

NASAL HIGH FLOW THERAPY WITH OPTIFLOW



Nasal High Flow Therapy is quickly becoming a popular addition to today's respiratory care continuum in Ontario, as well as the rest of Canada. By its design, Nasal High Flow Therapy allows Respiratory Therapists to comfortably and effectively deliver oxygen therapy to hypoxemic patients who have a clinical presentation of mild to moderate respiratory distress.

When creating Nasal High Flow, the Fisher and Paykel Research and Development team, merged their proven expertise of Optimal Humidification delivery with an ability to accurately deliver up to 100% oxygen. What allows us to deliver these higher concentrations of oxygen is the unique blueprint of our Optiflow interfaces. The Optiflow design permits a delivery of up to 60 lpm of laminar gas flow that enables an accurate delivery of flow and oxygen. Normally when we as clinicians think of delivering gas flows greater than 6 lpm through nasal prongs, we imagine how uncomfortable the high flows would feel in our nares. However, because Nasal High Flow Therapy implements the principle of Optimal Humidification at body temperature, rather than the direct delivery of the cold, dry gas that is generated from our wall outlets, the flows that are delivered are found to be quite comfortable and well tolerated by most patients. Nasal High Flow allows patients to talk, eat, drink, wear their glasses, and sleep comfortably throughout their therapy. As clinicians, we all are very aware, that if our patients are comfortable with their therapy, they will be more compliant with their therapy, and if they are more compliant, the therapy will be beneficial to their care and clinical outcome.

If we were to look at Nasal High Flow Therapy from a clinical standpoint, we acknowledge that there are 4 key benefits to this therapy.

1. The delivery of up to 100% O₂ accurately
2. The washout of anatomical deadspace
3. Positive Airway Pressure
4. Optimized mucociliary clearance

As we had touched on earlier in our discussion, Nasal High Flow Therapy has the ability to deliver up to 100% of O₂ accurately to our patients. This result

is accomplished by the ability to meet or exceed our patients Peak Inspiratory Flow Rates (PIFR). If we are able to meet our patients PIFR demands accurately, we minimize room air entrainment and therefore we have a very limited O₂ dilution effect, so as a result, whatever percentage of O₂ is set to be delivered, will be fully delivered to our patients.

The second key benefit is the washout of anatomical deadspace. This is achieved by the system having a continual high flow. Normally when we exhale we have a mixed gas volume in our upper anatomical deadspace. Since Nasal High Flow is a continuous flow system, this continual flow is able to washout our upper anatomical deadspace and replace the mixed gas that is normally present, with enriched gas from the Optiflow system. This gas replacement gives our patients a reservoir of oxygen enriched gas to begin their next inspiration.

The third key benefit, low level of positive airway pressure, is achieved due to the higher flows that are being generated throughout the respiratory cycle. These higher flows create an opposing flow for the patient to exhale against. It is this opposing flow that elevates the patient's respiratory baseline, creating a low level positive airway pressure during the respiratory cycle. This effect is illustrated in an article written in 2008 by R.L. Parke et al, "Delivering Humidified High Flow Therapy at increasing gas flow rates generates higher airway pressures". In this article it mentions that even with an open mouth, patients still benefited from the positive pressure values that were created. However, in a mouth open vs. mouth closed comparison, there was a significant positive pressure difference noted in those patients who had their mouth closed during therapy.

Lastly, the fourth key benefit of Nasal High Flow is that mucociliary clearance is enhanced by the delivery of optimal humidification. As Respiratory Therapists, we have all learned that optimal humidification is the key to the maintenance of the mucociliary transport system, our patient's primary defense mechanism against inhaled contaminants. If this defense mechanism is optimally maintained, secretions will remain mobile which will enhance the ability to expectorate and in turn will

reduce patient risk of future respiratory infections. As practitioners, this will achieve our clinical goal of creating better respiratory health for our patients.

To better illustrate the key benefits that we have discussed, we can use the patient case examples in a recently published article, written by Roca et al. "High Flow Oxygen Therapy in Acute Respiratory Failure" published in *Respiratory Care*, April 2010. The article denotes all the key benefits of Nasal High Flow Therapy and how they have contributed to patient care in the study population.

Indications for Nasal High Flow Therapy with Optiflow include those patients who present in mild to moderate respiratory distress who may benefit from some means of supportive therapy beyond that of oxygen therapy alone. Some patient examples may include:

- Obstructive disorders, such as Emphysema, Asthma, Lung CA.
- Restrictive disorders, such as Pulmonary Fibrosis or Pneumoconiosis.
- Patients with Pneumonia, presenting with lung consolidations, or tenacious secretions.
- Patients with Atelectasis, perhaps either post operative or post trauma derived

An excellent example of a patient trauma case was written by A. Beaumont RRT from York Central Hospital, published in August 2009, "Treatment of Chest Trauma Patient with Rib Fractures using Nasal High Flow Therapy with Optiflow". This case study describes how the use of Nasal High Flow with Optiflow was found to be beneficial, especially in the fragile first hours, of this patient's respiratory care.

