CPAP in the treatment of acute cardiogenic pulmonary oedema patients in the pre-hospital setting

Michael A Austin
Senior Emergency Medicine Trainee, Royal College of Physician and Surgeons of Canada

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A randomised controlled trial of continuous positive airway pressure (CPAP) in the treatment of acute cardiogenic pulmonary oedema (ACPO) patients in the pre-hospital setting

Michael A Austin\textsuperscript{1,2,3}, KE Wills\textsuperscript{3}, D Kilpatrick\textsuperscript{4}, M Gibson\textsuperscript{5}, EH Walters\textsuperscript{3,4}

1. Department of Emergency Medicine, University of Ottawa, Ontario, Canada
2. Ottawa Hospital Research Institute, Ottawa, Ontario, Canada
3. Menzies Research Institute Tasmania, Australia
4. School of Medicine, University of Tasmania, Australia
5. Ambulance Tasmania, Australia
Thank you

› Professor Haydn Walters
› Dr Karen Wills
› Professor David Kilpatrick
› Michael Gibson
› Royal Hobart Hospital Emergency Department
› Professor Ian Stiell & Ottawa Hospital Research Institute (OHRI)
Sponsors – Thank you!

- NHMRC Centre of Research Excellence (CRE) for Chronic Respiratory Disease

- Fisher and Paykal (suppliers of the Whisperflow® CPAP device)

- Ambulance Tasmania (Training and IT support)
Disclosure

No conflicts of interests to disclose
**Background**

- Congestive heart failure (CHF) is common

- In 2008, CHF occurred in 5.7 million Americans, and in 10 million Europeans
Background

- Substantial burden 1-2% total health costs with 70% related to hospitalisation

- Course characterized by episodes of acute breathlessness and hypoxia

- The disease is associated with poor prognosis and reduced quality of life
Increased back pressure of pulmonary venous circulation – precipitates extravasations of fluid into the lungs

Fluid causes intrapulmonary shunting and V-Q mismatch (redistribution of blood flow)
Clinical Presentation

- Tachypnoea
- Difficulty breathing
- Hypoxaemia
- Anxiety
Out-of-hospital Management

- Standard pre-hospital management includes:
  - High flow oxygen
  - Nitroglycerin
  - Severe cases assisted ventilation
  - (Frusemide, Morphine)
The pre-hospital use of CPAP ventilation is a relatively new management for acute cardiogenic pulmonary oedema (ACPO), little evidence
Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary edema (Review)


- **Cochrane Review 2008**
- 21 Studies, 1071 patients
  - NPPV significantly reduced
  - hospital mortality (RR 0.6, 95% CI 0.45 to 0.84)
  - endotracheal intubation (RR 0.53, 95% CI 0.34 to 0.83)
  - with numbers needed to treat of 13 and 8, respectively
Out-of-Hospital Continuous Positive Airway Pressure Ventilation Versus Usual Care in Acute Respiratory Failure: A Randomized Controlled Trial

James Thompson, MD, FRCPC  
David A. Petrie, MD, FRCPC  
Stacy Ackroyd-Stolarz, PhD (C)  
Darrell J. Bardua, ACP

From the Department of Emergency Medicine, St. Paul's Hospital, Vancouver, British Columbia, Canada (Thompson); Department of Emergency Medicine, Dalhousie University, Halifax, Nova Scotia, Canada (Petrie, Ackroyd-Stolarz); Emergency Health Services, Dartmouth, Nova Scotia, Canada (Bardua).

Annals of Emergency Medicine 2008

71 patients (2002-2006)

- Intubation 17/34 (50%) usual care versus 7/35 (20%) CPAP group
- Mortality 12/34 (35%) usual care versus 5/35 (14%) CPAP
Objectives

Goal: To determine whether patients in severe respiratory distress from ACPO treated with CPAP in the pre-hospital setting have a lower mortality than those treated with usual care.

ACPO patient

- Continuous Positive Airway Pressure (CPAP)
- Inspired Positive Pressure Ventilation (IPPV)
Methods

- Randomised, controlled, parallel group trial
- Randomised number generator (excel)
- Opaque envelope
Methods

Inclusion Criteria:
- Patients >18 yrs of age, severe respiratory distress, hypoxia, impeding respiratory failure
- Presumed from history and exam to be Acute Cardiogenic Pulmonary oedema (ACPO)

Exclusion Criteria:
- Primary presentation for another condition e.g. AECOPD or Asthma
Hobart, Tasmania (June 2009-July 2010)

- Population 300,000 (Urban and Rural distribution)

- Paramedics and Intensive Care Paramedics all trained in IPPV and CPAP
Outcomes

Primary Outcome:
- In hospital mortality from cardiovascular cause

Secondary Outcomes:
- Length of hospital stay
- Blood gas results
- Requirement for intubation
- Vital signs (BP, HR, Respiratory rate, oxygen saturation, GCS)
Randomisation

- Intervention
- active arm
  - received CPAP delivered by Whisperflow®
Whisperflow®

▷ 14-16 L/min Oxygen
▷ Flow 120 L/min
▷ Oxygen delivered 28-33%

▷ PEEP – 10 cm of H₂O

WHY?
1. Controlled oxygen delivery
2. Consumption of oxygen
**Randomisation**

- **Intervention**
- **control arm**
  - received inspired positive pressure ventilation (bagging), administered by bag valve mask with oxygen attached at rate of 8-15 l/min
Ambulance Tasmania Guidelines

› basic support (Oxygen)

› nitroglycerine sublingual
  
  › incremental doses starting at 400 mcg to 1600 mcg
  Q 5 min (BP > 100 mmHg)
Ambulance Tasmania Guidelines

