Nasal High Flow Therapy as a Quality Improvement Strategy in a Provincial Combined ICU / HDU / CCU

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Declarations

• Dr T S Browne has not received any financial gain from Fisher & Paykel Healthcare Limited

• Fisher & Paykel Healthcare Limited supplied the equipment and provided a small study grant

• The data were independently analysed by Y Jiang – Dept. Statistics, University of Auckland
Introduction

• Tauranga Hospital ICU / HDU / CCU is a combined 20 bedded unit in New Zealand

• Historically $O_2$ therapy was achieved with standard nasal cannula, Hudson mask, non-invasive ventilation / CPAP, invasive ventilation

• Nasal High Flow Cannula not used routinely

• We sought to introduce Nasal High Flow Cannula as a standard of care as a Quality improvement initiative
Oxygen as a therapy

- Thomas Beddoes, James Watt and Sir Humphry Davies England, late 1700’s
- Early 1900’s oxygen streamed into nasopharynx to treat WW1 gas poisonings
- 1925 – first nasal cannula appeared
- 1940 – early version of the modern plastic over-the-ear nasal cannula appeared
- Nasal cannula preferred over face masks because less claustrophobic and patients can eat, drink, talk, speak and expectorate more easily

Ward J. Respiratory Care, Jan 2013, Vol 58:1
Oxygen therapy devices

**Standard Nasal Cannula**

- Well tolerated
- Allow speaking, eating, expectorating
- Low flow only, otherwise too drying on nose
- Cannot meet peak inspiratory demand
- Ideal for relatively well patient requiring supplemental oxygen e.g. post minor surgery, minor chest infection
- Cannot set FiO\textsubscript{2} accurately

Ward J. Respiratory Care, Jan 2013, Vol 58:1
Oxygen therapy devices

Face mask

- Claustrophobic
- Impedes speaking, eating, expectorating
- Often found on patient’s head
- $O_2$ delivery only up to about 60 %, despite non – rebreathing bag
- Can often meet peak inspiratory flow
- Cannot set $FiO_2$ accurately
- Longer term $O_2$ use in more critical patient, but higher flows still drying to nasal and respiratory mucosa

Ward J. Respiratory Care, Jan 2013, Vol 58:1
What would constitute an ideal device?

- Flow rates to meet peak inspiratory demand (2 – 60 L/min)
- Confidence and safety in accurate O₂ delivery (21 – 100 %)
- Heated (to 37 °C) and humidified to saturation (44gH₂O /L flow) to allow high flow rates to be tolerated without discomfort to nasal or respiratory passages or dehydration damage to respiratory mucosa
- Delivered via nasal cannula for patient comfort
- Afford some degree of respiratory support / CO₂ washout / PEEP

Oxygen therapy in non-intubated adult intensive care patients: a point prevalence study

Rachael L Parke, Glenn M Eastwood and Shay P McGuinness on behalf of the George Institute for Global Health and the Australian and New Zealand Intensive Care Society Clinical Trials Group

• ANZICS sponsored audit (26 participating ICUs)
• Tauranga Hospital contributed data

• Many patients receive oxygen therapy – only 13/26 had protocol
• All units had HFNC – 16/26 had protocol
• 18.5% of non-ventilated patients received NHFC
• Study notes that excessive oxygen can be bad for patients
• Study shows oxygen rarely prescribed, documented or titrated to end points
• $O_2$ should be prescribed according to measurable flow rates, measurable concentration and consistent with a protocol

Parke R et al. Critical Care and Resuscitation, Dec 2013, Vol 15:4
Current practice at Tauranga ICU/HDU/CCU

- Standard stepwise approach based on patient status, disease type, time of day, staff skill mix etc.
- Generally therefore nasal cannula / facemask O₂ as standard and generally initiated prior to arrival in ICU / HDU / CCU
- Escalated to non-rebreather mask
- CPAP/NIPPV as temporary / definitive therapy (often not tolerated for long periods)
- Final option intubation and IPPV
- Weaning either via direct extubation to facemask O₂ or tracheostomy
- Nasal High Flow Cannula not used regularly
- We sought to introduce Nasal High Flow Cannula as a standard of care as a Quality improvement initiative
Methods

• Observational historic controlled two-phase study of 864 adult and 69 paediatric patients

• Retrospective (Phase I) data were extracted from anonymised clinical records and AORTIC database reports during the first 40 hours post admission to the ICU/HDU/CCU. Prospective (Phase II) data collected thereafter

• The predicted benefit ratio between the two phases was deemed to be equivalent

• The equipment (Airvo™ flow source and Optiflow™ high flow nasal cannula) was provided by Fisher & Paykel Healthcare Limited

• **INCLUSION**: All spontaneously breathing patients with a requirement for O₂ therapy and no contraindication to NHFC as per manufacturer specification
Retrospective (Phase I) data collection

• Retrospective (Phase I) data were collected (N=450) over the six month period May 2012 – November 2012