In summary, we have discussed Nasal High Flow Therapy, listing the clinical features of this therapy, the key benefits as well as the patient populations that would benefit most from its use. If interested in learning more about Nasal High Flow Therapy and how it would benefit your patient population, please contact your local Fisher and Paykel Clinical Product Specialist.

By Nancy Johnson BA RRT
Clinical Product Specialist
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Treatment of Chest Trauma Patient with Rib Fractures using Nasal High Flow Therapy with Optiflow™



CASE STUDY

Optiflow™ Nasal High Flow

SUBMITTED BY

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INTRODUCTION

The patient involved in this case study is a 65-year-old man who fell backwards 10 to 15 feet while pruning fruit trees. The fall is not thought to have any underlying health-related causes. He was transported to the Emergency Department (ER) of York Central Hospital on May 19, 2009. Upon examination, the patient exhibited obvious back pain and difficulty breathing with no concurrent neck pain. There was no loss of consciousness and no obvious neurological deficits and vital signs were stable on admission. Past medical history includes hypercholesterolemia, hypertension, atrial fibrillation and obstructive sleep apnea.

Initial chest X-ray results exhibited fractures to the right third to eighth rib and subcutaneous emphysema with no obvious pneumothorax. Radiological findings of a subsequent CT of the chest, abdomen and pelvis are outline in the following report:

Non contract chest abdomen and pelvis - there are fractures of the right third and through 10th ribs, several with displacement.

There are fractures of the right transverse process of T3 and T5 to T11. There is a comminuted fracture of the left scapular spine and there is also a comminuted fracture of the right scapula involving the body as well as the glenoid with extension into the glenohumeral joint. There is a moderate amount of right-sided subcutaneous emphysema and a small right-sided pneumothorax measuring maximally 17 mm at the right base anteriorly. There is a small right hemothorax and mild patchy opacity in the right lung dependently, most likely representing atelectasis although a degree of pulmonary contusion cannot

be completely excluded. Tracheobronchial tree and left lung are clear. No evidence of mediastinal hematoma. No evidence of free intraperitoneal fluid or air. No obvious evidence of intra-abdominal injury within the limits of an uninfused study.

At this point the patient was admitted to a medical bed and analgesics were provided for pain control and to prevent chest splinting.

CLINICAL COURSE

The patient tolerated general analgesics and prophylactic antibiotics for roughly 24 hours before becoming increasingly short of breath, diaphoretic and hypoxic. Internal medicine determined that this gentleman was likely to face impending respiratory failure due to pulmonary complications of his fall including pulmonary contusions, atelectasis, pneumonia and a worsening right-sided pneumo/hemothorax breathing. The patient had a 90% oxygen saturation on 4 LPM O₂ via nasal prongs at this time and was breathing 35 to 45 breaths per minute. The patient was transferred to the Intensive Care Unit (ICU) for a thoracic epidural insertion to be followed by a right sided chest tube insertion. A quandary arose in determining how best to support this patients respiratory efforts during the epidural insertion and possibly beyond. Since it appeared that conventional oxygen delivery systems were not enough, invasive and noninvasive options were examined. The Optiflow™ system was currently on trial at this institution and the author suggested using it as a test during the procedure with invasive ventilation as a back-up in the event of further respiratory failure.

The Optiflow was applied at 40% oxygen with a flow of 35 liters per minute using the large bore nasal cannula. The humidifier was set to the noninvasive mode. The patient was then assisted into a sitting position whereby the epidural could be inserted. After both the epidural and the Optiflow application the patient's work of breathing and respiratory distress decreased dramatically. The respiratory rate dropped from 42 to 23 per minute. A chest tube was then inserted into the fourth intercostal space. Over the course of the subsequent night, the epidural level was titrated upwards to better control the patient's pain and Levophed was started to control a lowered blood pressure.

By the following morning the patient's status had improved and this trend would continue for the next seven days while remaining on the Optiflow for the duration. The patient was able to ingest fluids and oral medications with no noticeable problems and was able to speak coherently with staff and family members. Staff and family noted also that the patient did not appear to significantly snore or obstruct his airway while sleeping in spite of previously being diagnosed as having obstructive sleep apnea. The sole complaint voiced by this particular patient is the noticeable drying of the oro-pharynx while wearing the Optiflow for such a long duration.

