Non-Invasive Ventilation: Overrated

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Grand Rounds
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Since 1997, there have been more than 50 RCT’s looking at NIV in the acute setting...
...And who knows how many in The Journal of Unpublished Data. So, why all the excitement?
“Non-invasive ventilation: BiPAP or Buy Crap?”
-Jim Haenel, RRT, Ventilator Guru.
What is non-invasive positive pressure ventilation (NIV, NPPV)?

NIV (NPPV) is mechanical ventilation using techniques that do not require an endotracheal airway.

- **CPAP** = PEEP
- **BiPAP** = CPAP + PSV
- **Bilevel (bilevel CPAP)** = ARPV w/ spontaneous breathing
CPAP vs BIPAP

CPAP does not actively assist inspiration

“They tried to switch me to BIPAP but I couldn't tolerate the warm humidified component of the apparatus...made me feel like I was drowning.” Katie Bakes, MD
Why Low Lung Volumes are Bad

• The Functional Residual Capacity (FRC) is the lung’s physiologic reserve
• Loss of chest wall or lung compliance causes reduced FRC.
What is the Closing Volume?

• The closing volume (CV) is the point at which dynamic compression of the airways begins.

• The CV increases with age, smoking, lung disease, and body position (supine > erect).
What does NIV do?

• Decreases work of breathing
• Recruits alveoli to improve FRC
• Increases closing volume
• Optimizes lung compliance
• Assists with ventilation, poor device for oxygenation
How does NIV work?

www.icmtutorials.com
Positive pressure: optimizing ventilation

Pressure-volume curve

www.icmtutorials.com
Indications for NIV

- COPD and CHF exacerbations
- Pulmonary infiltrates in immunocompromised patients
- Weaning of previously intubated stable patients with chronic obstructive pulmonary disease.
- To palliate symptoms in terminally ill patients

Benefits of NIV

• Decreased work of breathing in select patients
• Improved gas exchange in select patients
• Avoid complications of intubation; decreased risk of VAP

Pieracci FM. Am Surg 2007; 73:419-432
NIV: Absolute Contraindications

- Unable to fit mask
- Respiratory arrest
- Untrained staff

**NIV: Contraindications**

- Patient unable to protect airway
- Swallowing Impairment
- Hemodynamic Instability (Systolic BP < 90 mmHg)
- Severe Acidemia (pH < 7.25)
- Copious Secretions
- Agitation
- Recent UGI Surgery
- MOF

NIV: Contraindications

- Epistaxis
- Barotrauma (Pneumothorax)
- Facial and Skull Trauma (Pneumocephalus)
- Obtunded Patient

Crummy M. Naughton T. Internal Medicine Journal. 2007; 112–118.
Respiratory Distress

Failure to ventilate or failure to oxygenate?

Respiratory Failure
Disorders of Oxygenation

- Acute Respiratory Distress Syndrome/ ALI
- Pulmonary contusion
- Pneumothorax
- Pulmonary embolism
- Aspiration
- Pneumonia
- Pulmonary Edema
  - Congestive heart failure
  - Iatrogenic fluid overload
Respiratory Failure
Disorders of Ventilation

• Obstructive
  ➢ COPD
  ➢ Mucus plugging
• Altered mental status/ CNS injury
• Pain
  ➢ Rib fractures
  ➢ Abdominal/Thoracic surgery
• Chest wall trauma
Benefits and risks of noninvasive ventilation

A prospective observational study in 70 ICUs 1076 patients requiring ventilatory support.

- Failure associated with increased mortality for de novo (non-CHF, non-COPD) patients.

- Nosocomial pneumonia rates were not statistically different in the NIV and ETI groups

Complications of Noninvasive Ventilation in Acute Care

Systematic Review of RCT’s from 1989-2007 grouped by etiology of respiratory failure

• Conclusion:
  If NIV is inappropriately applied for too long, the consequences may lead to death, presumably due to excessive delay of intubation.

NIV in acute respiratory failure outside clinical trials: Experience at the Massachusetts General Hospital.

Prospective observational study consisting of 449 patients over the course of one year.

60% intubation rate with an associated 64% mortality.

