High Flow Nasal Cannula: Use across the clinical spectrum; More than just Oxygen

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Declaration of Interest.

• Hawke’s Bay Hospital, Hastings New Zealand.
• College of Intensive Care Medicine (Australia and New Zealand) Board Member, Melbourne, Australia
  – Immediate Past President & Censor
• Chinese University of Hong Kong, Shatin, HK, China
  – Adjunct Associate Professor, Dept of Anaesthesia & Intensive Care
• Vice President Asian Pacific Association of Critical Care Medicine

• I do not (nor any member of my family) own shares or stocks in Fisher & Paykel, nor have received gratuities or fees from Fisher & Paykel.
WHY DO WE ASSIST BREATHING?

• Oxygen in
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• Oxygen in

• Carbon dioxide out
HOW DO WE ASSIST BREATHING?

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  – ↑FiO2

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  - ↑ F\textsubscript{I}O\textsubscript{2}
  - ↑ mean alveolar pressure
    - TV /PAUSE/I:E/ PEEP
  - PEEP
    - Re–open alveoli and ↓ shunt

- **Carbon dioxide out**
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  - $\uparrow$ FiO2
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• Carbon dioxide out
  - REDUCE WOB
  - ↑ Minute ventilation
    • ↑ RR
    • ↑ tidal volume
    • Decrease dead space
      • ECCO2R.
        • A–lung
        • Hemolung
Treatment—Other than invasive ventilation

• Treat the underlying cause

• Supportive treatment
  – NIV
  – Oxygen therapy
  – CPAP/HF Nasal Cannula
NIV techniques

• **Useful**
  - COPD
  - Cardiogenic Pulmonary Oedema
  - Asthma
  - Postop Extubation

• **Increased WOB**
• **Respiratory Fatigue**

• **Not useful in Hypoxemia (in the long term)**

Traditional Oxygen Therapy

Oxygen is typically delivered using one or more different oxygen delivery devices.
Oxygen therapy

- Can be divided into:
  - Fixed performance devices
  - Variable performance devices
Variable performance device—at peak flow
O$_2$ Delivery Variable performance device

- **Flow**
  - 30 l/min O$_2$
  - 24 l/min air
  - 37% O$_2$
  - 6 l/min O$_2$

- **Time**
O₂ Delivery Constant performance device

- 100% O₂ 15 l/min
- Air 15 l/min
- 60% O₂ 30 l/min

Flow

Time
Nasal High Flow Therapy with Optiflow
Integrates heated, humidified and blended gases which are delivered via nasal cannula

- Gas flows 3 - 60L/min
- 21 - 100% oxygen
- Nasal cannula
- Single limb, heated circuit
Confidence in constant $O_2$ Delivery

Breathing profile
standard nasal cannula
4L/min with entrainment of
air:
Peak inspiratory demand not
met

Masclans JR. *Clinical Pulmonary Medicine*, 2012; 19:127–
Emerging Clinical Applications

- Bronchoscopy
- COPD/hypercapnia
- Chronic degenerative pulmonary disorders
- Domiciliary
- Heart Failure
- Palliative Care
- Pneumonia
- Radio-oncology treatment of oral mucositis
- Rapid sequence intubation
Low level positive airway pressure

Pressures profile from one patient, mouth closed

- vs standard facemask at 35L/min
- 10 F catheter inserted into the nasopharynx via the nose to measure nasopharyngeal pressure
- Mean airway pressure with Optiflow = 2.7 ± 1.04 vs. facemask = 1.2 ± 0.76 cmH₂O ($p < 0.001$)
Optiflow vs standard facemask at 35L/min

10 F catheter inserted into the nasopharynx via the nose to measure nasopharyngeal airway pressure

Mean airway pressure with Optiflow = 2.7 ± 1.04 vs. facemask = 1.2 ± 0.76 cmH₂O ($p < 0.001$)

Parke R. Br J Anaesth. 2009;103:886-90
Christmas Eve

- 28 year old female
- 6 weeks post partum
- No past history
  - Hypotensive in pregnancy (1 collapse)
- Arrest / CPR / ROSC after 30 minutes.
On admission

- No PE
- No Intracranial bleed or infarction
- Global hypokinesis of heart
- Poor perfusion
- Moderate aspiration
Day I day Post Arrest
36 hrs Normothermia therapy

• Ventilated / sedated,
• Sedation stopped
• Rousing but agitated
• Tube intolerant
• Minimal secretions
  – Pulmonary oedema
  – Sensitive to sedation
Post extubation
CPAP

• reduces shunt by recruiting partially collapsed alveoli

• Opens up collapsed alveoli, and prevents further tidal collapse
Lung compliance and FRC

• Positive end pressure (or CPAP) reduces work of breathing
Positive Cardiovascular effects: Afterload

• **Increased intra–thoracic pressure**
  - decreases afterload
  - due to decreased LV transmural pressure

\[ T = \frac{P_{tm} \times R}{2H} \]
Positive Cardiovascular effects: Afterload

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\[ T = \frac{P_{tm} \times R}{2H} \]
Dynamic Positive Airway Pressure

