different systems available, and also in discussions with colleagues with experience of them, there were several factors that led to the decision. Chiefly, there was greater flexibility in controlling the FiO_2, so we

could perform laser surgery safely. Also, as with most decisions in the NHS, cost also had a major role, particularly the initial outlay. Moreover, there was also a lot of support from Armstrong Medical in training the theatre healthcare professionals particularly the ODP members of our team.

How long have you been using the POINT® system & how many patients?

Dr Nair: Approximately a year and we have completed 20 cases to date.

What concerns did you have when starting?

Dr Nair: Nothing significant really as both the surgeon and anaesthetist understood what was to be done.
Mr Mansuri: Dr Nair seeing the technique in action prior to its introduction into our practice meant there was no significant concern from our end. Other members in the team were reassured once its usefulness was explained, and the training was provided.

What has been the biggest challenge in implementing this technique?

Mr Mansuri: Getting everyone to understand what was involved and ensuring all pre-preparations where complete prior to the patient being anaesthetised, as time is critical. Like any new technique being introduced we had to justify it in terms of improvement in patient care and safety; as well as the cost. Dr Nair did a great job in achieving a better understanding amongst the hospital team of how this was a useful additional tool to have in the anaesthetic arsenal, rather than a direct replacement of existing practice. We are currently formalising a protocol that is tailored to our own settings as we found practice elsewhere could not be directly transferred.

How essential is teamwork between anaesthesia & surgical team?

Mr Mansuri & Dr Nair: Extremely important and actually the key element in being successful. It seems a clichéd phrase but it is very much a shared airway. Communication and empathy is required. Amongst us, we have a good understanding of each other's individual practice and concerns.

What advice would you give anyone wanting to implement THRIVE for laryngeal surgery?

Mr Mansuri & Dr Nair: Both surgeon and anaesthetist have to understand the concept and buy into it. Following this, a discussion must be had within the team identifying areas of practice they would like to improve in terms of care and safety, and then see if THRIVE is a tool that can help achieve these aims. If so, do not be afraid to learn from others and visit colleagues in other centres.

What is your protocol when using diathermy for LASER?

Mr Mansuri & Dr Nair: The main aim is to prevent a fire and to keep the patient safe. To achieve this, there needs to be excellent communication between the surgeon and anaesthetist.
Dr Nair: The surgeon is informed once the oxygen saturation starts dropping and once it reaches 92-94%, surgery is halted. The FiO_2 is increased to 100% and an Aintree catheter is inserted by the surgeon, and the patient is ventilated until the oxygen saturation increases again to acceptable levels and surgery continues. If the saturation continues to fall alarmingly, then the patient is intubated and procedure is continued. A jet ventilator would be ideal in such situations.
Mr Mansuri: The laser is only switched on once the FiO_2 has been reduced to 20% or less, also there are no combustible materials such as patties in the field.

Does adjustable FiO_2 address the concerns about airway fire during LASER/Diathermy use?

Mr Mansuri: For any fire to develop you need 3 elements, an ignition, a combustible material and oxygen. By eliminating even one of these factors a fire will not develop, which is achieved by reducing the FiO_2.

How does POINT® high flow compare with Jet Ventilation?

Dr Nair: They are two separate entities. POINT® High Flow is to be used for oxygenation and should not be confused for a ventilation device. It cannot ventilate or recruit the lungs as a jet ventilator can. They should not be considered as alternatives to each other and it is our opinion that any unit performing complex laryngeal surgery should have access to both.
Mr Mansuri: Whilst jet ventilation is useful in longer procedures, from my own personal opinion, I found there is less movement of target lesions with the POINT® system and with the humidification, there seemed a lot less obscuring smoke. In our practice POINT® is best used in short duration procedures particularly if there are multiple back to back cases.

POINT® Features

1

Variable Oxygen Concentration 21-100% for recovery, laser/diathermy and patients with COPD.

2

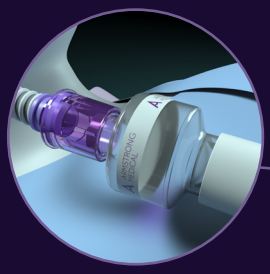
Autofill Humidification Chamber maintains water level when using a bag of sterile water.

3

AquaVENT® Humidifer displays airway temperature.

4

Extra long 1.8m heated breathing system designed for perioperative application protected by BioCote® antimicrobial technology.



5

Tube clip ensures optimal positioning.

6

For reuse of circuit, use our low-profile filter with cannula.

7

Options available with Bi-lateral applications or tracheostomy connection.

8

Enhanced headstrap stability and comfort.

