RESPIRATORY FAILURE
NON INVASIVE VENTILATION TREATMENT

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Inability of the Respiratory system to maintain the metabolic demands of the body

Elimination of CO2
Oxygenation of blood
- **Acute**: A sudden catastrophic life threatening event

- **Chronic**: Gradual progressive deterioration of respiratory functions with partial metabolic compensation with little or no reserve

- **Acute on chronic**
• Type I/Acute Hypoxaemic respiratory failure
  Pa O2 <60 mm Hg on room air

• Type II/Acute Ventilatory (Respiratory) failure
  PaCO2 >45 mm of Hg

• Type III Respiratory failure
• Provision of mechanical ventilation without the need for an invasive artificial airway

- Pneumobelts
- Negative pressure ventilators
- Rocking beds
- Positive pressure ventilation
- NPPV
- CPAP
Positive pressure ventilation

- Invasive
- Non-invasive
NIV – THE BASIC PRINCIPLE

- Inspiratory plateau level
- I to E cycling
- PEEP level
- Pressurisation
- Inspiratory triggering
When **delivering** mechanical ventilation there are 2 ventilatory pumps acting together:

- the ventilator and
- the patient’s own respiratory pump

These two pumps must work in harmony to deliver.
Airspace collapse
Alveolar filling
Obesity

Low VA/Q

Hypoxia

Surfactant abns
Airspace filling 0.235 0.92 Crs
Post-op changes

Airway narrowing
Alveolar hypoventilation

CPAP/PEEP
IPAP

Low VA/Q

Shunt

Hypoxemia

CPAP/PEEP
IPAP

Airway narrowing
Alveolar hypoventilation

28 FiO2

PEEP

Hypoxia

235/92 Venous return
235/92 LV after load

235/92

Improve oxygenation

RATIONALE OF VENTILATION- TYPE I
**RATIONALE OF VENTILATION - TYPE II**

- **Bronchospasm**
  - ↑ Airway mucus
  - Airway inflammation

- **Diaphragm flattening**
- **Muscle Weakness**
- **Dyspnea**

- **Respiratory Muscle Failure**

- **Air trapping**

- **PEEPi**

- **Elastic recoil**

- **Work of breathing**

- **IPPV**

- **VT**

- **CPAP/PEEP**

- **PaCO2**

- **Raw**

- **Decrease PaCO2**

- **235/92 PaCO2**
SHIFT IN UTILITY OF NIV DURING LAST TWO DECADES

- More Clinical Indications
- Used in ICU as well as other locations such as ER, HDU, general wards
- Most of the critical care ventilators are equipped with NIV mode
- Paramedical staff increasingly trained to initiate NIV
- NIV increasingly used at home for chronic respiratory failure (besides OSA)
TRENDS IN USE OF INITIAL VENTILATORY SUPPORT IN AECOPD IN USA (Chandra et al)

The graph shows the percentage of admissions for COPD exacerbation due to initial IMV and initial NIPPV over the years from 1998 to 2008. The percentage for initial IMV generally increases from 1998 to 2008, while the percentage for initial NIPPV decreases from 2000 to 2008.

Am J Respir Crit Care Med 2012;185:152-159.
Hypercapnic Acute Respiratory Failure

- Acute exacerbation of COPD
- Post extubation/weaning difficulties
- Post surgical respiratory failure
- Thoracic wall deformities
- Obesity hypoventilation syndrome
Hypoxemic Acute Respiratory failure

- Cardiogenic pulmonary edema
- Community acquired pneumonia
- Immuno-compromised individuals with opportunistic infections
NIV in COPD Acute Exacerbation
RECOMMENDATION (CLASS-A)

Acute exacerbation of COPD

Respiratory acidosis (PH < 7.35 & PaCO2 > 45)

