Conflicts of Interest

INSTITUTIONAL:

- Research grants from:
  - Draeger
  - Maquet
  - Airway Medix
  - Chiesi Farmaceutica, SPA

- Patent transferal to: Draeger

PERSONAL

- Consultancy fee from: Draeger
Helmets for CPAP

Giacomo Bellani, MD, PhD
University of Milan-Bicocca
A.O. San Gerardo
Monza (Italy)
### Acute Cardiogenic PE

#### Figure 2. Effects of Noninvasive Ventilation on Death

<table>
<thead>
<tr>
<th>Source</th>
<th>Mortality, No. of Events/Total No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noninvasive Ventilation</td>
</tr>
<tr>
<td><strong>Continuous Positive Airway Pressure</strong></td>
<td></td>
</tr>
<tr>
<td>Räsänen et al.(^3), 1985</td>
<td>3/20</td>
</tr>
<tr>
<td>Bersten et al.(^4), 1991</td>
<td>2/19</td>
</tr>
<tr>
<td>Lin et al.(^5), 1995</td>
<td>4/50</td>
</tr>
<tr>
<td>Takeda et al.(^29), 1997</td>
<td>1/15</td>
</tr>
<tr>
<td>Park et al.(^30), 2001</td>
<td>1/9</td>
</tr>
<tr>
<td>Kelly et al.(^31), 2002</td>
<td>2/27</td>
</tr>
<tr>
<td>Crane et al.(^32), 2004</td>
<td>0/20</td>
</tr>
<tr>
<td>L’Her et al.(^7), 2004</td>
<td>12/43</td>
</tr>
<tr>
<td>Park et al.(^8), 2004</td>
<td>1/27</td>
</tr>
<tr>
<td>Overall Category</td>
<td>26/230</td>
</tr>
</tbody>
</table>

| **Noninvasive Pressure Support Ventilation** | | |
| Levitt,\(^33\), 2001 | 3/21 | 3/17 |
| Masip et al.\(^9\), 2000 | 0/19 | 2/18 |
| Park et al.\(^30\), 2001 | 0/7 | 0/10 |
| Nava et al.\(^34\), 2003 | 6/65 | 9/65 |
| Crane et al.\(^32\), 2004 | 5/20 | 6/20 |
| Park et al.\(^8\), 2004 | 2/27 | 6/26 |
| Overall Category | 16/159 | 26/156 |

**Overall**

42/389 78/394
Helmet CPAP vs. oxygen therapy in severe hypoxemic respiratory failure due to pneumonia
pressures in the airways. On the basis of personal data and experience, participating physicians were advised not to exceed 60% FiO₂ when unnecessary, in order to ensure maximal gas flow between 120 and 140 L/min and thus to maintain positive airway pressure. Each patient (or next
F = 90 l/min

Paw

Airway flow

Pat flow

Azienda Ospedaliera San Gerardo
F = 40 l/min

F = 90 l/min

F = 50 l/min

Paw

Airway flow

Pat flow
F = 90 l/min

F = 120 l/min

Paw

Airway flow

Pat flow
Comparison of two flow generators with a noninvasive ventilator to deliver continuous positive airway pressure: a test lung study
Expiratory valve resistance

Isgrò S et al., Minerva anestesiol 2003
Comparison of two flow generators with a noninvasive ventilator to deliver continuous positive airway pressure: a test lung study
Keep airway pressure stable

High fresh gas flow rates

Low FiO2 (venturi)

High O₂ consumption

Expiratory workload

Humidification
Then, what do we need?
What does reservoir do?

