RESPIRATORY EMERGENCIES SYMPOSIUM

NIV use in ED

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SQUH
Outline

• Historical background
• Basic mechanical ventilation
• Indications/ contraindications
• Protocol for Non Invasive Ventilation
• Auto PEEP
Questions

• Are there specific NIV settings for specific respiratory conditions?
• CPAP or BiPAP for acute pulmonary edema?
History of Ventilation

• 1940’s: Polio epidemics
• 1960’s: Rise of positive pressure ventilation
• 1980’s: Resurgence of interest in NIV in Treatment of hypoventilation & neuromuscular syndromes
• 1990’s: use of NIVs in acute respiratory failure
# NIV vs. Intubation

<table>
<thead>
<tr>
<th>NIV</th>
<th>Intubation</th>
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<tbody>
<tr>
<td>Non-invasive</td>
<td>Invasive</td>
</tr>
<tr>
<td>Easily discontinued</td>
<td>Intubated stays intubated</td>
</tr>
<tr>
<td>Easily adjusted</td>
<td>Requires highly trained personnel</td>
</tr>
<tr>
<td>Use by EMS levels down to EMT-Basic</td>
<td>Significant complications</td>
</tr>
<tr>
<td>Minimal complications</td>
<td>Can require sedation or RSI</td>
</tr>
<tr>
<td>Does not require sedation</td>
<td>Potential for infection</td>
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<tr>
<td>Comfortable</td>
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Ventilators deliver gas to the lungs using positive pressure at a certain *rate*. The amount of gas delivered can be *limited* by time, pressure, or volume. The duration can be *cycled* by time, pressure, or flow.
## Advantages and disadvantages of pressure-controlled and volume-controlled ventilation

### Pressure-controlled ventilation

**Advantages**
- Reduction of peak pressure and of risk of barotrauma
- Improved gas exchange due to decelerating flow
- More homogeneous ventilation in cases of distribution disorders
- Compensates for leaks

**Disadvantages**
- Hypoventilation secondary to changes in lung compliance and resistance

### Volume-controlled ventilation

**Advantages**
- Maintains constant tidal volume
- Precise control of partial pressure of carbon dioxide in arterial blood (PaCO₂)

**Disadvantages**
- Potential for high airway pressures and acute lung injury
- Inability to compensate for leaks
Goals of NIV

- Relieve symptoms
- Reduce work of breathing
- Offset the effect of $i$ PEEP
- Improve gas exchange
- Minimize risk of barotrauma
- Avoid intubation
Non-Invasive Ventilation

• CPAP
  – Continuous pressure
  – Settings: Typically 5-10 cm H2O

• BIPAP
  – Inspiratory and expiratory levels
  – Settings: IPAP set at 10, EPAP set at 3 cm H2O
Invasive mechanical ventilation

- CMV
- AC
- SIMV
- APRV
The device operates in the following modes:

- Continuous Positive Airway Pressure (CPAP)
- Spontaneous (S)
- Spontaneous/Timed (S/T)
- Timed (T)
- Pressure Control (PC)
Ventilator Breath
<table>
<thead>
<tr>
<th>Mode</th>
<th>Trigger</th>
<th>Limit</th>
<th>Cycle</th>
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<tbody>
<tr>
<td>S</td>
<td>Patient</td>
<td>Pressure</td>
<td>Patient/Device</td>
</tr>
<tr>
<td>S/T</td>
<td>Patient/Device</td>
<td>Pressure</td>
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</tr>
<tr>
<td>PC</td>
<td>Patient/Device</td>
<td>Pressure</td>
<td>Device</td>
</tr>
<tr>
<td>T</td>
<td>Machine</td>
<td>Pressure</td>
<td>Device</td>
</tr>
</tbody>
</table>
S/T Mode

Example:
- IPAP = 14 cm H₂O
- EPAP = 6 cm H₂O
- Rate = 10 BPM
- PS = 8 cm H₂O

1 = Spontaneously-triggered pressure support breaths.
2 = Time-triggered, pressure-limited, time-cycled breath.
INDICATIONS OF NIMV (A) Acute respiratory failure

