Discloses

No disclosures to report
Objectives

• Introduce types of Non-Invasive Ventilation (NIV) and High Flow Oxygen therapies.

• Identify the indications and contraindications for Non-Invasive Ventilation and High Flow Oxygen therapies.

• Update benefits of NIV and High Flow Oxygen therapies in certain disease states.
  • Acute Respiratory Failure
  • Neuromuscular disease
  • Respiratory Muscle dysfunction

• Review possible complications of NIV and High flow oxygen therapy.
Addressing the Elephant In The Room

• When to perform Endotracheal Intubation (ETT)
  • Is there failure by the patient in maintaining or protection their airway?
  • Has there been a failure of oxygenation or ventilation in the current clinical setting?
  • What is the expected clinical course?

• Common and uncommon clinical situations
  • Acute Respiratory Failure
  • Depressed mental status
  • Perioperative settings
  • Secure compromised airway from trauma, secretions, or bleeding
Addressing the Elephant In The Room

• Complications and the consequences of ETT
  • Potential complications of initial intubation
    • Traumatic
      • Perioral and airway trauma
      • Neck and cervical spine trauma
      • Pulmonary (Pneumothorax and Barotrauma)
    • Non-traumatic
      • Esophageal intubation
      • Cardiac arrest
      • Aspiration Pneumonia
  • Potential consequences of mechanical ventilation
    • In-hospital mortality
    • Prolonged ICU and hospital admission
    • Possible hemodynamic collapse
    • Cardiac Arrest
Advantages for NIV and High Flow Oxygen Therapy

- Avoid invasive complications
- Allows for intermittent administration
- Can be utilized for a variety of disease states
- Decreases necessity for sedation
- Preserves oral patency for speech, cough, and swallowing
- Decreases hospital admission length
- Decreases risk for mortality
- Decreases risk for Nosocomial infections (VAP)
Blast From the Past
Non-Invasive Positive Pressure Ventilation Classification

- Variable/intermittent noninvasive pressure support
  - BiPAP
  - Intermittent abdominal pressure support
  - Cough Assistance
    - Manual vs Mechanical
- Constant noninvasive ventilator pressure support (NVS)
  - CPAP
    - Mouthpiece NVS
    - Nasal NVS
    - High flow Oxygen by nasal cannula
Tools In The Toolbox

- Non-Invasive Positive Pressure Ventilation Initiation
  - Most commonly used interfaces for inpatient non-invasive ventilation
  - Components and mechanism
  - Two major types
    - CPAP
    - BiPAP
Modes of NIV

- **CPAP**
  - delivery of a continuous level of positive airway pressure.
  - Functionally similar to PEEP.
  - Prevents Alveolar collapse which increase functional residual capacity
  - Increases Alveolar recruitment (increases oxygenation)
  - Increases intrathoracic pressure → decreasing preload → assisting in cardiogenic pulmonary edema

- **BiPAP**
  - Bilevel positive airway pressure delivers a preset inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP).
  - The tidal volume correlates with the difference between the IPAP and the EPAP.
  - IPAP → assists with ventilation
  - EPAP → improves oxygenation
Types of Interfaces
Types of Interfaces

• Nasal interface
  • Utilized in patients who are more cooperative
  • Not claustrophobic
  • Less aspiration with emesis
  • Generally well tolerated
  • Disadvantages include:
    • Higher amounts of leakiness
    • Difficult in patients with nasal deformities
    • Increased resistance to air flow limiting efficacy

Types of Interfaces

• Oralfacial or full facial masks
  • Better for less cooperative patients
  • More efficacious in patients with higher severity of disease.
  • Better efficacy in patients who are mouth breathers
  • More effective means of ventilation than nasal masks
  • Disadvantages include:
    • Increased claustrophobia
    • Increased risk for aspiration with emesis
    • Limits speech, oral intake, and coughing
Types of Interfaces

- Studies for efficacy for oralfacial and full facial mask interfaces
- Interface strategy during noninvasive positive pressure respiratory failure.

Assessment of initial mask choice in the management of hypercapnic acute respiratory failure.

**Abstract**

OBJECTIVE: To assess the influence of initial mask choice on the clinical efficacy of noninvasive positive pressure ventilation (NIPPV) in the management of hypercapnic acute respiratory failure.

DESIGN: A prospective randomized controlled clinical study.

SETTING: A medical intensive care unit at a university hospital.

INTERVENTION: Randomization between two NIPPV interfaces.

PATIENTS: Initial mask choice was randomized between two standard masks: point was mask failure (i.e., mask change and/or intubation). Secondary end points were during the first 3 days, and patient outcome. Results were analyzed.