NIV for Acute Respiratory Failure: The Randomized Controlled Trials

Systematic Review of RCT’s from 1989-2007 grouped by etiology of respiratory failure

- Conclusion: NIV for ARF is supported by strong evidence in COPD.
- For patients with pneumonia or ALI, RCT-level evidence is lacking or does not suggest benefit.

Noninvasive ventilation for respiratory failure after extubation.

Multicenter RCT consisting of 221 patients, trial stopped early.

• Conclusion: noninvasive positive-pressure ventilation does not prevent reintubation or reduce mortality in unselected patients who have respiratory failure after extubation.

Esteban A, et. al. NEJM. 2004; 350;2452-60.
Treatment of acute hypoxemic respiratory insufficiency with CPAP

RCT examined patients with hypoxemic respiratory failure.

Treatment failed to reduce:
• the intubation rate, hospital mortality or ICU length of stay

• A higher number of adverse events occurred with CPAP treatment (18 vs 6; P=0.01) including cardiac arrest

Continuous positive airway pressure for treatment of postoperative hypoxemia.

RCT: 209 patients with severe hypoxemic respiratory failure after abdominal surgery

• Results: decreased intubation rate and PNA in patients with severe hypoxemia (P:F < 300)

• Conclusion: study not generalizable

Continuous positive airway pressure for treatment of postoperative hypoxemia.

RCT: 209 patients with severe hypoxemic respiratory failure after abdominal surgery

- **Finding:** Hypoxemic respiratory failure caused by atelectasis.
- **Conclusion:** did not compare standard medical therapies to CPAP. Venturi mask at 50% O2 not standard therapy for atelectasis.
Indications for NIV: Best Use

Acute or acute on chronic ventilatory failure, PaCO2 $>45$ mm Hg, pH $<7.35$

Is NIV cost-effective?

Table 6. Diagnosis-Related Groups and National Average Payments

<table>
<thead>
<tr>
<th>Current DRG</th>
<th>Former DRG</th>
<th>Description</th>
<th>Payment* ($)</th>
<th>Type of Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>189</td>
<td>87</td>
<td>Pulmonary edema and respiratory failure</td>
<td>6,780</td>
<td>NIV</td>
</tr>
<tr>
<td>190-192</td>
<td>88</td>
<td>Chronic obstructive pulmonary disease</td>
<td>5,528</td>
<td>NIV</td>
</tr>
<tr>
<td>208</td>
<td>566</td>
<td>Respiratory system diagnosis: intubation and ventilatory support &lt; 96 h</td>
<td>11,150</td>
<td>Intubation</td>
</tr>
<tr>
<td>207</td>
<td>565</td>
<td>Respiratory system diagnosis: ventilatory support ≥ 96 h</td>
<td>25,429</td>
<td>Intubation</td>
</tr>
<tr>
<td>004</td>
<td>483</td>
<td>Tracheostomy, except for face, mouth, and neck diagnoses</td>
<td>56,694</td>
<td>Tracheostomy and mechanical ventilation</td>
</tr>
</tbody>
</table>

* Payment assumes a 2008 standardized amount of $4,963.64, a hospital with a wage index of 1.000, and does not include capital payment or any add-on payments for teaching, disproportionate share, etc. The amount does not take into account the current blended-payment formula, under which payment is based on both old and new Diagnosis-Related Groups (DRGs).
NIV: in the field and ED

“When Littleton Fire Rescue arrived, I had a pulse ox of 55% and HR around 200. They gave me CPAP in the ambulance, and it was the first time I felt like I might actually live.”
NIV in the SICU? No thanks!

• NIV requires holding tube feeds due to aspiration risk.
• NIV is not cost-effective.
• Evidence does not support routine use in abdominal surgery patients post-op.
• Evidence advises against use in patient with ALI/ARDS.
• Using NIV to prevent reintubation is not recommended and may even be dangerous.
Take Home Points

1. For respiratory failure in the SICU treat the patient not the symptom.

2. CPAP/BIPAP: good for ventilation, poor oxygenation device.

3. NIV use has potential for harm in patients with ALI/ARDS.


Crummy M, Naughton T. Non-invasive positive pressure ventilation for acute respiratory failure: justified or just hot air? Internal Medicine Journal. 2007; 112–118.