1. Hypercapnic acute respiratory failure
   - Acute exacerbation of COPD
   - Post extubation
   - Weaning difficulties
   - Post surgical respiratory failure
   - Thoracic wall deformities
   - Cystic fibrosis
   - Status asthmaticus
   - Acute respiratory failure in Obesity hypoventilation Syndrome
2. Hypoxaemic acute respiratory failure
   - Cardiogenic pulmonary edema
   - Community acquired pneumonia
   - Post traumatic respiratory failure
   - ARDS
   - Weaning difficulties

Evidence is less convincing to show efficacy of NIMV in hypoxaemic respiratory failure.
INDICATIONS OF NIMV

• (B) Chronic Respiratory Failure

• (C) Immunocompromised Patients

• (D) Do Not Intubate Patients
Patient selection

- Patient is able to cooperate
- Patient can control airway and secretions
- Adequate cough reflex
- Patient is able to co-ordinate breathing with ventilator
- Patient can breathe unaided for several minutes
- Haemodynamically stable
- Blood pH $>$ 7.1 and PaCO2 $<$ 92 mmHg
- Normal functioning gastrointestinal tract
NIV unlikely to work

- Severe hypoxemia (PaO2/FiO2 <75),
- Severe acidemia
- Multi organ failure or slowly reversible disease (in short term)
- Uncooperative patient
- Encephalopathy with inability to protect airways and a high risk of aspiration
- Increased risk of aspiration: copious secretions, vomiting or severe gastrointestinal bleeding
- Recent airway or gastrointestinal surgery
- Inability to fit mask
Contraindications

Respiratory arrest
Unstable cardiorespiratory status
Uncooperative patients
Unable to protect airway - impaired swallowing and cough
Facial Oesophageal or gastric surgery
Craniofacial trauma/burn
Anatomic lesions of upper airway
DISADVANTAGES

- Does not offer pressures as high as their critical care ventilator counterparts. (>30 cm H20)
- Mask uncomfortable/claustrophobic
- Time consuming for medical and nursing staff
- Facial pressure sores
- Airway not protected
- No direct access to bronchial tree for suction if secretions are excessive
- Have a single-limb tubing
Protocol for Non Invasive Ventilation

Explain to the patient what you are doing and what to expect

Keep the head of the patient's bed at >45 degree angle

Choose the correct interface

Turn on the ventilator and dial in the settings
Alternative interfaces

EXPIRATORY PORT

• An expiratory port is essential in any single limb circuit (ie one tube) to allow for carbon dioxide to be removed on expiration.

• The port can either be in the mask or circuit.
• It is essential to know where the port is and ensure it is not covered.
Hold the mask gently over the patient's face until the patient becomes comfortable with it. Strap the face mask on using the rubber head strap and minimize air leak without discomfort.

Connect humidification system.
Initial Ventilatory Settings

Initial ventilator setting should be very low i.e. IPAP of 6 cm H2O, and EPAP of 5 cmH2O

Increase EPAP by 1-2 cm increments till the patient triggers the ventilator in all his inspiratory efforts.

Increase IPAP in small increments, keeping it 4cmH2O above EPAP, to a maximum pressure, which the patient can tolerate without discomfort and major leaks.

Titrate pressure to achieve a respiratory rate of <25 breaths/min and Vt >7ml/kg
Increase FiO2 to improve O2 saturation to 90%
Protocol for initiation of noninvasive positive pressure ventilation

1. Appropriately monitored location, oximetry, respiratory impedance, vital signs as clinically indicated
2. Patient in bed or chair at >30-degree angle
3. Select and fit interface
4. Select ventilator
5. Apply headgear; avoid excessive strap tension (one or two fingers under strap)
6. Connect interface to ventilator tubing and turn on ventilator
7. Start with low pressure in spontaneously triggered mode with backup rate; pressure limited: 8 to 12 cmH₂O inspiratory pressure; 3 to 5 cmH₂O expiratory pressure
8. Gradually increase inspiratory pressure (10 to 20 cmH₂O) as tolerated to achieve alleviation of dyspnea, decreased respiratory rate, increased tidal volume (if being monitored), and good patient–ventilator synchrony
9. Provide O₂ supplementation as needed to keep O₂ saturation >90 percent
10. Check for air leaks, readjust straps as needed
11. Add humidifier as indicated
12. Consider mild sedation (eg, intravenously administered lorazepam 0.5 mg) in agitated patients
13. Encouragement, reassurance, and frequent checks and adjustments as needed
14. Monitor occasional blood gases (within 1 to 2 hours) and then as needed

setting CPAP

• It is reasonable to start higher, around 8 to 12 cm H2O, when providing CPAP therapy for ACPE.