(a) Oxygen analyser t-piece

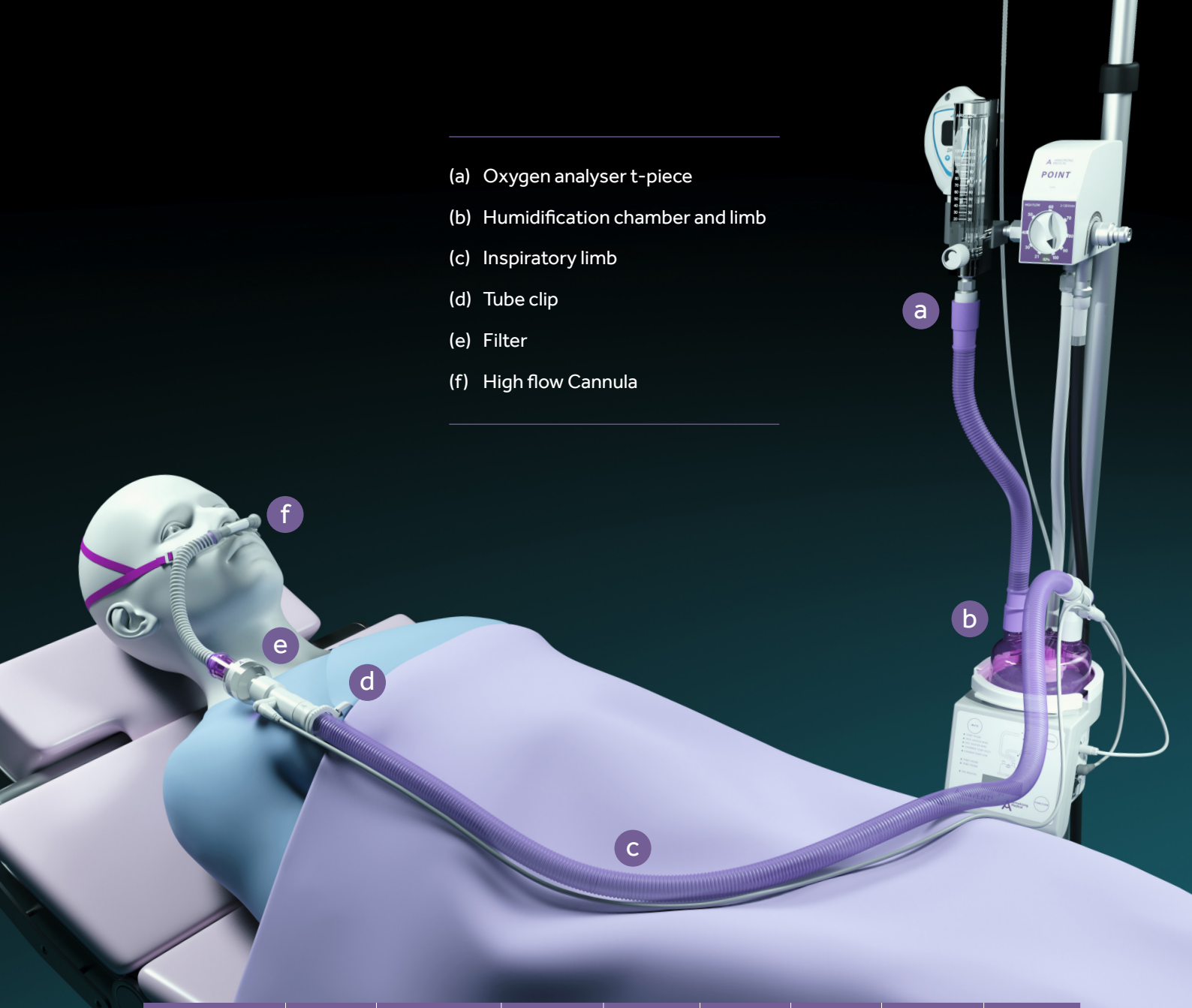
(b) Humidification chamber and limb

(c) Inspiratory limb

(d) Tube clip

(e) Filter

(f) High flow Cannula



Code	Oxygen analyser t-piece (a)	Humidification chamber and limb (b)	Inspiratory limb Length (c)	Tubing diameter	Tube clip (d)	Filter (e)	AquaNASE Cannula (f)	Box Qty
AMHO1509/030	No	Yes	1.8m	15mm	Yes	Venturi	Yes	20
AMHO1509/034		Yes	1.8m	15mm	Yes	No	Yes	20
AMHO1509/035	Yes	Yes	1.6m	15mm	Yes	No	Yes	20
AMHO1509/042	No	Yes	1.8m	15mm	Yes	Patient	Yes	20
AMNS2005/002	High flow cannula with bi-lateral positioning and filter							10
AMNS1005/002	High flow cannula and filter							10
AMTC1100	Tracheotomy high flow cannula							10

Armstrong manufacture a complete range of disposable respiratory products for anaesthesia and critical care applications. For supply of these products or any product within the Armstrong range, please contact your local representative.

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