Non-Invasive Ventilation on the acute take

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Inspiring Change

A review of the quality of care provided to patients receiving acute non-invasive ventilation

www.ncepod.org.uk

#acuteNIV
Overall quality of care

Figure 12.1 Overall quality of care – reviewers’ opinion
Effective NIV care is more complex than it appears

In 4 out 5 cases reviewed, care was rated as less than good

Wide organisational variation (staffing and monitoring)

Treatment frequently delayed (service organisation, poor recognition)

Ventilator and non-ventilator management often poor
BTS/ICS Guidelines for the ventilatory management of acute hypercapnic respiratory failure in adults

British Thoracic Society

Intensive Care Society

Better Lung Health for All
Better Lung Health for All
Introduction

• There is evidence that patients with AHRF are not receiving optimal therapy:
  • BTS NIV audit reports 2011-13
  • Acidosis, non-invasive ventilation and mortality in hospitalised COPD exacerbations. Thorax 2011
  • National COPD Audit Programme: secondary care clinical audit report: “Who Cares Matters 2014”
    https://www.rcplondon.ac.uk/projects/national-copd-audit-programme

• “provision of NIV is often poorly performed, patients not treated until acidosis severe and some patients inappropriately denied admission to the ICU” Better Lung Health for All
68% of deaths that occurred were in those in whom NIV was started after 3 hours.
Why all the fuss?

Noninvasive ventilation for acute respiratory failure: a prospective randomised placebo-controlled trial

F. Thys*, J. Roeseler#, M. Reynaert*, G. Liistro†, D.O. Rodenstein‡

Table 3. – Main patient outcomes

<table>
<thead>
<tr>
<th>Protocols</th>
<th>Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active bi-level NPPV</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Placebo NPPV</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Rescue</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Failure: need of endotracheal intubation in the active bi-level noninvasive positive-pressure ventilation (NPPV) arm, and of crossing over to active NPPV (rescue) in the placebo arm.
BTS Recommendations

At risk: Target saturations 88-92%

COPD

Chest wall

NMD

Obesity
The origin of ward based NIV

THE LANCET

The early use of NIV for acute exacerbations of COPD.
(YONIV study)

- Is NIV feasible in the real world?
- Can it be performed successfully outside the ITU?
- Does early use prevent deterioration?
CPAP vs NIV

**CPAP**
- Single pressure
- Does not ventilate
- Alveolar recruitment
- Upper airway splinting
- Treat T1RF (mainly)
  - APO
  - CAP

**NIV**
- 2 pressures
- PS to assist ventilation
- Treat T2RF
  - COPD
  - NMD
  - CWD
  - Obesity
NIV use

**Contraindications**
- GCS<8
- pH<7.25
- Agitation
- Vomiting
- Facial burns/deformity
- Pneumothorax (undrained)
- Upper airway obstruction
- Asthma!!

**Indications**
- AECOPD
- Decompensated OSA/OHS
- Acute (on chronic) RF in NM/CWD
Acute exacerbations COPD

- Commonest cause of AHRF: 20% AECOPD
- In COPD signals advanced disease, high risk of future hospitalisations and limited long term prognosis
- In COPD mortality 8% without AHRF and up to 30% with AHRF depending on the degree of acidosis

Better Lung Health for All
NIV is beneficial in acute acidotic COPD

Based on trial evidence

• Decrease in mortality 48%
• Decreased rate of intubation 59%
• Decreased hospital stay 3 days

Ram FSF et al. Cochrane Database of Systematic Reviews 2004.
Pneumonia?

**PREDICTORS OF FAILURE:**
- Worse CXR on admission
- Lower PaO2/FiO2
- ↑ severity scores
- Higher HR
- Lower bicarbonate

May be a role in selected population – COPD/heart failure (data 2019)
Currently - ITU
## Acute Pulmonary Oedema: 3CPO trial

(Gray et al 2008, NEJM)

