World Congress
WFSICCM Seoul 2015
National Martyrs' Memorial
# Bangladesh Demographics Profile 2014

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>166,280,712 (July 2014 est.)</td>
</tr>
<tr>
<td>Birth rate</td>
<td>21.61 births/1,000 population (2014 est.)</td>
</tr>
<tr>
<td>Death rate</td>
<td>5.64 deaths/1,000 population (2014 est.)</td>
</tr>
<tr>
<td>Health expenditures</td>
<td>3.7% of GDP (2011)</td>
</tr>
<tr>
<td>Physicians density</td>
<td>0.36 physicians/1,000 population (2011)</td>
</tr>
<tr>
<td>Hospital bed density</td>
<td>0.6 beds/1,000 population (2011)</td>
</tr>
</tbody>
</table>
Non-Invasive Ventilation in Acute Respiratory Failure

Mirza Nazim Uddin

Consultant
Internal Medicine & Critical Care
Deputy Director Medical Services
SQUARE Hospitals Ltd
Definition of Non-Invasive Positive Pressure Ventilation

• The application of positive pressure via the upper respiratory tract for the purpose of augmenting alveolar ventilation

• NPPV typically is administered through a nasal or an oral mask – unlike invasive positive pressure ventilation (through an endotracheal or tracheostomy tube)

ARFC Consensus Conference: non-invasive positive pressure ventilation: consensus statement, Respir Care 42:362, 1997
So Why Use Non-invasive Positive Pressure Ventilation

No invasive airway....

- No trauma, no risky intubation
- Less infection risk
- Can take off mask and allow patient to talk, interact with family, eat
- Doesn’t have to be in the ICU
Non-Invasive Positive Pressure Ventilation

- No CV Line
- No ET Tube
- No Sedation
- No Catheterization
Benefits of NIV

- Symptomatic relief of dyspnea
- Correction of gas exchange
- Improve lung mechanics
- Facilitate sleep
- Correct mental status
- Pre-oxygenate for intubation
- Prevent ETI

- Avoid complications of ETI
  - VAP
  - Sepsis/shock
  - Tracheotomy
  - GI bleed
  - DVT

- Decrease mortality associated with respiratory failure
- Assist DNI patients with respiratory failure
Not Always That Simple......

• Needs Careful Patient Selection.

• When is the Right Time to Start NIV

• How do you Make Sure the Patient is doing ‘OK’?

• Knowing When to Stop and Intubate
When to Start NIV

- Indicated when there are Functional and Clinical Signs of Acute Respiratory Distress
- Dyspnea (moderate to severe, short of respiratory failure / agonal breathing)
- Tachypnea (RR > 24  For Hypercapnic & 30 for Hypoxic )
- Increased work of breathing (+accessory muscle use, pursed lip breathing)
- Abdominal Paradox.
- Ventilatory Pump Failure ( Paco2 > 45, pH < 7.35)
- Poor Alveolar Gas Exchange ( PaO2/ FiO2 ratio < 200)
When not to start NIV

- Respiratory/Cardiac arrest
- Medically Unstable
- Unable to Protect Airway
- Excessive Secretion.
- Agitated, Uncooperative
- Recent UGI or Airway Surgery.
- Unable to fit Mask.
RECOMMENDED ALGORITHM

Noninvasive ventilation in acute exacerbations of COPD

M.W. Elliott, Eur Respir Rev 2005

Patient presents to hospital acidic with an acute exacerbation of COPD

Institution of standard medical therapy, particularly controlled oxygen (20% of patients acidic) on arrival to hospital will correct their pH into the normal range, regardless of the severity of the initial acidosis

Repeat arterial blood gas analysis

- **pH > 7.35**
  - NIV not indicated
  - 80% will get better with conventional treatment, but only 10 patients need to receive NIV to avoid one "treatment failure" (=ETI)
  - NIV leads to more rapid resolution of dyspnoea

- **pH < 7.35 but > 7.30**
  - NIV advised

- **pH < 7.30**
  - NIV strongly advised
  - Without NIV 50% will deteriorate to the point at which ETI indicated
  - NIV improves survival

- **pH < 7.20**
  - Although 50% will fail with NIV there is a clear advantage both in hospital outcome and to one year

