Noninvasive Ventilation for Acute Hypoxemic Respiratory Failure: Does it still have a role?

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Disclosures

• Research Grants
  – Breathe Technologies
  – Fisher Paykel

• Advisory Board
  – Alung technologies
  – Fisher Paykel

• Consultant
  – Breathe Technologies
  – Respiromics
  – ResMed
  – Vapotherm
Outline

- Noninvasive Ventilation for AHRF
- Older evidence
- Concerns re recent evidence
- High Flow Nasal Cannula as alternative
- Possible role of helmet
- Where does it currently fit in?
### Acute Hypoxemic Respiratory Failure

- Italian multicenter study of 354 NIV cases, 30% failures; 50% ARDS or CAP, 10% cardiogenic pulmonary edema

<table>
<thead>
<tr>
<th>Condition</th>
<th>Odds Ratio</th>
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<tbody>
<tr>
<td>ARDS or Comm Acq Pna</td>
<td>3.75</td>
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<tr>
<td>PaO2/FIO2 &lt; 200</td>
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<tr>
<td>Resp Distress, RR &gt; 30-35</td>
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<tr>
<td>Non-COPD dx</td>
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<tr>
<td>Pneumonia (incl immunosuppr)</td>
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<tr>
<td>ARDS</td>
<td></td>
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<tr>
<td>Trauma</td>
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<tr>
<td>Cardiogenic Pulm Edema</td>
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</tbody>
</table>

- PaO2/FIO2 < 200
- Resp Distress, RR > 30-35
- Non-COPD dx
- Pneumonia (incl immunosuppression)
- ARDS
- Trauma
- Cardiogenic Pulmonary Edema

- SAPS II ≥ 35 1.81
- Age > 40 1.72

Antonelli et al, Int Care Med 2001 27:1718
Poor Outcomes of ALI/ARDS/Pneumonia treated with NIV

Pneumonia associated with poor outcome with NIV
– Ambrosino N, Thorax ’95

Severe CAP – initial oxygenation better, 66% need for intubation – Jolliet P et al, ICM 2001

ARDS – 38/54 (70%) intubation. P/F 147 success; 112 failure; all septic shock failed – Rana S et al, Crit Care ’06

Canadian Clinical Practice Guideline: No recommendation due to lack of RCTs – Keenan S et al, CMAJ 2011
NIV as “First Line” Therapy in ARDS

- 147 pts eligible of 479 (332 intubated), had dyspnea, RR > 30 and ≤ 2 new organ failures
- 54% avoided intubation –
  VAP rate 2 vs 20%, mortality 6 vs 53%
- Success more likely if SAPS II ≤ 34 and PaO2/FIO2 > 175 p 1\textsuperscript{st} hr of NIV therapy

Antonelli et al, CCM, 2006
Why is NIV so challenging for ARDS/Severe Hypoxemic RF?

- Severe oxygenation defect – more PEEP, more leak, desaturation if mask “falls” off
- High minute volumes, tachypnea – harder to meet demands, synchronize
- Stiff lungs – Higher insp pressure, more leak, less comfort
- Sick patients – sepsis, secretions, MODS, deteriorating
- Prolonged respiratory failure
High Flow Nasal Cannula (HFNC): Technical Aspects

- Delivers nasal flows up to 60 l/min
- Provides heat and humidification up to 37°, 44 mg/l (Body temperature and saturation)
- Precise FIO2 ranging from RA to 100%
- Preserves ability to speak and eat
Heat and Humidification

• Enhances comfort and tolerance compared to traditional high flow oxygen or NIV
• Interface loose fitting and compact
• Less dessication and cooling of mucosal surfaces
High Flow Nasal Cannula (HFNC)

- Heated, humidified oxygenated gas enhances secretion mobilization, preserves mucociliary function

- Clears dead space in upper airway, improves ventilatory efficiency

- Decreases resp rate, helps to reduce work of breathing

- Effective oxygenator; high flow reduces entrapment of room air

- Provides PEEP - roughly 1 cm H2O for each 10 L/min flow
Enhancing Efficiency of Ventilation

- Washes out expired CO₂ from upper airway before next inhalation
- Reduces dead space ventilation and VD/VT

Muller W, Tatkov S et al, JAP 2015
Positive End Expiratory Pressure with HFNO

Corley A et al, Brit J Anaesth 2011
Airway Pressure with NIV v HFNC

NIV

HFNO
What about NIV for AHRF?