<table>
<thead>
<tr>
<th>Variable</th>
<th>CPAP (N=346)</th>
<th>NIPPV (N=356)</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death or intubation within 7 days (% of patients)</td>
<td>11.7</td>
<td>11.1</td>
<td>0.94 (0.59 to 1.51)</td>
<td>0.81</td>
</tr>
<tr>
<td>Death within 7 days (% of patients)</td>
<td>9.6</td>
<td>9.4</td>
<td>0.97 (0.58 to 1.61)</td>
<td>0.91</td>
</tr>
<tr>
<td>Death within 30 days (% of patients)</td>
<td>15.4</td>
<td>15.1</td>
<td>0.98 (0.64 to 1.49)</td>
<td>0.92</td>
</tr>
<tr>
<td>Intubation within 7 days (% of patients)</td>
<td>2.4</td>
<td>3.5</td>
<td>1.48 (0.60 to 3.67)</td>
<td>0.40</td>
</tr>
<tr>
<td>Admission to critical care unit (% of patients)</td>
<td>44.5</td>
<td>45.8</td>
<td>1.06 (0.78 to 1.43)</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Myocardial infarction (% of patients)

- WHO criteria: 27.2 vs 26.8 (0.98 (0.70 to 1.37) P = 0.90)
- Universal criteria: 49.1 vs 54.7 (1.25 (0.93 to 1.69) P = 0.14)

<table>
<thead>
<tr>
<th>Variable</th>
<th>CPAP (N=346)</th>
<th>NIPPV (N=356)</th>
<th>Difference between Means (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length of hospital stay (days)</td>
<td>11.3</td>
<td>11.5</td>
<td>0.2 (–1.1 to 1.5) P = 0.81</td>
</tr>
<tr>
<td>Mean change at 1 hr after start of treatment:‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyspnea score§</td>
<td>4.7</td>
<td>4.5</td>
<td>–0.2 (–0.8 to 0.4) P = 0.52</td>
</tr>
<tr>
<td>Pulse rate (beats/min)</td>
<td>17</td>
<td>15</td>
<td>–2 (–5 to 1) P = 0.26</td>
</tr>
<tr>
<td>Blood pressure (mm Hg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>38</td>
<td>37</td>
<td>–1 (–6 to 5) P = 0.77</td>
</tr>
<tr>
<td>Diastolic</td>
<td>23</td>
<td>21</td>
<td>–2 (–6 to 2) P = 0.31</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>7.3</td>
<td>7.1</td>
<td>–0.1 (–1.2 to 1.0) P = 0.82</td>
</tr>
<tr>
<td>Peripheral oxygen saturation (%)</td>
<td>3.5</td>
<td>2.6</td>
<td>–0.9 (–2.2 to 0.3) P = 0.14</td>
</tr>
<tr>
<td>Arterial pH</td>
<td>0.12</td>
<td>0.10</td>
<td>–0.01 (–0.02 to 0.00) P = 0.05</td>
</tr>
<tr>
<td>Arterial PaO₂ (kPa)</td>
<td>−1.1</td>
<td>0.0</td>
<td>1.2 (–0.5 to 2.8) P = 0.16</td>
</tr>
<tr>
<td>Arterial PaCO₂ (kPa)</td>
<td>1.5</td>
<td>1.4</td>
<td>–0.1 (–0.3 to 0.2) P = 0.67</td>
</tr>
<tr>
<td>Serum bicarbonate level (mmol/liter)</td>
<td>2.3</td>
<td>1.3</td>
<td>–0.9 (–1.8 to 0.0) P = 0.04</td>
</tr>
</tbody>
</table>
Acute Pulmonary Oedema

Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary oedema (Review)

What do you need the team need to have thought about/done?

- Ceiling of care
- Is there an advance care directive?
- Can you discuss with pt/NOK?
- DNACPR
- Documentation
Physiology

- Pressure support (PS)
  \[ \text{PS} = \text{IPAP} - \text{EPAP} \]
  More PS, higher \( V_T \)

- Back-up rate (BUR)
  - Higher BUR, higher RR (if patient’s RR not high enough)

- EPAP
  - Constant flushing out of ventilator circuit
    - Reduces physiological \( V_d \)
  - Increases alveolar recruitment – improves oxygenation
  - Reduces threshold load – (triggering)
  - Keeps airways open

- \( PV_{CO_2} \) \( \propto \) \( \frac{V_{CO_2}}{V_A} \)

- \( V_A = V_E - V_D \)

- \( V_E = RR \times V_T \)
Modes of Ventilation

• S/T mode
  – Spontaneous/Timed mode

• AVAPS
  • Average Volume Assured Pressure Support

• iVAPS
  • Intelligent Volume Assured Pressure Support
### Figure 1 Summary for providing acute NIV