Relative contraindications

- Coma or confusion, inability to protect the airway, significant co-morbidity, vomiting, obstructed bowel, haemodynamic instability
Example NPPV Settings

Common IPAP Orders
- 8 to 12 cm H$_2$O
- Adjust to Change Tidal Volume

Typical EPAP Setting
- 4 cm H$_2$O
- Increase to Improve Oxygenation

Respir Care 2004;49(1):72-87
PREDICTORS OF SUCCESS DURING ACUTE APPLICATIONS OF NPPV

Younger age
Lower acuity of illness (APACHE score)
Able to cooperate; better neurologic score
Able to coordinate breathing with ventilator
Less air leaking, intact dentition
Hypercarbia, but not too severe ($P_{aCO_2} > 45 \text{ mm Hg, } < 92 \text{ mm Hg}$)
Acidemia, but not too severe ($\text{pH} < 7.35, > 7.10$)
Improvements in gas exchange and heart and respiratory rates within first 2 h
Predictors of Failure

COPD
- Air Leaking
- APACHE II ≥ 29
- Asynchrony
- Copious secretions
- Glasgow Coma Score ≤ 11
- Lack of compliance or, Tolerance
  - pH < 7.25
- Respiratory Rate ≥ 35 b/m

Hypoxemic Respiratory Failure
- ALI/ARDS
- Metabolic acidosis
- PaO2/FiO2 ≤ 146 (or ≤ 175 for ARDS) 1 hr of NIV
- Pneumonia
  - Severe hypoxemia
- Shock
Monitoring of NIV for Acute Respiratory Failure

**Subjective**
- Mask comfort
- Tolerance of ventilator settings
- Respiratory Distress

**Physical finding**
- Respiratory Rate
- Other vital sing
- Accessory muscle use
- Abdominal paradox

**Ventilator parameters**
- Air leaking
- Adequacy of pressure support
- Adequacy of PEEP
- Tidal volume (5-7ml/kg)
- Patient-ventilator synchrony

**Gas Exchange**
- Continuous Oxymetry
- ABGs, baseline and 1-2 hrs, then as indicated.
Criteria for Termination of NPPV for Invasive Ventilation

- Worsening pH and PaCO$_2$
- Tachypnea (> 30 breaths/min)
- Hemodynamic instability
- SpO$_2$ < 90%
- Decreased level of consciousness
- Inability to clear secretions
- And inability to tolerate interfaces
Weaning Algorithm

Does patient meet weaning guidelines?
- Clinically stable
- RR < 24
- HR < 110
- pH > 7.35
- SpO2 > 90% on < 50%

- Yes
  - Slowly titrate IPAP downward in decrements of 2-3 cm H₂O
  - Trial off NPPV with supplemental oxygen

- No
  - Continue with NPPV therapy
  - If patient status does not improved consider intubation

Does patient demonstrate clinical evidence of respiratory distress?
- Yes
  - Restart NPPV at previous settings
- No
  - Discontinue NPPV and place on supplemental oxygen
# Outcome of NIV in Critical Care Setting: Experience from a Tertiary Care Center

Md. Motiul Islam¹, Mirza Nazim Uddin², ARM Nooruzzaman³, Raihan Rabbani⁴, Ahmad Mursel Anam⁵, Mohammad Mufizul Islam Polash⁶, Shahzadi Sayeeda Tun Nessa⁷, Muhammad Mahbubur Rahman Bhuiyan⁸

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Population</th>
<th>Positive outcome</th>
<th>Negative outcome</th>
<th>%Positive outcome</th>
<th>%Negative outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD</td>
<td>15</td>
<td>13</td>
<td>2</td>
<td>86.6 %</td>
<td>13.4 %</td>
</tr>
<tr>
<td>Acute LVF/Pulmonary edema</td>
<td>41</td>
<td>31</td>
<td>10</td>
<td>75.6 %</td>
<td>24.4 %</td>
</tr>
<tr>
<td>Bronchial Asthma</td>
<td>10</td>
<td>8</td>
<td>2</td>
<td>80 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>50 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Post Extubation</td>
<td>4</td>
<td>4</td>
<td>NIL</td>
<td>100 %</td>
<td>NIL</td>
</tr>
<tr>
<td>Carcinoma</td>
<td>3</td>
<td>3</td>
<td>NIL</td>
<td>100 %</td>
<td>NIL</td>
</tr>
<tr>
<td>Mecelneous</td>
<td>26</td>
<td>20</td>
<td>6</td>
<td>76.9 %</td>
<td>23.1 %</td>
</tr>
</tbody>
</table>

**Total no. of Patients 111 – Study from ICU in Square Hospitals Ltd.**

**Success Rate in COPD** – 86.6 %

**Acute PE** – 75.6 %

**Post Extubation** – 100 %
Vitacca et al Compared NIPPV (n=30) and Mechanical Ventilation (n=27) in Patients with COPD and Acute Respiratory Failure.