• Retrospective analysis of the diagnostic data to determine a list of the most common diagnostic admission categories for the ICU/HDU/CCU

• Establish current practice for $O_2$ therapy in the 1st 40 hours post admission to the ICU/HDU/CCU
Prospective (Phase II) data collection

- The process of recruitment during the Prospective Phase II continued until the numbers of patients per diagnostic category in each group equalled those in the Retrospective Phase I

- CCU 3 diagnostic categories: e.g. Acute MI, CCF, rhythm disturbance
- ICU 9 diagnostic categories: e.g. Post Cardiac arrest, sepsis – non-urinary
- HDU 11 diagnostic categories: e.g. Metabolic, post op GI neoplasm
Overall no significant differences between adult patient characteristics between phases at baseline
Outcomes
(First 40 hours post admission)

• **Primary**
  - Highest type of respiratory support device required

• **Secondary**
  - Optiflow Therapy usage data e.g. O₂ % and flow rates used
  - Length of stay in ICU, HDU, CCU and Hospital
  - Vital status at discharge ICU, HDU, CCU and Hospital
  - Destination at discharge ICU, HDU, CCU and Hospital
  - Number of therapy failures requiring escalation in type of respiratory support
Data analysis

The following analyses / tests were applied according to the data types:

• **Descriptive summaries of the data at each phase by ICU/HDU/CCU and diagnostic categories:**
  • mean and SD for continuous variables
  • frequency and percentage for categorical variables

• **Tests of statistical significance between the two phases done for all patients and by ICU/HDU/CCU categories:**
  • Two sample t-test for continuous variables
  • Chi-square or Fisher’s exact test for categorical variables
Highest level of respiratory support all adult participants (ICU/HDU/CCU)

<table>
<thead>
<tr>
<th></th>
<th>Retrospective n=450</th>
<th>Prospective n=414</th>
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</thead>
<tbody>
<tr>
<td>Resp. support all</td>
<td>257 (57%)</td>
<td>231 (56%)</td>
</tr>
<tr>
<td>*NIV</td>
<td>223 (49%)</td>
<td>10 (2%)</td>
</tr>
<tr>
<td>*Optiflow</td>
<td>7 (1%)</td>
<td>192 (46%)</td>
</tr>
<tr>
<td>INV</td>
<td>27 (6%)</td>
<td>29 (7%)</td>
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*Significant differences were found in NIV and Optiflow modes between the two cohorts

(Chi-square Test, p-values <.0001)
Highest level of respiratory support - CCU

<table>
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<tr>
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<th>Retrospective n=249</th>
<th>Prospective n=248</th>
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</thead>
<tbody>
<tr>
<td>Resp. support all</td>
<td>107 (43%)</td>
<td>67 (27%)</td>
</tr>
<tr>
<td>*NIV</td>
<td>107 (43%)</td>
<td>7 (3%)</td>
</tr>
<tr>
<td>*Optiflow</td>
<td>0</td>
<td>60 (24%)</td>
</tr>
<tr>
<td>INV</td>
<td>NA</td>
<td>NA</td>
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</tbody>
</table>

*Significant differences were found in both modes between the two cohorts (Fisher’s Exact Test, p-values <.0001)
Highest level of respiratory support - HDU

<table>
<thead>
<tr>
<th></th>
<th>Retrospective</th>
<th>Prospective</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>n=162</td>
<td>n=130</td>
</tr>
<tr>
<td>All resp. support</td>
<td>116 (72%)</td>
<td>128 (98%)</td>
</tr>
<tr>
<td>*NIV</td>
<td>112 (70%)</td>
<td>3 (2%)</td>
</tr>
<tr>
<td>*Optiflow</td>
<td>4 (2%)</td>
<td>125 (96%)</td>
</tr>
<tr>
<td>INV</td>
<td>NA</td>
<td>NA</td>
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</tbody>
</table>

*Significant differences were found in both phases between the two cohorts (Fisher’s Exact Test, p-values < .0001)
No significant differences were found in all modes between the two cohorts (Fisher’s Exact Test, p-values >0.05)
Paediatric Data

• 35 phase I retrospective patients and 34 phase II prospective patients

• Significant differences were found for:
  • Age in years (2.3 vs. 5.9; p-value=0.001)
  • Weight (12.6 vs. 21.6; p-value=0.02)
  • Optiflow use (0 vs. 13; p-value <0.0001)
    ▪ Mean flow rate  13.5 L/min
    ▪ Mean FiO$_2$  51.2%
    ▪ Mean SpO$_2$  96.1%
    ▪ Mean duration on therapy  10.5 hours
Study Outcomes