MAIN RESULTS: Ninety patients with underlying chronic lung disease were included. The overall success rate of NIPPV was 83%. Mask failure occurred significantly because of the need for mask change (32/44 vs. 0/46; p < 0.001) because of cases. Improvement in respiratory parameters was similar in the two groups. Venous oxygenation was assessed as lower and complications more frequent.

CONCLUSIONS: A face mask should be the first-line strategy in the initial management of acute respiratory failure. However, if NIPPV has to be prolonged, switching to an oronasal mask may improve comfort by reducing face mask complications.
Types of Interfaces

- Helmet
  - Can improve patient tolerance
  - Minimizes complications
  - High flow and short inspiratory time are required to pressurize the helmet rapidly.
  - Disadvantages include:
    - Increased CO2
    - High level of noise
    - Patient-ventilator asynchrony
    - Less relief of inspiratory effects
Interfaces in Neuromuscular Disease States

• Respiratory muscles can be aided manually or mechanically.
  • Mechanical interfaces that can be used for nocturnal or daytime use include
    • Mouth NVS - most useful of the daytime inspiratory aids
    • Nasal NVS
    • Intermittent abdominal pressure support (IAPV)
    • Mechanical Insufflation-exsufflation (MIE)
• Manual methods include:
  • Quad coughing

Bach JR. The Management of Patients with Neuromuscular Disease, Hanley & Belfus, Philadelphia 2004. p.331

[Respir Care 2011;56(6):744–750. © 2011]
Interfaces in Neuromuscular Disease States

- Nasal NVS
  - Provide greater patient comfort and better preservation of speech and swallowing than do other interfaces
  - Nasal NVS is used during daytime hours if neck rotation or lip strength is not adequate for the patient to grab a mouthpiece
  - Nasal CPAP masks are the preferred option for chronic applications
  - If patient able to maintain a mouth seal then the application of Nasal pillows can be considered.
  - High Flow Oxygenation can be considered in milder disease states.
 Interfaces in Neuromuscular Disease States

• Mouth NVS
  • Initial benefit
  • A convenient method of daytime ventilatory support
  • Ventilator Circuits on portable ventilators can be volume preset.
  • Improves lung volume recruitment and oxygenation

Bach JR. The Management of Patients with Neuromuscular Disease, Hanley & Belfus, Philadelphia 2004. p.331

Tools In The Toolbox

• High Flow Oxygenation Therapy
  • Delivers heat and humidified air to the nose through bipronged nasal cannula
  • High flow oxygenation leads to
    • Low levels of positive pressure in the upper airways
    • A decrease in the physiologic dead space
  • Better tolerated
Predictors of Success with NIPPV

• Patient tolerability
• Patient-Ventilatory Synchrony
• Noninvasive Ventilation effectiveness
• Decrease in PaCO$_2$ >8 mmHg
• Improvement of pH >0.06
• Correction of Respiratory Acidosis
Location, Location, Location

Indications
• Acute hypoxemic respiratory failure
• Acute hypercapnic COPD exacerbation
• Acute cardiogenic pulmonary edema
• Acute status asthmaticus
• Respiratory muscle disorders
• Neuromuscular and motor neuron disease states

Contraindications
• Cardiac or respiratory arrest
• Non-respiratory organ failure that is acutely life threatening
• Facial surgery, trauma, or deformity
• High aspiration risk
• Prolonged duration of mechanical ventilation anticipated
• Recent esophageal anastomosis
• Inability to cooperate, protect the airway, or clear secretions
• Severely impaired consciousness
Clinical Scenarios For NIPPV

• Acute COPD Exacerbation
  - High quality evidence for use in patients with Hypercapnic Acidosis
    - a meta-analysis of (14 RCTs, 758 patients) in 2003 compared standard therapy alone to NIV plus standard therapy in patients having a COPD exacerbation complicated by hypercapnia (PaCO$_2$ >45 mmHg)
      - decreased mortality (11 versus 21 percent),
      - intubation rate (16 versus 33 percent)
      - treatment failure (20 versus 42 percent).
      - Hospital length of stay and complications related to treatment were also reduced by NIV.
    - More recently a large observational cohort study from Massachusetts in 2014 demonstrated similar findings
      - 74% overall success rate in 211 patients with NIV
      - 76% success in the subset of patients with acute on chronic lung disease