• studies that found a benefit to CPAP used these initial levels
Mask intolerance

• Patients often complain about the tightness of the interface when it is first applied. Allowing the anxious patient to hold the mask in place while low amounts of PEEP are first applied (3–5 cm H2O) is a technique these authors have used with some anecdotal success.
First hour........

- Titrate settings and FiO2
- Aim to reduce work of breathing /RR
- Assist patient comfort and tolerate mask
- Minimal sedation may be used Morphine 2 mg or Haldol 2 mg
- Monitor mental status
- Intubate if worsening
- KEEP PATIENT NPO!
- Check ABGs in 1-2 hours
Monitoring

- HR
- BP
- RR
- SpO2
- Mental status
- Work of breathing
BiPAP Graphics

Patient Monitoring

- Inspiratory Pressure
- Expiratory Pressure
- Breath Rate
- Duration of Inspiratory Phase for Timed Breath
- Exhaled Tidal Volume
- Exhaled Minute Ventilation
- % Patient Triggered Breaths
- Inspiratory Time/Total Cycle Time
- Patient Leak
- Measured Peak Inspiratory Pressure

Oxygen Concentration
Time to Reach Inspiratory Pressure
Auto-PEEP

• Intrinsic PEEP (iPEEP, aka occult, vent-associated) occurs because of incomplete ventilation: Initiating a new breath prior to complete exhalation causes air-trapping
Premature flow termination during expiration = “gas trapping” = deadspace (Vd/Vt) will increase.
NIV effect on Hemodynamics

• Decrease Preload:
  – Increases in intrathoracic pressure impede venous return.
  – Hypovolemic patients are the mostly

• Left Ventricular output:
  Increases in intrathoracic pressure also assist the left ventricle by lowering cardiac afterload.
Assessment of Mechanics

- Flow (L/s)
- Paw (cmH₂O)

Auto-PEEP

End-Expiratory

End-Inspiratory
Effect of extrinsic PEEP in the presence of auto-PEEP

- **No PEEP applied, 7 cm H₂O auto-PEEP**
  - End expiration
    - End-expiratory flow: +7
    - Inspiratory effort: -7
    - No inspiratory flow
  - Inspiratory effort no flow
    - Inspiratory effort: -2
    - No inspiratory flow
  - Increased inspiratory effort, flow begins
    - Inspiratory effort: -3
    - Flow begins

- **+5 cm extrinsic PEEP, 7 cm H₂O auto-PEEP**
  - End expiration
    - End-expiratory flow: +7
    - Inspiratory effort: -2
    - No inspiratory flow
  - Inspiratory effort no flow
    - Inspiratory effort: -3
    - No inspiratory flow
    - Increased inspiratory effort
  - Increased negative pressure is required to overcome intrinsic PEEP

Extrinsic applied PEEP reduces the negative inspiratory effort needed to overcome intrinsic PEEP.
Criteria for discontinuation of NIPPV and intubation

- Mask intolerance and poor adherence
- Failure to improve dyspnea, gas exchange (e.g., PaO2/FiO2 ≤146 [or ≤175 for ARDS] after 1 hr of NIPPV)
- Failure to improve mental status within 30 min
- Hemodynamic instability, cardiac ischemia or arrhythmias
- Difficulties with secretions management
Disadvantage of NIV

- Delay in intubation
- Acute unrecognized deterioration
- Aspiration
- Poor tracheal toileting
- Abdominal distention (GE sphincter pressure up to 25 cmH₂O)
- Difficult transport
- Poor tolerance
- Facial pressure necrosis, local barotrauma.
Complications and Side effects

Air leak

Skin necrosis - particularly over bridge of nose

Retention of secretions

Gastric distension

Failure to ventilate

Sleep fragmentation

Upper airway obstruction
Take home messages

• Applicability of NIV is expanding to many causes of ARF in ED.
• Awaiting better evidence in some conditions it still could be used as a bridging device before intubation.
• careful selection and close monitoring of patients will increase chance of successful NIV trial.