DISCUSSION

Traumatic chest injuries such as suffered by the patient in this case study often run a complicated course. Because of the pulmonary contusions and pain, these patients frequently develop atelectasis and pneumonias requiring more invasive ventilatory care. In the case of this patient, the Optiflow used in conjunction with excellent pain control and prophylactic antibiotics led to the best possible outcome for his chest injury. Length

of stay and the cost of admission particularly in the ICU, were likely significantly decreased since intubation and invasive ventilation along with concurrent sedation were not required. The alternative supportive equipment available, namely the Respironics Vision BiPAP, required the use of a full face mask. This interface would limit the patient's ability to both speak and ingest fluids only during opportunities where it was felt safe to remove the mask for short periods of time. A further ongoing complication with the full face mask BiPAP is the pressure damage caused by long term use on the face. Since the Optiflow is a flow generator, not a pressure generator, and since the interface utilized was a type of wide bore nasal cannula, the patient comfort was improved over traditional noninvasive means.

The sole major complaint of the patient regarding his respiratory status was the dryness he developed in his mouth - this, in spite of using a Fisher & Paykel Healthcare humidifier in-line with the Optiflow. Of note is that the humidifier was set to the traditional noninvasive mode of humidification which drops the overall temperature felt at the interface. Since so little of the interface is in contact with the facial skin, it may have served better to try the system using the invasive humidification setting.

Overall, the Optiflow system served this trauma patient very well and the eventual outcome could not have been better, considering the circumstances surrounding the injury and treatment.

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RESPIRATORY THERAPY 101

ENDOTRACHEAL TUBES

At first glance, an article on endotracheal tube (ETT) basics may seem a bit mundane to a Respiratory Therapy audience – do we really need to go back to the basics for such a fundamental item used so regularly and by so many allied health professionals? The answer is unfortunately, “YES” - as a clear understanding does not exist across our profession.

We have all intubated and managed ETT cuff pressures and have a general sense that once inflated to the appropriate level (the “green zone” on the manometer), an adequate seal exists. Indeed, an adequate “air” seal does exist to permit ventilation, but the paradox of the “seal” statement is that an adequate “fluid” seal does not exist. In fact, not only is the fluid seal not adequate, it is completely incompetent! As a result, the following article is a Respiratory Therapy 101 overview of ETT concepts.

In the 1970’s endotracheal tubes had a revolutionary improvement that exchanged High Pressure, Low Volume (Figure 1) cuffs to High Volume, Low Pressure (Figure 2) cuffs. The rationale was simple and well understood. High pressure cuffs required pressures in excess of 60 cmH₂O which caused tracheal wall ulceration, hemorrhage and even perforation. Reducing cuff pressures to 25cmH₂O while maintaining a seal was an obvious solution and thus an end to the High Pressure, Low Volume cuff injuries that were commonly seen.



Figure 1. High Pressure Low Volume cuff.



Figure 2. High Volume Low Pressure cuff.

Soon after the release of the new cuffs, a paper was published in “Anesthesiology” (V42, No 2, Feb 1975) titled, “Failure of a High-Compliance Low-Pressure Cuff to Prevent Aspiration”. In the opening paragraph, Pavlin, Vanminwagen & Hornbein (1975) say: “large volume cuffs, while affording an effective seal for positive pressure ventilation, may not protect against aspiration...”

Unfortunately, many practitioners may not even be aware of this issue associated with a HiLo (High volume Low Pressure) cuff, despite several more papers citing the same issue and concerns.

“The incidence of dye tracking past the large-volume cuffs studies was 100 per cent where as no aspiration of dye was seen past the red rubber tubes.” (Seagobin & van Hasselt, 1986)

Today, it seems strange that the medical community is aware of ventilator associated pneumonia (VAP) and has adopted a variety of “VAP Bundle” strategies (including EVAC lines) to minimize the amount of leak around the cuff, yet there remains a lack of awareness of how the secretions get past the cuff in the first place. We have all gone through the exercise of inflating the cuff prior to intubation to test its integrity and have observed the smooth profile of the HiLo cuff but what happens to the cuff when it is inflated in a constricted space like the trachea?

“Extensive folding of cuff material containing secretions is seen at all cuff pressures (25–100 cmH₂O).” (Seagobin & van Hasselt, 1984)

Cuffs are made 1.5 to 2 times larger than the trachea to ensure contact when inflated. However, when inflated in a restricted space, the excessive cuff material causes folds or it crumples in on itself. It is these folds that create perfect channels for the secretions above the cuff to pass into the lungs. Although HiLo cuffs have saved us from the tracheal injury seen with the red rubber tubes, we have been battling the complications of microaspiration for decades.