RCT of HFNC v NIV v SO

- 2506 pts with AHRF – 525 eligible - 313 enrolled
- P/F ≤ 300, RR > 25, No PaCO2 > 45, no CRF
- Baseline RR 33/min, P/F 155, 75-80% PNA
- NRB ≥ 10 l/min, HFNO 50 l/min, FIO2 1.0 (82 %), NIV VT 7-10 ml/kg (PS 8, PEEP 5, 67%, 9.3 ml/kg), 8 hrs daily X 2d

Frat J-P et al, NEJM 2015
# RCT of HFNC v NIV v SO in AHRF

<table>
<thead>
<tr>
<th></th>
<th>HFNO</th>
<th>SO</th>
<th>NIV</th>
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<tbody>
<tr>
<td>n</td>
<td>106</td>
<td>94</td>
<td>110</td>
</tr>
<tr>
<td>Intubation (%)</td>
<td>38</td>
<td>47</td>
<td>50</td>
</tr>
<tr>
<td>Intub P/F &lt; 200</td>
<td>35</td>
<td>53</td>
<td>58*</td>
</tr>
<tr>
<td>Vent free days</td>
<td>24</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Death ICU (%)</td>
<td>11</td>
<td>19</td>
<td>25*</td>
</tr>
<tr>
<td>Death 90d (%)</td>
<td>30</td>
<td>45</td>
<td>49*</td>
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* P<0.05

Frat J-P et al, NEJM 2015
RCT of HFNO v NIV v SO in AHRF

Frat J-P et al, NEJM 2015
Concerns re Frat Study

• NIV was actually 16hrs HFNC, 8 hrs NIV for 1\textsuperscript{st} 2 days

• Explanation for mortality difference?
  • More refractory shock in NIV group (6\% v 17\%)
  • Average VT 9.2 ml/kg during NIV

• No accurate VT measurements

• Impossible to blind
High Tidal Volumes with NIV

- 62 pts, 51 with ARDS; VT set at 6-8 ml/kg

Carteaux G et al, CCM 2016
Observations on NIV Use in the LUNG SAFE study on ARDS

- International prospective study involving 459 ICUs in 50 countries
- Collected data on 2813 ARDS pts (P/F < 300) and new bilat infiltrates
- 507 (18%) managed with NIV
- Rate of use same in mild, mod, severe, but mortality 22%, 42% and 47%, respectively
- Propensity analysis showed mortality greater (36% v 25%) in NIV v INV in subgroup with P/F<150

Bellani G et al, AJRCCM 2016 epub ahead of print
Helmet for ARDS

• 83 pts with ARDS (Berlin crit), usual contraindications for NIV
• Face mask via single limb, PEEP for FIO2 < 90% (PS 11, PEEP 5), Helmet dual limb (8 and 8)
• Intubation 62% v 18%*, LOS: Hosp 15 v 10d
• Mortal: Hosp 49% v 27%*, 90d 56% v 34%*

Patel B et al, JAMA 2016
Helmet study – 90d mortality

Patel B et al, JAMA 2016
Summary: NIV for ARDS

• To treat AHRF, NIV has a shaky record due to technical and tolerance limitations, and nature of dz
• HFNC has comfort and tolerance advantages over NIV and is an effective oxygenator
• Recent studies on ARDS demonstrate better outcomes of HFNC over NIV, worse outcomes of NIV c/w invasive in mod severe hypoxemia and concerns re excessive VTs with NIV = death knell
• NIV techniques such as use of helmet may improve NIV outcomes in ARDS and require further study
Where do NIV and HFNC fit in for Rx of AHRF?

Hypoxemic Respiratory Failure

SO₂  HFNC/NIV?  Intubation  ECMO

Mild  Severe