• Significant differences seen in the level (type) of respiratory support required for HDU and CCU patients (NHFC largely replacing NIV)
• No significant differences seen in the level of respiratory support required for ICU patients - it was unchanged
• No difference seen in length of stay in hospital or ICU/HDU/CCU (combined data)
• No difference seen for mortality (combined data)
• NHFC introduced to paediatric patients
• Therapy failure rates in both phases were consistent and comparatively low (no change in intubation rates)
• A three-armed multicentre RCT - NHF vs. NIV vs. standard O₂ therapy
• 23 French and Belgium ICUs 2010 – 2013

• Primary outcome: - Intubation rate within 28 days - all comers
• Secondary outcome: - 90 day mortality all participants hazard analysis

• Post hoc subgroup analysis (PaO₂:FiO₂ ≤200) treatment with NHF resulted in a significantly lower 28-day intubation rate (P = 0.009)
• Significant difference in favour of HFNC for 90-day mortality and number of ventilator free days (P = 0.02)

Frat J-P et al. NEJM, May 17 2015
High-Flow Nasal Oxygen vs Noninvasive Positive Airway Pressure in Hypoxemic Patients After Cardiothoracic Surgery: A Randomized Clinical Trial

François Stéphan, MD, PhD; Benoît Barbucand, MD; Pascal Petit, MD; Saida Rézaiguia-Delclaux, MD; Anne Médard, MD; Bertrand Delannoy, MD; Bernard Cosserant, MD; Guillaume Flicoteaux, MD; Audrey Imbert, MD; Catherine Pilorge, MD; Laurence Bérard, MD; for the BiPOP Study Group

- Multicentre, randomised, non-inferiority study
- 6 French ICUs
- 2.5 years - June 2011 to Jan 2014
- 414 / 416 patients

CONCLUSIONS AND RELEVANCE Among cardiothoracic surgery patients with or at risk for respiratory failure, the use of high-flow nasal oxygen therapy compared with intermittent BiPAP did not result in a worse rate of treatment failure. The findings support the use of high-flow nasal oxygen therapy in similar patients.
One year observational study
560 /607 ARDS patients requiring $O_2$/IPPV
HFNC as first line in ARF (n = 87)

Messika J et al. Respiratory Care, February 2015 Vol 60, No.2
Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation
Effects on Oxygenation, Comfort, and Clinical Outcome

Salvatore Maurizio Maggiore¹, Francesco Antonio Iacono¹, Rosanna Vaschetto², Rossano Festa¹, Andrea Cataldo¹, Federica Antonicelli¹, Luca Montini¹, Andrea De Gaetano³, Paolo Navalesi⁴,⁵,⁶, and Massimo Antonelli¹

• Italy
• Randomised, controlled, open-label trial
• 105 patients
• P/F ratio < 300 prior to extubation
• Re-intubation rate 4% vs 21% in favour of NHFC

In conclusion, as compared with the Venturi mask, the use of the NHF system in the postextubation period results in better oxygenation for the same set $\text{Fi}_O_2$. In addition, the NHF decreases $\text{Pa}_CO_2$ and the respiratory rate, while improving patient comfort and reducing episodes of interface dislodgement and oxygen desaturation.
Quality Outcomes

• **We have changed the way we work in ICU / HDU / CCU**

• *Developed a Respiratory Therapy Guideline involving Nasal High Flow Cannula throughout all aspects of a patient's journey in ICU / HDU / CCU*

• *Presented this research to the hospital, and now have co-operation to introduce Nasal High Flow Cannula to all aspects of the patient's journey throughout the hospital – particularly from ED / Respiratory Physicians*

• **Intend expanding this principle on intra- and interhospital patient transfers**

• *Completely changed the way we extubate ICU patients - The Tauranga Technique*

• *(Hudson $O_2$ masks still available on Resuscitation Trollies)*
**Tauranga Hospital Respiratory Therapy Guideline**

**POTENTIAL / ESTABLISHED RESPIRATORY FAILURE**

Immediate need for intubation

- Yes: Intubate
- No: Specific Indication for CPAP/NIV e.g. pulmonary oedema

Specific Indication for CPAP/NIV e.g. pulmonary oedema

- Yes: CPAP/NIV
- No: HFNC

HFNC

- Improvement: CPAP/NIV
- Deterioration: Extubate to NHFC using Tauranga Technique

Intubate

Extubate to NHFC using Tauranga Technique
ICU Extubation – **The Tauranga Technique**

- Patient prepared for extubation in the conventional manner - but kept asleep. Consider removing nasogastric tube
- Optiflow Nasal Cannula placed on ventilated, sleeping patient - Airvo set to 30 – 45 L/min flow and O₂ set to 60 – 100%
- Patient woken up and extubated conventionally
- Nothing further to do!!
  - Patients not agitated and very compliant
  - Staff not distracted
  - High quality, high safety extubation

**Try it**
Conclusion

• Nasal High flow Therapy has changed the way we care for critically ill patients in Tauranga Hospital New Zealand from their arrival and throughout their care period

• Preventing escalation (reduced NIV)
• Peri-intubation
• During extubation
• Post extubation
• End of life care