<table>
<thead>
<tr>
<th>Mortality</th>
<th>NIPPV</th>
<th>MV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>20%</td>
<td>26%</td>
</tr>
<tr>
<td>3 month</td>
<td>23%</td>
<td>48%</td>
</tr>
<tr>
<td>1 year</td>
<td>30%</td>
<td>63%</td>
</tr>
</tbody>
</table>

The **Success Rate** of NIPPV was 74%.

8 patients in The NIPPV group needed intubation. 74% of patients in the MV group wear successfully weaned to extubation.

*Vitacca, Intensive Care Medicien, 1996.*
# Summary of Randomized Controlled Studies Using NPPV in Acute Respiratory Failure Caused by COPD

<table>
<thead>
<tr>
<th>Author</th>
<th>Yr.</th>
<th>Technique/Mask</th>
<th>Insp/Exp Pressure (cm H2O)</th>
<th>Patient No.</th>
<th>Diagnoses</th>
<th>PaCO2 (mmHg)</th>
<th>PaO2 (mmHg)</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td>NPPV</td>
<td>Control</td>
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<td>A</td>
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<td></td>
<td></td>
<td></td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Bott</td>
<td>1993</td>
<td>Volume /nasal</td>
<td>-</td>
<td>30(3)</td>
<td>30(9)</td>
<td>COPD</td>
<td>65</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>Kramer</td>
<td>1995</td>
<td>BIPAP/ nasal</td>
<td>B/2</td>
<td>16(5)</td>
<td>15(17)</td>
<td>COPD</td>
<td>74</td>
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<td></td>
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<td></td>
<td>67</td>
<td>92</td>
</tr>
<tr>
<td>Brochar</td>
<td>1995</td>
<td>PSV/ oronasal</td>
<td>20</td>
<td>43(11)</td>
<td>42(31)</td>
<td>COPD</td>
<td>70</td>
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<td></td>
<td></td>
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<td>68</td>
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<td></td>
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<td></td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Angus</td>
<td>1996</td>
<td>PSV/ nasal</td>
<td>14/18</td>
<td>9(0)</td>
<td>8(3)</td>
<td>COPD</td>
<td>76</td>
</tr>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Celikel</td>
<td>1998</td>
<td>PSV/ oronasal</td>
<td>15/5</td>
<td>75(1)</td>
<td>15(6)</td>
<td>COPD</td>
<td>69</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>85</td>
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</tr>
<tr>
<td>Plant</td>
<td>2000</td>
<td>VPAP/ nasal/oronasal</td>
<td>-</td>
<td>118(18)</td>
<td>118(32)</td>
<td>COPD</td>
<td>66</td>
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<td></td>
<td>56</td>
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<td>Barbe</td>
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<td>BiPAP/ nasal</td>
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<td>10(0)</td>
<td>COPD</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>45</td>
</tr>
</tbody>
</table>

| Totals                          | 245(42) | 238(29) | Means | 68     | 60     | 54     | 67     |
| Success rate                    | 83%     | 61%     |       |        |        |        |        |

### Summary

- Total patients: 245 (42%), 238 (29%)
- Mean PaCO2: 68 mmHg
- Mean PaO2: 60 mmHg
- Overall success rate: 83%
Noninvasive positive pressure ventilation in acute respiratory failure due to COPD vs other causes:  
Ritesh Agarwal, Rajesh Gupta, Ashutosh N Aggarwal, Dheeraj Gupta

Supportive Ventilation:  
Both hypoxic and hypercapnoic patients responded to NIV:  
• COPD patients improved their PCO2 and pH

