Stewardship of the use of Inhaled Nitric Oxide

Peter C. Laussen MB.BS., FCICM
Why “stewardship”? 

• **Stewardship**: the conducting, supervising, or managing of something; *especially the careful and responsible management of something entrusted to one's care.*

• **Iterative learning**
  – Variable indications & practice at HSC

• **Wise resource utilization**
  – Expensive
iNO, FY 2008-09 CHCA-associated Hospitals
Total costs: $50.5m

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Total Annual Spend</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$7,150,000</td>
</tr>
<tr>
<td>B</td>
<td>$4,290,000</td>
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<tr>
<td>C</td>
<td>$2,755,000</td>
</tr>
<tr>
<td>D</td>
<td>$2,645,000</td>
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<tr>
<td>E</td>
<td>$2,025,000</td>
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<tr>
<td>F</td>
<td>$1,850,000</td>
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<tr>
<td>G</td>
<td>$1,820,000</td>
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<tr>
<td>H</td>
<td>$1,770,000</td>
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<tr>
<td>I</td>
<td>$1,735,000</td>
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<tr>
<td>J</td>
<td>$1,640,000</td>
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<tr>
<td>K</td>
<td>$1,600,000</td>
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<tr>
<td>L</td>
<td>$1,600,000</td>
</tr>
<tr>
<td>M</td>
<td>$1,590,000</td>
</tr>
<tr>
<td>N</td>
<td>$1,545,000</td>
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</table>
Collaboration between critical care physicians and pharmacy. Initiation and weaning protocols in the PICU & CICU developed

Followed utilization (hours) & costs / mth
Reduced utilization for iNO by 33% (32,000 to 20,000 hours/yr)

Did not track clinical use, no learning, no stewardship
Problem: FY 2013-14
- Need to identify reductions of ~$1m in operating budget for critical care

Opportunity:
- iNO most costly drug administered in the ICUs, and
- New contract negotiations with Ikaria started early 2013
**Stakeholders:** Physicians (PICU, CCCU, NICU), Respiratory therapy and nursing

**Observation:** Nitric Oxide expenditure increased by 65% at Sick Kids during the period 2009-2011

“What are we doing?”: Comprehensive retrospective review of iNO utilization

“We can do better”: Nitric Oxide Stewardship Program
<table>
<thead>
<tr>
<th></th>
<th>PRE (2011-2012)</th>
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<tbody>
<tr>
<td>Total hours iNO (hospital-wide)</td>
<td>11,686</td>
</tr>
<tr>
<td>Projected hours 2013-2014</td>
<td>13,000</td>
</tr>
<tr>
<td>No. of patients treated</td>
<td>51</td>
</tr>
<tr>
<td>Response to iNO</td>
<td>30/51 (60%)</td>
</tr>
<tr>
<td>No. of excess hours where wean not</td>
<td>979</td>
</tr>
<tr>
<td>initiated despite criteria being met</td>
<td></td>
</tr>
<tr>
<td>No. of excess hours attributable to</td>
<td>1296</td>
</tr>
<tr>
<td>not following weaning algorithm</td>
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</table>
Iterative process

• Physician champions (ICU leadership) with Interprofessional leadership (Respiratory Therapy)*

• Clear evidence- and consensus-based guidelines, plus
  – Desire to obtain new information & learning

• Setting targets, identifying measurable outcomes

• Regular discussions at bedside

• Prospective data collection:
  – Collect, review and share data
  – revise guidelines and targets*
No restriction for use. Physiology-based, not disease-based

Identified the continuous variables to detect response

Daily discussion
Staff order

Record and collect data

1. 40 ppm may be more effective than lower doses, therefore if no effect noted at this dose establishes lack of response to iNO.
2. The effect on oxygenation should be apparent within minutes, a trial period longer than 30 minutes may be confounded by other physiologic changes other than iNO.
3. O2 saturations < 70% are not reliable, measure PaO2.
4. 20 ppm is associated with less NO synthase suppression, ↓risk of MetHbG and NO2 production.
5. More time may be required to appreciate changes in some response criteria (e.g., lactate).
Weaning iNO in the Critical Care Unit

1. Improved V/Q mismatch, OI improved, ↓PVR, C.O. or has transitioned to alternate therapies.
2. Attempt wean of iNO once patient is stabilized and other therapies are not being adjusted.
3. Mild to moderate rebound hypoxemia may occur and can be managed briefly with increased FiO2 and adjustment of mechanical ventilation, consider alternate pharmacological treatments.
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<td>Target: 7,600 hrs</td>
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<tr>
<td>Projected hours (13,000 hrs)</td>
<td></td>
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<td>No. of patients treated</td>
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# 5 year pricing history