Severe respiratory distress

use of accessory muscles

paradoxical movement

Intercostal recession

Respiratory muscle fatigue

GOLD guidelines 2011, CMAJ 2011
CARDIOGENIC PULMONARY EDEMA

Both CPAP & NIV are effective

- Significant & rapid improvement
- \(\frac{235}{92}\) rate of intubations (19-47%)
- No effect on Mortality
- \(\frac{2}{8}\) incidence of MI.
ABSOLUTE CONTRAINDICATIONS

- Coma
- Cardiac arrest
- Respiratory arrest
- Any condition requiring immediate intubation
• Cardiac instability
  - Shock and need for pressor support
  - Ventricular dysrhythmias
  - Complicated acute myocardial infarction
• GI bleeding - Intractable emesis and/or uncontrollable bleeding
• Inability to protect airway
  - Impaired cough or swallowing
  - Poor clearance of secretions
  - Depressed sensorium and lethargy
PRACTICAL APPLICATION OF NIPPV

MACHINES

Proportional assist ventilation (PAV)

Volume

Pressure (Commonly used)
DELIVERY OF NIV

MASKS AND INTERFACE

- Inexpensive
- Disposable/Reusable
- Comfortable

Nasal Mask

Oronasal Mask

Helmet

VENTILATORS

- Easy to administer
- Low cost
- Monitoring capabilities
- Oxygen blender

Critical care

Portable ventilator
MASKS AND INTERFACES
Interfaces are devices that connect ventilator tubing to patients face

- Choice of interface --- CRUCIAL

- No clear cut superiority of one interface over the other

- Full face masks best for acute conditions

- Nasal masks best for long term use
**ACCESSORIES**

**Humidification**
- Heated humidifier preferred over heat and moisture exchanger
- Reduces nasal resistance
- Improves compliance
- Reduces mouth dryness

**Oxygen supplementation**
- Can be given via inspiratory circuit or mask
- Variable delivery of oxygen by portable ventilators
- Critical care ventilators provide high Fio2

**Nebulisation**
- Can be carried out with most continuous flow circuits without changing the delivered pressures

**Power supply**
- Most ventilators have in-built battery backup
- Newer ventilators have an automatic switch over making battery use much easier
MONITORING

- Clinical Most Important
- Vital Sign Decrease in RR indication of effectiveness
- Symptoms
  - Decrease breathlessness
  - Decrease Sleep
  - Improved neurological status
- Adequate gas exchange
  - SPO2
  - BGA
PATIENT AND MACHINE INTERACTION

Synchrony ---- KEY

- Chest wall movement
- Mouth leak
- Mask pressure
- Esophageal pressure
- Respiratory EMG activity
MASK LEAK

• REASON
  • High IPAP
  • Severe acute respiratory failure
  • Small Jaw/ overbite
  • Sleep

• EFFECT
  • Decrease expiratory triggering sensitivity of the device
  • Asynchrony between patient and device
  • Worsening gas exchange
  • Sleep fragmentation
Effects of leak on ventilation
Normal

With leaks

Cycling from I to E during leaks:
«expiratory trigger»
Switch from flow-limited to time-limited
Emergency Department vs. ICU

Benefits of use in ED:

- Reduction in the need for intubation
- Reduction in mortality
- Decrease in Hospital stay

LOCATION

CONT'D.
FACTORS To be Considered Whether NIV Should be performed in an ICU or an ED

- Severity of respiratory failure
- Significant co morbidity
- Will the patient be intubated if NIV fails
- Patient’s nursing requirements
- Staffing level, expertise & experience
EMERGENCY DEPARTMENT vs. ICU

(a) 50 patients of ARF-variable etiology like CHF, COPD, Pneumonia, Status Asthmatics etc.- 86 % success rate


(c) Wood et al Chest 1998, 113339

(i) 43 % on NIV needed intubation vs. 45% on CT

(ii) $\frac{2}{3}$ mortality on NIV.