Pressure

$P_{pl}$

$P_{aw}$

$WOB$ imposed by circuit
<table>
<thead>
<tr>
<th></th>
<th>4Vent - Rüsh</th>
<th>PN500 - Harol</th>
<th>CaStar - StarMed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helmet volume (L)</strong></td>
<td>13</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td><strong>Helmet compliance (ml/cmH$_2$O)</strong></td>
<td>726</td>
<td>1131</td>
<td>826</td>
</tr>
<tr>
<td>PEEP 5</td>
<td>726</td>
<td>1131</td>
<td>826</td>
</tr>
<tr>
<td>PEEP 10</td>
<td>456</td>
<td>666</td>
<td>496</td>
</tr>
<tr>
<td>PEEP 15</td>
<td>354</td>
<td>503</td>
<td>385</td>
</tr>
<tr>
<td><strong>Helmet Hose Resistance (cmH$_2$O/Lxsec$^{-1}$)</strong></td>
<td>0.48</td>
<td>0.6</td>
<td>0.24</td>
</tr>
</tbody>
</table>
Figure 2: effect of different CPAP levels on FRC during CPAP$_H$ (left side) and CPAP$_M$ (right side) in each subject. Each point represent mean ± sd of FRC between different gas flow rates. Dotted lines refer to subjects with evidence of expiratory muscle contraction.

* effect of CPAP levels during CPAP$_H$ p<0.05; # effect of CPAP levels during CPAP$_M$ p<0.05.
Noninvasive continuous positive airway pressure delivered by helmet in hematological malignancy patients with hypoxemic acute respiratory failure

<table>
<thead>
<tr>
<th></th>
<th>Helmet</th>
<th>Mask</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial improvement in PaO₂/FIO₂</td>
<td>17 (100%)</td>
<td>17 (100%)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Sustained improvement in PaO₂/FIO₂ without intubation</td>
<td>17 (100%)</td>
<td>13 (76%)</td>
<td>0.10</td>
</tr>
<tr>
<td>PaO₂/FIO₂ after 2 h</td>
<td>245.67±139.29</td>
<td>265.43±127.62</td>
<td>0.67</td>
</tr>
<tr>
<td>PaO₂/FIO₂ after 4 h</td>
<td>225.50±118.27</td>
<td>265.43±127.62</td>
<td>0.35</td>
</tr>
<tr>
<td>PaO₂/FIO₂ after 6 h</td>
<td>242.01±82.48</td>
<td>210.84±110.58</td>
<td>0.36</td>
</tr>
<tr>
<td>PaO₂/FIO₂ after 12 h</td>
<td>252.54±63.74</td>
<td>185.55±100.79</td>
<td>0.03</td>
</tr>
<tr>
<td>PEEP applied (cmH₂O)</td>
<td>8±2</td>
<td>8±2</td>
<td>n.s.</td>
</tr>
<tr>
<td>FIO₂</td>
<td>0.60</td>
<td>0.60</td>
<td>n.s.</td>
</tr>
<tr>
<td>Hours of continuous CPAP (min)</td>
<td>28.44±0.20</td>
<td>7.50±0.45</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Total period CPAP (min)</td>
<td>34.13±0.19</td>
<td>28.15±0.35</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Intubation</td>
<td>0 (0%)</td>
<td>7 (41%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Tolerance, level 0</td>
<td>0 (0%)</td>
<td>8 (47%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Tolerance, level 1</td>
<td>1 (6%)</td>
<td>7 (41%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Tolerance, level 2</td>
<td>3 (18%)</td>
<td>2 (12%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Tolerance, level 3</td>
<td>13 (76%)</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Complications related to nCPAP</td>
<td>0</td>
<td>4 (24%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Skin necrosis</td>
<td>0</td>
<td>2 (12%)</td>
<td>0.48</td>
</tr>
<tr>
<td>Gastric distension</td>
<td>0</td>
<td>0</td>
<td>n.s.</td>
</tr>
<tr>
<td>Eye irritation</td>
<td>0</td>
<td>2 (12%)</td>
<td>0.48</td>
</tr>
</tbody>
</table>
Noninvasive Ventilation by Helmet or Face Mask in Immunocompromised Patients*

A Case-Control Study

Monica Rocco, MD; Donatella Dell’Utri, MD; Andrea Morelli, MD; Gustavo Spadetta, MD; Giorgio Conti, MD; Massimo Antonelli, MD; and Paolo Pietropaoli, MD