Avoided ETI in 87% of COPD patients and 61% all other etiologies

Mortality: 12% in COPD, 18% other etiologies

<table>
<thead>
<tr>
<th>Table 3 Serial clinical and arterial blood gas parameters during the ICU course of the two groups receiving NIPPV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARF–COPD</strong></td>
</tr>
<tr>
<td>0 hour</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>RR</td>
</tr>
<tr>
<td>HR</td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>PaO₂</td>
</tr>
<tr>
<td>PaCO₂</td>
</tr>
</tbody>
</table>
NIV for acute exacerbations COPD
Brochard, NEJM, 1995

Figure 2. The Time at Which Endotracheal Intubation Was Performed in the Two Treatment Groups.
A total of 17 patients required intubation after the first hour in the standard-treatment group, as compared with only 3 patients in the noninvasive-ventilation group.

Table 1. Characteristics of Patients with Acute Exacerbations of Chronic Obstructive Pulmonary Disease Assigned to Standard Treatment or Noninvasive Ventilation, at Admission and after One Hour of Therapy.*

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>STANDARD TREATMENT</th>
<th>NONINVASIVE VENTILATION</th>
<th>P VALUE†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADMISSION (n = 42)</td>
<td>1 HOUR (n = 39)</td>
<td>P VALUE‡</td>
</tr>
<tr>
<td></td>
<td>mean ±SD</td>
<td>mean ±SD</td>
<td></td>
</tr>
<tr>
<td>Age (yr)</td>
<td>69±10</td>
<td>71±9</td>
<td>0.28</td>
</tr>
<tr>
<td>SAPS</td>
<td>13±5</td>
<td>12±4</td>
<td>0.64</td>
</tr>
<tr>
<td>Systolic pressure (mm Hg)</td>
<td>145±25</td>
<td>143±25</td>
<td>0.82</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>107±15</td>
<td>105±23</td>
<td>0.61</td>
</tr>
<tr>
<td>Encephalopathy score</td>
<td>1.6±1.2</td>
<td>1.9±1.3</td>
<td>0.01</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>33±7</td>
<td>33±7</td>
<td>0.83</td>
</tr>
<tr>
<td>PaO₂ (mm Hg)</td>
<td>39±12</td>
<td>41±10</td>
<td>0.01</td>
</tr>
<tr>
<td>PaCO₂ (mm Hg)</td>
<td>67±16</td>
<td>70±12</td>
<td>0.17</td>
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<tr>
<td>pH</td>
<td>7.28±0.11</td>
<td>7.27±0.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bicarbonate (mmol/liter)</td>
<td>32±7</td>
<td>33±7</td>
<td>0.49</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>13.8±2.2</td>
<td>14.5±2.0</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Factors for NIV Failure

**NIPPV failure:** likely to need intubation

- APACHE 2 score higher than 29
- Higher PaCO2 on admission (>85)
- Lower pH (7.2 or less) leads to higher intubation rates but not worse outcomes

- Failure to reduce PaCO2 in 1-2 hours
- Often related to air leak/poor interface
- Hypercapnic encephalopathy
- Asynchrony, copious secretions
Cardiogenic Pulmonary edema

The Rational: Effects of CPAP/PS

- Augmentation of Cardiac Output and Oxygen Delivery
- Improved Functional Residual Capacity
- Improved Respiratory Mechanics
- Decreased Left Ventricular After load
Figure 1. How NIPPV reduces afterload and improves left ventricular (LV) function

1. Positive pressure - squeezing LV

2. LV-aorta gradient reduced

3. Less LV wall tension/work required to contract

Afterload is defined as work required during contraction or LV wall tension:
Intra-ventricular pressure = \(2hT/r\), where \(h\) = ventricular wall thickness, \(T\) = LV wall tension and \(r\) = radius of ventricular cavity (Laplace’s law)
Redistribution of H2O

- Application of CPAP/PEEP to the edematous lung.
- Decreases Intra-alveolar fluid volume.