(iii) $\frac{2}{3}$ Time before intubation

(iv) No difference in length of stay, duration of ventilation in both groups

(c) Nava et al – studied NIV for Pulmonary Edema in ED AM J Respiratory crit care Med 2003 168; 1432

rapid improvement in gases without $\frac{235}{92}$ in intubations rate except in patients with hypercapnia.
Causes of NIV failure (Approx. 40%)

- Acuity of illness
- Poor clinical tolerance (Includes patient ventilator asynchrony)
- Failure to correct hypercapnic acidosis in first hour of NIV
<table>
<thead>
<tr>
<th></th>
<th>GROUP I (CONSERVATIVE) (MEAN ±SD)</th>
<th>GROUP II (NIPPV) (MEAN ±SD) (N=25)</th>
<th>p VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAYS OF RESOLUTION</td>
<td>2.6 ± 2.88</td>
<td>1.4 ± 0.763</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>LENGTH OF HOSPITAL STAY</td>
<td>9.6 ± 4.5</td>
<td>7.2 ± 3.12</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>INTUBATIONS</td>
<td>6</td>
<td>1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>DISCHARGE</td>
<td>19 (76%)</td>
<td>25 (100%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>NO. OF DEATH (%)</td>
<td>6 (24%)</td>
<td>0 (0%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>Group 1 (N=25) (Control)</td>
<td>Group II (N=25) (NIV)</td>
<td>P value</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------</td>
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<td>--------------</td>
</tr>
<tr>
<td>Duration of resolution (Hr.)</td>
<td>42±26.92</td>
<td>9.2±3.38</td>
<td>HS &lt; .001</td>
</tr>
<tr>
<td>Length of hospital stay (days)</td>
<td>9.06±4.35</td>
<td>4±1.603</td>
<td>HS &lt; .001</td>
</tr>
<tr>
<td>Discharge</td>
<td>23</td>
<td>23</td>
<td>NS</td>
</tr>
<tr>
<td>No. of death</td>
<td>2</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>No. of Intubations</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Ref. Thesis for M.D in Medicine; MDU Rohtak 2004
## NIV vs PSV in Weaning in COPD (Rohtak Study)

<table>
<thead>
<tr>
<th></th>
<th>Group I (NIV) N=15</th>
<th>Group II (PSV) N=15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of ventilation (in days)</td>
<td>6.20 ± 5.20</td>
<td>7.47 ± 6.38*</td>
</tr>
<tr>
<td>Duration of weaning (in hours)</td>
<td>35.17 ± 16.98</td>
<td>47.05 ± 20.98</td>
</tr>
<tr>
<td>Duration of ICU stay (in days)</td>
<td>8.47 ± 4.79</td>
<td>10.80 ± 5.28</td>
</tr>
<tr>
<td>Death in ICU</td>
<td>3 (20%)</td>
<td>5 (33.33%)*</td>
</tr>
<tr>
<td>Death at 30 days</td>
<td>5(33.33%)</td>
<td>9(60%)</td>
</tr>
<tr>
<td>Nosocomial pneumonia</td>
<td>1(6.66%)</td>
<td>5(33.33%)</td>
</tr>
</tbody>
</table>

**Recommendation:** should be used when conventional weaning fails. (B)
• NIV leads to faster resolution of breathlessness & use of AMR.

• NIV in AA though improved pulmonary function but did not do significantly.

• *Routine use over & above* medical management in Acute Asthma can’t be recommended at present.

SUMMARY

- NIV use has increased remarkably over last two decades
- Ventilation of choice in AECOPD & CPO
- Patients needs close monitoring while on NIV
- Mask leaks are the commonest cause for patient ventilator asynchrony & failure
- Can be used safely across all age groups
- Failure of NIV is associated with increased mortality
RECOMMENDATIONS FOR NIV IN ED

(1) Initiate NIV in ED only after adequate Training of staff

(2) Patients with severe Acidosis (ph<7.3) should be ventilated in ICU

(3) Lack of improvement in Clinical state & BGA of patients after 1-2 hr of NIV use, should be shifted to ICU/HDU [C]

(4) In patients of ARF, Where the role of NIV is not yet clearly established should receive NIV in ICU

BTS guidelines 2002.
thanks