Today, you can read any paper on VAP and the opening sentence starts with the classic point that VAP is the most serious and costly issue in any ICU. It is well understood that microaspiration causes VAP and that a reduction of microaspiration has a positive impact on the occurrence of VAP. Since Mallinckrodt first introduced the HiLo EVAC tube approximately a decade ago, most clinicians have adopted this concept into their ICU’s. However, even with the use of an EVAC tube along with the rest of the VAP bundle, complications from microaspiration continue to be a problem. Also, while almost all VAP studies have shown that EVAC can marginally improve early onset VAP rates, no study on EVAC tubes alone has shown an improvement to late onset VAP. Early onset VAP is typically defined as occurring before 4-7 days, and involves different microorganisms than seen with late onset VAP.

“...VAP is associated with excess mortality, mostly restricted to late-onset VAP and despite appropriate antibiotic treatment.” (Vallés & Fernández, 2007)

Although EVAC tubes try to remove secretions above the cuff, they can’t stop the continuous flow into the lungs through the channel folds within the

cuff. Most experts agree that VAP is the result of continued slow microaspiration over time. Thus, late on-set VAP is unaffected by an EVAC tube. However, it is our belief that this situation can be significantly improved upon.

Awareness of microaspiration has forced researchers to assess its consequences in all airway protection devices (ETTs, tracheostomy tubes and LMAs) and in all areas of the hospital. Why does a relatively healthy 30 year old post-op knee repair need bronchodilators in PACU? Why does a post-op bowel patient get antibiotics from his family physician two weeks after discharge? Although patients are supposed to be NPO before surgery to minimize the risk of vomiting and gross aspiration, the microaspiration of highly acidic gastric juices can cause a severe burn to lung tissue. In the US, analysis of almost 12 million discharged patients between 2003 and 2004 revealed some shocking results.

"...51.5% of those who had been discharged after surgical procedures were rehospitalized or died within the first year after discharge." (Jencks, Williams & Colman, 2009)

Pneumonia was the 2nd most frequent reason for readmission! According to Tablin, Anderson, Besser, Bridges & Hajjeh (2003), the aspiration of contaminated secretions in the oropharynx containing microorganisms resulting in VAP has also been associated with an additional \$40,000 US cost to a typical hospital admission

The issue of microaspiration via the channel folds occurring in all HiLo cuffs since the 1970's has recently

been addressed with a new tapered cuff design. At its widest, the cuff still needs to be 1.5 to 2 times larger than the tracheal diameter to ensure contact when inflated, but as the cuff progresses distally, it tapers until meeting the wall of the ETT (Figure 3).

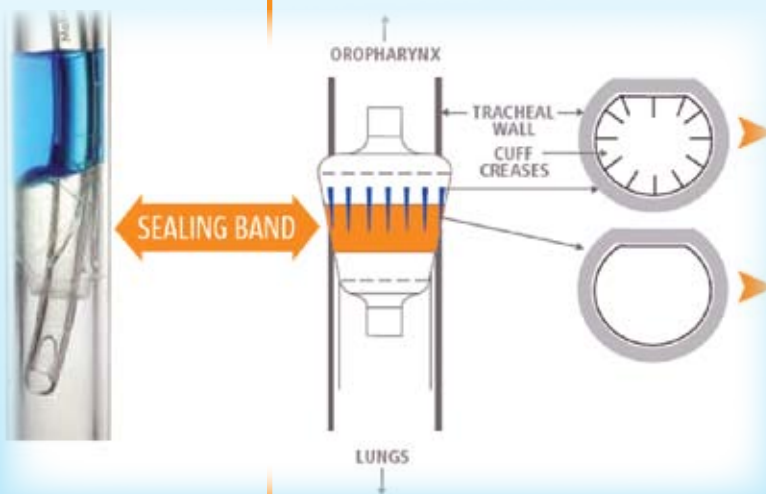


Figure 3. New tapered cuff shape.

At some point, the cuff diameter is exactly the same diameter of the trachea. Here, a seal is created without excess cuff material and thus no folds or microchannels. Ironically, the first referenced paper above from 1975 that raises the issue of microchannels and leakage, also provided us with the solution.....

"What is apparently needed is a smaller-diameter high-compliance cuff that will fit the trachea at low inflation pressures without invaginations." (Pavlin, Vanminwagen & Hornbein, 1975)

VAP is a struggle faced by healthcare professionals throughout the world. Through awareness and discussion, we have learned that we must not allow any aspiration or microaspiration into the lungs. To do this, we need to have an effective seal and a means to evacuate secretions above the cuff. Finally, we must utilize this knowledge to assure that every patient who requires an artificial airway is protected, as this patient may be a family member or a friend to any one of us.