- Moves of Water from Interstitial Spaces Where Gas Exchange Occurs (Between the Alveolar Epithelium and Pulmonary Capillary endothelium) to the More Compliant Interstitial Spaces (Peri bronchial and Hilar Regions)

- Redistribution of Interstitial Water Improves Oxygenation, Lung Compliance and V/Q Matching.
Increasing FRC

CPAP/PEEP results in an increased FRC by two distinct mechanisms:

- 10 cm H$_2$O or Less Increases the Volume of Patent Alveoli
- 10 cm H$_2$O or More is Generally Responsible for Alveolar Recruitment
# Studies On the Efficacy of Continuous Positive Airway Pressure in Acute Pulmonary Edema

<table>
<thead>
<tr>
<th>Author</th>
<th>Yr.</th>
<th>Technique</th>
<th>Positive pressure (cm H₂O)</th>
<th>Patient No</th>
<th>PaCO₂ (mmHg)</th>
<th>PaO₂ 9mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPAP</td>
<td></td>
<td></td>
<td></td>
<td>B</td>
<td>A</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rasane</td>
<td>1985</td>
<td>CPAP</td>
<td>10</td>
<td>20(7)</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td>20(13)</td>
<td>52</td>
<td>60</td>
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<td>Viasane</td>
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<td>40(7)</td>
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<td>36</td>
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<td>n</td>
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<td>35</td>
<td>55</td>
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<tr>
<td>Lin</td>
<td>1991</td>
<td>CPAP</td>
<td>12.5</td>
<td>25(7)</td>
<td>30</td>
<td>32</td>
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<tr>
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<td>30(18)</td>
<td>326</td>
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<td>Beresten</td>
<td>1991</td>
<td>CPAP</td>
<td>10</td>
<td>19(8)</td>
<td>58</td>
<td>46</td>
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<td>20(7)</td>
<td>138</td>
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<tr>
<td>Lin</td>
<td>1995</td>
<td>CPAP</td>
<td>12.5</td>
<td>50(8)</td>
<td>-</td>
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<td>50(18)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Totals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>154(29)</td>
<td>81%</td>
</tr>
<tr>
<td>Success rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>129(56)</td>
<td>53%</td>
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<td></td>
<td>Mean 47</td>
<td>38</td>
</tr>
</tbody>
</table>
Cardiogenic Edema

- NIV with CPAP or BiPAP is superior to standard therapy in CHF
- Success rate varies
- Improvement in oxygenation, RR, HR

Conclusion

NIPPV - Standard Care, effective & Safe

Cochrane Review

RCT - 21 studies with 1071 patients
- Decrease Mortality
- Decrease ETI Rate & Decrease LOS
- No Significant Increase in Heart Attack During or After Treatment
Immunocompromised Patients

Immunosuppressed Patients with Fever/ARF and CXR Infiltrates: RCT in Canada

- 52 Patients with Neutropenia, Transplant, Hematological Malignancies or Chemo
- Method: NIV for 45 Minutes Every 3 Hours for 24 hrs
- RESULTS:
  - ETI 46% (12/26) NIV vs. 77% (20/26) in Control Needed ETI
  - ICU Mortality 38% vs. 69%
  - Mortality in Hospital 50% vs. 81%

# Evidence of Efficacy & Strength of recommendation

**NIV in Acute Respiratory Failure**

Nicholas S. Hill, MD; John Brennan, MD; Erik Garpestad, MD; Stefano Nava, MD 2007

<table>
<thead>
<tr>
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<th>Level of Evidence</th>
<th>Strength of Recommendation</th>
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**Strength of Recommendation**

**Recommended**: First choice for ventilatory support in selected patients

**Guideline**: Can be used in appropriate patients but careful monitoring advised

**Option**: Suitable for a very carefully selected and monitored minority of patients

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**Level of Evidence**

A : Multiple randomized controlled trials and meta-analyses

B : More than one randomized, controlled trial, case control series, or cohort studies

C : Case series or conflicting data
Take Home Points

• Timing of NIV is CRUCIAL to achieve a success rate; the earlier the better.

• Close monitoring of functional (tachypnoea) and blood gas parameters (PCO2, PaO2/ FiO2) can identify patients FAILING NIV and requiring invasive ventilation.
Take Home Points

- NIV should be the first ventilatory option for COPD exacerbations or Cardiogenic Pulmonary edema

- Patients who are immunosuppressed due to hematologic malignancies or chemotherapy and develop ARDS should be considered for a trial of NIV
Take Home Points

Patients with COPD can be considered for a trial of early extubation to NIV

Other possible indications are:

• Prevention of hypoxemia during procedures

• Prevention & treatment of postoperative hypoxemia