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mask Group (n = 19)</th>
<th>Helmet Group (n = 19)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement at 1 h PaO₂/FIO₂ ratio, No. (%)</td>
<td>12 (63)</td>
<td>12 (63)</td>
<td>0.63</td>
</tr>
<tr>
<td>Sustained improvement PaO₂/FIO₂ ratio, No. (%)†</td>
<td>7 (37)</td>
<td>14 (74)</td>
<td>0.02</td>
</tr>
<tr>
<td>PaO₂/FIO₂ ratio after 1 h</td>
<td>202 (61)</td>
<td>224 (111)</td>
<td>0.45</td>
</tr>
<tr>
<td>PaO₂/FIO₂ ratio at treatment discontinuation</td>
<td>178 (61)</td>
<td>247 (131)</td>
<td>0.04</td>
</tr>
<tr>
<td>Paco₂ after 1 h</td>
<td>39 (8)</td>
<td>39 (9)</td>
<td>0.91</td>
</tr>
<tr>
<td>Paco₂ at treatment discontinuation</td>
<td>40 (6)</td>
<td>40 (8)</td>
<td>0.95</td>
</tr>
<tr>
<td>pH after 1 h</td>
<td>7.42 (0.06)</td>
<td>7.43 (0.07)</td>
<td>0.08</td>
</tr>
<tr>
<td>pH at treatment discontinuation</td>
<td>7.42 (0.04)</td>
<td>7.41 (0.08)</td>
<td>0.64</td>
</tr>
<tr>
<td>RR after 1 h, breaths/min</td>
<td>27 (4)</td>
<td>27 (9)</td>
<td>0.96</td>
</tr>
<tr>
<td>RR at treatment discontinuation, breaths/min</td>
<td>29 (7)</td>
<td>26 (11)</td>
<td>0.35</td>
</tr>
<tr>
<td>HR after 1 h, beats/min</td>
<td>100 (17)</td>
<td>101 (17)</td>
<td>0.41</td>
</tr>
<tr>
<td>HR at treatment discontinuation, beats/min</td>
<td>106 (21)</td>
<td>98 (20)</td>
<td>0.20</td>
</tr>
<tr>
<td>SAP after 1 h, mm Hg</td>
<td>135 (15)</td>
<td>135 (20)</td>
<td>0.98</td>
</tr>
<tr>
<td>SAP at treatment discontinuation, mm Hg</td>
<td>128 (16)</td>
<td>137 (13)</td>
<td>0.06</td>
</tr>
<tr>
<td>Pressure support, cm H₂O</td>
<td>15 (2)</td>
<td>15 (2)</td>
<td>0.30</td>
</tr>
<tr>
<td>PEEP, cm H₂O</td>
<td>7 (2)</td>
<td>8 (2)</td>
<td>0.27</td>
</tr>
<tr>
<td>Duration of NPPV, d</td>
<td>3.7 (2)</td>
<td>3.3 (1)</td>
<td>0.4</td>
</tr>
<tr>
<td>Duration NPPV, h/d</td>
<td>13 (6)</td>
<td>11 (3)</td>
<td>0.15</td>
</tr>
<tr>
<td>Number of discontinuations first 24 h (SD)</td>
<td>2.94 ± 1.02</td>
<td>1.21 ± 1.18</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*CHEST 2004; 126:1508–1515*
Bias Flow in the Head Tent MUST be > 30 L/min.

Head Helmet versus Face Mask for Non Invasive CPAP: a physiological study

Patroniti N., Foti G., Manfio A., Coppo A., Bellani G., Pesenti A.

ICM September 2003 29:1680-1687
Face Mask  60 L/min  30 L/min  10 L/min  Ventilator

Noise exposure during noninvasive ventilation with a helmet, a nasal mask, and a facial mask
Conclusion

- Helmet CPAP is an effective way to provide noninvasive CPAP
- As effective as face mask (less O2 consumption, higher FiO2)
- Some data suggest a better comfort than face mask
- Rebreathing has to be taken into account (avoid the use of a MV to provide CPAP)
Thank you!