High flow nasal oxygen generates positive airway pressure in adult volunteers
Nicole Groves Bachelor of Health Science (Nursing)

Evaluation of a humidified nasal high-flow oxygen system, using oxygraphy, capnography and measurement of upper airway pressures

Nasal high-flow therapy delivers low level positive airway pressure
R. Parke\textsuperscript{1*}, S. McGuinness\textsuperscript{1} and M. Eccleston\textsuperscript{2†}

The Effects of Flow on Airway Pressure During Nasal High-Flow Oxygen Therapy
Rachael L. Parke, RN, MHSc (Hons)

Pressures delivered by nasal high flow therapy during all phases of the respiratory cycle
Rachael L. Parke, RN, MHSc (Hons)

Trauma

• 65 year old Tourist
• Passenger in Fatal care accident
• # spine,
• # clavicle
• # ribs (4 R 6 L)
• Lung contusion
Chest Injury
• n = 10 bronchiectatic patients

• Measured lung mucociliary clearance before and after 7d domiciliary Optiflow at 20–25L/min (3h/d)

• $^{99m}$Tc–labelled tracer particles

• Assessed AUC tracheobronchial retention curve

• AUC ↓ 319±50 to 271±46%h ($p<0.007$)

Hasani A. *Chron Respir Dis.* 2008;5:811-6
Reduced Dead Space/ WOB

Stereoscopic PIV measurements of flow in the nasal cavity with high flow therapy

C. J. T. Spence · N. A. Buchmann · M. C. Jermy · S. M. Moore

Spence . Experiments in Fluids. 2011
Facial trauma
Post Op: Comfort
Post Operative care

- 75 year old with Severe RA
  - Bowel obstruction from tumour
  - Fixed Neck Movement
  - Difficult ++ Intubation
  - Severe restrictive & obstructive lung disease

- Post operative in ICU
Extubated to Optiflow
Skin damage from previous NIV mask (pre operative)
High flow nasal cannula appear to provide improved comfort and allows greater tolerance, compared to oxygen delivered by face masks\textsuperscript{1,2}

\textsuperscript{1}Ward JJ. \textit{Respir Care}. 2013;58:98-122; \textsuperscript{2}Ricard J-D. \textit{Minerva Anestesiol}. 2012;78:836-41
Conclusion:

- “The use of HFNC was well tolerated and provided acceptable oxygenation without escalation to NIV in 82% of patients.”
- “HFNC requires less training than NIV and may be more acceptable to hospital staff. This modality could be more broadly applied and might allow many patients to be treated outside the ICU environment.”

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<thead>
<tr>
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<th>Pre - Optiflow</th>
<th>Post-Optiflow</th>
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<tbody>
<tr>
<td>Respiratory rate</td>
<td>30.6</td>
<td>24.7</td>
<td>&lt;0.001</td>
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<tr>
<td>O₂ saturation</td>
<td>89.1%</td>
<td>94.7%</td>
<td>&lt;0.001</td>
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Transport
Bronchial Obstruction

- 32 year old
- Sarcoma resected 2004
- Recurrence in 2010, aggressive therapy
- Further Recurrence with bronchial involvement
• Plan for insertion of bronchial stent
  – Middlemore Hospital (Auckland)
    • 400 km (5–6 hours drive/1 hour flight)
  – Transfer difficult
    • Hypoxemia SatO₂ 88–90% on 6L
    • WOB–RR 30
    • Potential gas trapping (ball valve effect)
    • AVOID Ventilation
Arriving ( safely )
High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure

Jean-Pierre Frat, M.D., Arnaud W. Thille, M.D., Ph.D., Alain Mercat, M.D., Ph.D., Christophe Girault, M.D., Ph.D., Stéphanie Ragot, Pharm.D., Ph.D., Sébastien Perbet, M.D., Gwénaël Prat, M.D., Thierry Boulain, M.D., Elise Morawiec, M.D., Alice Cottereau, M.D., Jérôme Devaquet, M.D., Saad Nseir, M.D., Ph.D., Keyvan Razazi, M.D., Jean-Paul Mira, M.D., Ph.D., Laurent Argaud, M.D., Ph.D., Jean-Charles Chakarian, M.D., Jean-Damien Ricard, M.D., Ph.D., Xavier Wittebole, M.D., Stéphanie Chevalier, M.D., Alexandre Herblaud, M.D., Muriel Fartoukh, M.D., Ph.D., Jean-Michel Constantin, M.D., Ph.D., Jean-Marie Tonnelier, M.D., Marc Pierrot, M.D., Armelle Mathonnet, M.D., Gaëtan Béduneau, M.D., Céline Delétage-Métreau, Ph.D., Jean-Christophe M. Richard, M.D., Ph.D., Laurent Brochard, M.D., and René Robert, M.D., Ph.D., for the FLORALI Study Group and the REVA Network®
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