<table>
<thead>
<tr>
<th>Indications for NIV</th>
<th>Contraindications for NIV</th>
<th>NIV SETUP</th>
<th>NIV Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD pHi &lt; 7.35, pCO2 &gt; 46.5 RR &gt; 25 Monitoring with bronchodilators and controlled oxygen therapy</td>
<td>Absolute Severe facial deformity Fixed upper airway obstruction</td>
<td>Mask Full face mask (or own home user of NIV)</td>
<td>Oxygenation Aim 88-94% in all patients Note: Home style ventilators CANNOT provide &gt; 50% inspired oxygen. If high oxygen need or rapid desaturation on disconnection from NIV consider IMV.</td>
</tr>
<tr>
<td></td>
<td>Relative pHi &lt; 7.15 (pHi &lt; 7.25 with additional adverse feature) COPD</td>
<td>Initial Pressure settings EPAP: 3 (or higher if O2A known or suspected)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IPAP in COPD/OWS/KS 15 (D if pHi &lt; 7.25)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up to twice EPAP over 10 min to IPAP &gt; 30 to achieve adequate augmentation of chest wall movements and RR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IPAP should not exceed 30 cmH2O or EPAP if without expiratory hold</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IPAP in OWS 10 (as 5 above usual setting)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Backup rate Backup Rate of 16-20 per minute Inspiratory time</td>
<td>Red flags pHi &lt; 7.25 on optimal NIV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I:E Ratio COPD 1.2 to 1.3 OWS, NM &amp; CWD 1:1</td>
<td>New onset confusion or patient distress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inspiratory time 0.41-0.45 COPD 0.24-0.55 OWS, NM &amp; CWD</td>
<td>Actions Check synchronisation, mask fit, exhalation port, give physiotherapy/branchialkoxes, consider naloxone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NIV Not indicated Asthma/Pneumonia Refer to ICU for consideration of IMV with increasing respiratory rate/difficulties or pHi &lt; 7.35 and pCO2 &gt; 46.5</td>
<td>CONSIDER IMV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Possible need for EPAP &gt; 8 Severe CHF (BMI &gt; 35), long recruitment hypoxia in severe hypocapnia, opposite with PEEP in severe airflow obstruction or to maintain adequate PaCO2 when high EPAP required.</td>
<td></td>
</tr>
</tbody>
</table>

Neuromuscular disease Respiratory failure with RR > 20 (usual VC -11 even if pCO2 > 6.5 Or pHi < 7.35 and pCO2 > 6.5

Obesity pHi < 7.35, pCO2 > 46.5 RR > 25 Or Daytime pCO2 > 6.0 and somnolent
Case

- 68 y.o male
- ECOPD
- Obese
- T2RF, not responding to optimal medical management
- NIV commenced.
- He was initially quite drowsy but is now more awake.
- Known severe COPD (FEV1 30%)
- Ambulatory oxygen at home but not LTOT.

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>6hrs post NIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.3</td>
<td>7.33</td>
</tr>
<tr>
<td>pCO₂</td>
<td>8</td>
<td>7.6</td>
</tr>
<tr>
<td>pO₂</td>
<td>6.5</td>
<td>7.5</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>BE</td>
<td>5.4</td>
<td>5.6</td>
</tr>
</tbody>
</table>

What next?
Possible changes....

What is the $V_T$?

What is the IPAP max?

What is the EPAP?

Is there significant bronchospasm?

- Currently set at 500mls, patients IBW is 80kg $\rightarrow$ 800mls
- Currently set at 25 $\rightarrow$ 30
- Currently set at 5 $\rightarrow$ 10cmH2O
- No
Troubleshooting

Persistent $\uparrow$CO2
- Check mask size, fit
- Is there leak? Circuit?
- Expiratory port
- Over oxygenation?
- Increase Vt
- ?Increase EPAP
- Pt position

Asynchrony
- Trigger sensitivity
- ?Insp effort
- Ti
Troubleshooting 2

Side effects

• Nasal sores/dryness
  – Padding, nasal steroids

• Dry mouth
  – Humidification

• Gastric distension
  – NGT

Difficulty inflating chest

• Low Vt

• Bronchospasm

• Mucous plugging

• PTX

• Collapse/consolidation
Further information

The guideline can be found on the BTS website at:

Contact: bts@brit-thoracic.org.uk
Questions?