Proximal cuff:
Cuff diameter > Tracheal diameter


Sealing band (mid cuff):
Cuff diameter = Tracheal diameter

Richard Kauc RRT

Ventilation and Airway Specialist
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¹Dullenkopf A. Fluid leakage past tracheal tube cuffs: evaluation of the new microcuff endotracheal tube. *J Int Care Med*. 2003; 29(10): 1849-1853.

²FDA 510(k) clearance.

³Madjdpour J, Mauch J, Koepfer N, Frotzler A, Weiss M. Comparison of air sealing quality in HVLP tracheal tube cuffs - tapered versus cylindrical shape. *European Journal of Anesthesiology* 2009; 26(45): 230.

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CLINICAL CORNER:

In December 2009, the British Journal of Anaesthesia published an editorial (BJA 103 (6): 783-5) and a study (BJA 103 (6): 867-73) that utilizes a prospective, randomized, multi-center clinical examination of a large patient population to scrutinize the debate of using cuffed versus uncuffed endotracheal tubes (ET tubes) in infants and children. These are some of the highlights from that study:

1. The study found that the incidence of tube exchange was 15 times less in children who received the cuffed ET tubes than those who received uncuffed tubes. Three out of 10 uncuffed tubes in this study needed to be exchanged and discarded. However, with the use of the recommended size selection chart, the endotracheal tubes utilized for the study were properly selected 98% of the time. (Tube exchange rate was only 2.1% in the cuffed study group versus 30.8% in the uncuffed group)
2. The post-extubation stridor rates between cuffed and uncuffed tubes were not different. This evidence challenges the traditional thinking about cuffed ET tubes for children less than 8 years of age, and confirms that cuffed tubes can be used in the patient population tested without an increased risk of tracheal trauma. (Post-extubation stridor was noted equally in the cuffed group (4.4%) and the uncuffed group (4.7%))
3. A total of 2246 (1119/1127 cuffed/uncuffed) children from birth to 5 years of age were studied in 24 different European paediatric anaesthesia units. This is the first multi-center study and the largest study to compare cuffed versus uncuffed ET tubes in pediatric patients. The results are consistent with previous clinical studies in terms of tube exchange rate, cuff sealing pressure, and comparison of tracheal trauma between uncuffed and cuffed tubes. This confirms the findings of previous single center studies and provides high quality clinical evidence favoring the use of cuffed tubes in small children.

For further information and detail, please read the study in the December 2009 issue of the British Journal of Anaesthesia.

STUDENT'S CORNER:



Holly Csikos GRT

RTSO Student Board Member

As the Student Board Member of the RTSO, one of my responsibilities is to act as a liaison between the RTSO and the Respiratory Therapy Student Federation, or RTSF. The RTSF originated at Fanshawe College in London, Ontario, and was founded by two RT students, Anil Charran and Denis Zaravinos. Since its inauguration in 2006, it has expanded to both Conestoga College and The Michener Institute, with similar student-founded organizations at each location.

The mandate of the RTSF is to promote the profession of Respiratory Therapy within the student community, and to raise awareness of who we are and what it is that we do as a profession. It has also served as an opportunity for students in the RT program to network with each other, and for potential students to learn more about Respiratory Therapy.

My colleague, Anil Charran, and I, have both served in leadership roles with the RTSF at Fanshawe. Along with the other executive members, we have organized events within the college and the community for RT week, organized fundraisers for beneficiaries such as the Lung Association, and have provided educational opportunities for RT students and RRTs in the area.

Most notably, each year the RTSF has organized a day-long conference both for students and professionals. They have included speakers from the profession in many areas, including anaesthesia, homecare, and acute care. This has also served as an opportunity for both students and professionals to learn and network with each other. This past year, both Conestoga College and Fanshawe College held such conferences, and both were very successful.

As students in a relatively young profession, an organization such as the RTSF gives us a voice and a chance to reach out to those who may be considering the profession. After all, as students, we are the future of Respiratory Therapy, and working together with the RTSO, we have a very real potential to assist the growth of the profession.

The RTSF thrives on its members and RT students who are passionate about the profession. So my message to you students out there is to get involved. Take pride in your future career and seek out your College's RTSF. It is a great way to meet other students like you, to give back to the profession and the community, and to network with RRTs working out in the field. If your school does not yet have an RTSF, consider starting one. Anil and I would love to hear from you and offer you our support. We can be reached through the RTSO webpage, or at rtstudentfederation@hotmail.com.