<table>
<thead>
<tr>
<th>Year</th>
<th>Contract Net Hourly price</th>
<th>Average hourly price</th>
<th>PMPRB * List Price/hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>$101.00</td>
<td>$89.78</td>
<td>$169.00</td>
</tr>
<tr>
<td>2011</td>
<td>$101.00</td>
<td>$75.28</td>
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<td>2012</td>
<td>$106.00</td>
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<tr>
<td>2013</td>
<td>$110.00</td>
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</tr>
<tr>
<td>2014</td>
<td>$125.00</td>
<td>$97.87</td>
<td>$169.00</td>
</tr>
</tbody>
</table>

*PMPRB- Patented medicine review board
** 2015 Non Contact price is $191.00/hr
# Contracts

<table>
<thead>
<tr>
<th>Type</th>
<th># in Canada</th>
<th>Description</th>
</tr>
</thead>
</table>
| Platinum         | 21          | • Unlimited use of drug  
                                • Committed monthly cost                                                   |
| Bronze           | 15          | • Purchase a set amount of hours at committed monthly cost  
                                • Anything above the purchased amount is billed at NH contract rate       |
| Net Hourly       | 19          | • Billed by the hour at contracted NH rate                                  |
| Non Contract price | 0          | • Device rental fee and current list price per hour                         |
Nitric oxide stewardship FY 2013-14

- Provide a focus for quality and patient safety
- Reduce variations in practice
- Promote efficient and appropriate use
- Cost savings

### Cumulative Monthly Usage
- April: 633.3
- May: 739.33
- June: 1,111.75
- July: 1,414.75
- August: 2,533.2
- September: 3,166.5
- October: 3,799.8
- November: 4,433.1
- December: 5,066.4
- January: 5,699.7
- February: 6,333.0
- March: 6,966.3
- April: 7,600.0

### Cumulative Monthly Usage Target
- April: 760.0
- May: 1,111.75
- June: 1,414.75
- July: 2,302.57
- August: 2,610.48
- September: 3,178.89
- October: 3,677.81
- November: 4,359.08
- December: 5,179.12
- January: 5,607.49
- February: 6,217.76
- March: 6,563.43

### Cumulative % of Target
- April: 0.00%
- May: 10.00%
- June: 20.00%
- July: 30.00%
- August: 40.00%
- September: 50.00%
- October: 60.00%
- November: 70.00%
- December: 80.00%
- January: 90.00%
- February: 100.00%
- March: 100.00%
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<td>31 (6; 19%)</td>
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<td>23/31 (74%)</td>
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<td>232</td>
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<tr>
<td>No. of excess hours attributable to not following weaning algorithm</td>
<td>1296</td>
<td>497</td>
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Nitric Oxide Fiscal Year 2014-15: New “stretch”

YTD Usage

Nitric Oxide Stewardship

Cumulative Monthly Usage
Target

Cumulative Monthly Usage

Target Annual Usage

Cumulative % of Target
In collaboration with CAPHC, a national forum was launched charged with achieving the following goal:

*To establish a standardised approach to the use of iNO for newborns and children in Canada*

Inaugural meeting in October 2013

Two working groups (Neonatal and Paediatric)
Survey of practice

16 Paediatric Health Care Centres surveyed:

- 7 had no guideline in place
- Majority had not recently reviewed iNO use
- Compliance with guideline, when available, not generally known
- Most common guideline deviations related to weaning (patients “stuck” on iNO)
- Strong willingness expressed to share guidelines, data and experience
Audit of guidelines

Documents from 11 Canadian ICUs reviewed.

Major variations:

- Recommended conditions
- Severity of illness at initiation
- Pre-initiation checklist (presence and content)
- Starting and maximum dose of iNO
- Criteria for determining response
- Criteria for weaning and weaning intervals
- Safety monitoring
- Management of rebound hypoxemia
Nitric Oxide Stewardship Program

Guidelines alone are not enough....

Stewardship

Improving quality of care and cost-effectiveness by:

- Understanding use (indications, alternatives, therapeutic goals, waste) and limiting practice variation
- Ownership and accountability
- Iterative learning and planning
- Partnerships: IKARIA.
  - Data, learning & new opportunities
CHAMPIONS

Zelia Da Silva RRT
Christina Sperling RRT
Michael Finelli RRT
Jason Macartney RRT
Leanne Davidson RRT
Dr. Bob Jankov
Dr. Tanya Di Genova