- Supportive IPPV for severe respiratory distress
- Frusemide 40 mg IV (severe respiratory distress)
- Morphine 1 – 2 mg IV (treat anxiety)
- Endotracheal intubation was performed if patient’s condition worsened and patients became unresponsive
ACPO Cases
N=377

327 excluded not ventilated

randomised
N=50

Control (Usual care)
n=26

Active (CPAP)
n=24

analyzed
n=26

n=24

All cause mortality 9
Cardiovascular cause mortality 9

All cause mortality 3
Cardiovascular cause mortality 1
### Pre-Treatment Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Bagging N=26</th>
<th>CPAP N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Male %</td>
<td>61%</td>
<td>29%</td>
</tr>
<tr>
<td>Age (years)</td>
<td>78.3 (11.8)</td>
<td>81.5 (11.9)</td>
</tr>
<tr>
<td>Pre-Hospital Treatment Time (Minutes)</td>
<td>35.3 (19.9)</td>
<td>42.3 (21.5)</td>
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<tr>
<td>Initial Oxygen Saturation (%)</td>
<td>75.5 (21.7)</td>
<td>77.1 (14.2)</td>
</tr>
<tr>
<td>Initial Respiratory Rate (breaths/min)</td>
<td>31.1 (11.6)</td>
<td>34.2 (10.8)</td>
</tr>
<tr>
<td>Initial Systolic BP (mmHg)</td>
<td>160.2 (61.7)</td>
<td>168.8 (24.6)</td>
</tr>
<tr>
<td>Initial GCS</td>
<td>13.7 (3.2)</td>
<td>14.1 (2.2)</td>
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## Post-Treatment Baseline Characteristics

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<tr>
<td>Oxygen Saturation (%)</td>
<td>95.1 (4.8)</td>
<td></td>
<td>87.5 (7.1)</td>
<td></td>
</tr>
<tr>
<td>Respiratory Rate (breaths/Min)</td>
<td>27.5 (9.0)</td>
<td></td>
<td>32.3 (9.7)</td>
<td></td>
</tr>
<tr>
<td>Systolic Blood pressure (mmHg)</td>
<td>143.3 (32.0)</td>
<td></td>
<td>136.4 (22.9)</td>
<td></td>
</tr>
<tr>
<td>GCS</td>
<td>13.6 (3.1)</td>
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## Results

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<tr>
<td><strong>Mortality</strong></td>
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<td>n = 24</td>
<td></td>
</tr>
<tr>
<td>All cause</td>
<td>9 (35%)</td>
<td>3 (14%)</td>
<td>0.09</td>
</tr>
<tr>
<td>Cardiovascular cause</td>
<td>9 (35%)</td>
<td>1 (4%)</td>
<td>0.04</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>5.4 (5.2)</td>
<td>3.1 (2.3)</td>
<td>0.05</td>
</tr>
<tr>
<td>Days (SD)</td>
<td></td>
<td></td>
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</table>
Mortality (Cardiovascular cause)

- All Patients (N=50): 10.0 deaths, NNH=6, p=0.04
- CPAP (N=24): 1.0 deaths
- Bagging (N=26): 9.0 deaths
Time to death in hours

- <24 hours: 7.0
- <48 hours: 2.0
- <72 hours: 1.0
# Results

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**Blood Gas results taken within 30 min of arrival**

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<th>CPAP n = 23</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BG (&lt;30 mins)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>pH mmHg (SD)</td>
<td>7.22 (0.12)</td>
<td>7.32 (0.08)</td>
<td>0.002</td>
</tr>
<tr>
<td>pCO2 mmHg (SD)</td>
<td>56.2 (14.5)</td>
<td>46.2 (12.1)</td>
<td>0.02</td>
</tr>
<tr>
<td>Bicarb mmHg (SD)</td>
<td>22.0 (4.2)</td>
<td>23.0 (3.4)</td>
<td>0.41</td>
</tr>
<tr>
<td>pO2 mmHg (SD)</td>
<td>107.2 (92.6)</td>
<td>95.7 (48.6)</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>n=14</td>
<td>n=9</td>
<td></td>
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</table>
Limitations

- small sample size
- No validated severity of respiratory distress score was used to determine eligibility (may limited comparability with other studies)
- Low rate of arterial blood gas sampling
  - 24/50 (48%)
- Could not determine the effect of in-hospital management on outcome (standard is BiPAP)
Discussion

This pilot RCT found that CPAP for ACPO reduced the risk of death by 88% (RR 0.12 95% CI (0.02, 0.88) p=0.04) with NNH of 6.

This is consistent with the Cochrane review results and trends from Thompson et al.

There was a reduction in length of hospital stay.

Patients were less acidotic and hypercarbic when treated with CPAP.
## Discussion - Hyperoxia

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Discussion - hyperoxia

- Hyperoxaemia can cause coronary artery vasoconstriction and reduced coronary artery blood flow
  - Troponin rise 25% in patient with COPD (Becker 1996)
  - Increased infarct size and trend toward mortality in ACS (Rawlings 1967)
Discussion - hyperoxia

- causes partial collapse of some lung units, a condition known as “absorption atelectasis”

- worsening ventilation perfusion mismatch
- worsening hypercarbia and acidosis
Conclusions

This pilot trial was consistent with the current literature on CPAP in the treatment of ACPO

- Reduction in risk of mortality
- Reduction in length of hospital stay and respiratory acidosis
- Therefore supporting the use of CPAP for patients with severe respiratory distress secondary to ACPO
Conclusions

Results from this study also support the caution in the use of hyperoxia for this patient population.
Next Step..

› Publish these results

› A large RCT is needed to validate CPAPs effectiveness in the management of ACPO in the pre-hospital setting