CHEST 2014; 145(5):964-971
### Clinical Scenarios For NIPPV

#### Table 4—Initiation, Failure, and Mortality Rates of Patients on NIV and INV as Per Etiology of ARF and DNI Status

<table>
<thead>
<tr>
<th>Diagnostic Category</th>
<th>NIV Initial Use, No. (%)</th>
<th>NIV Failure, No. (%)</th>
<th>NIV Total, No. (%)</th>
<th>DNI Subset No. Died/Total DNI (%)</th>
<th>INV Initial Use, No. (%)</th>
<th>INV No. (%)</th>
<th>30-d In-Hospital Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Acute-on-chronic lung disease</td>
<td>99 (76.7)</td>
<td>24 (24.2)</td>
<td>123 (15.1)</td>
<td>9/23 (39)</td>
<td>30 (23.3)</td>
<td>7 (23.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>COPD+</td>
<td>74 (82.2)</td>
<td>19 (25.3)</td>
<td>93 (12.2)</td>
<td>7/21 (33)</td>
<td>16 (17.8)</td>
<td>4 (25)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Asthma</td>
<td>5 (45.5)</td>
<td>1 (20)</td>
<td>0 (0)</td>
<td>0</td>
<td>6.5 (54.5)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Restrictive lung disease</td>
<td>2 (50)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0</td>
<td>2 (50)</td>
<td>1 (50)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>5 (50)</td>
<td>3 (60)</td>
<td>8 (80)</td>
<td>2/2 (100)</td>
<td>5 (50)</td>
<td>2 (40)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Decompensated OSA</td>
<td>13 (92.9)</td>
<td>2 (15.4)</td>
<td>15 (15.4)</td>
<td>0/2 (0)</td>
<td>1 (7.1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>II. De novo acute respiratory failure</td>
<td>37 (37.8)</td>
<td>20 (54.1)</td>
<td>57 (27.0)</td>
<td>2/3 (25)</td>
<td>61 (62.2)</td>
<td>19 (31.1)</td>
<td>4 (6.6)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>36 (41.4)</td>
<td>19 (52.8)</td>
<td>55 (25.3)</td>
<td>2/7 (29)</td>
<td>51 (58.6)</td>
<td>16 (31.4)</td>
<td>4 (7.8)</td>
</tr>
<tr>
<td>ARDS</td>
<td>0 (NA)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0</td>
<td>6 (100)</td>
<td>1 (16.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (20)</td>
<td>1 (100)</td>
<td>1 (100)</td>
<td>0/1 (0)</td>
<td>4 (80)</td>
<td>2 (50)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>III. Cardiogenic pulmonary edema</td>
<td>63 (68.5)</td>
<td>13 (20.6)</td>
<td>76 (17.5)</td>
<td>5/12 (42)</td>
<td>29 (31.5)</td>
<td>5 (17.2)</td>
<td>1 (3.4)</td>
</tr>
<tr>
<td>IV. Neurologic diseases</td>
<td>2 (1.9)</td>
<td>1 (50)</td>
<td>0 (0)</td>
<td>0</td>
<td>102 (98.1)</td>
<td>21 (20.6)</td>
<td>2 (0)</td>
</tr>
<tr>
<td>V. Cardiopulmonary arrest</td>
<td>0 (NA)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0</td>
<td>67 (100)</td>
<td>34 (50.7)</td>
<td>6 (9)</td>
</tr>
<tr>
<td>VI. Other</td>
<td>10 (17.2)</td>
<td>3 (30)</td>
<td>2 (20)</td>
<td>1/2 (50)</td>
<td>48 (82.8)</td>
<td>16 (33.3)</td>
<td>3 (6.3)</td>
</tr>
<tr>
<td>Total</td>
<td>211 (38.5)</td>
<td>55 (26.1)</td>
<td>35 (16.6)</td>
<td>17/45 (38)</td>
<td>337 (61.5)</td>
<td>102 (30.3)</td>
<td>16 (4.7)</td>
</tr>
</tbody>
</table>
Clinical Scenarios For NIPPV

• Patients with severe exacerbations of COPD respond better to NIV than patients with mild COPD exacerbations
  • A meta-analysis from 2003 in the Annuals of Internal Medicine
  • found that NIV improved clinical outcomes only in RCTs that enrolled patients with severe COPD exacerbations (defined as a baseline pH <7.3 or a control group mortality >10 percent).
Clinical Scenarios For NIPPV

• ERS/ATS
  • “Bilevel NIV should be considered when the pH is $\leq 7.35$, PaCO$_2$ is $>45$ mmHg and the respiratory rate is $>20–24$ breaths despite standard medical therapy.”
  • “Bilevel NIV remains the preferred choice for patients with COPD who develop acute respiratory acidosis during hospital admission.”
  • “Increased risk of failure with NIPPV in patients with severely low pH.”
    • Therefore, closely monitor with rapid access to endotracheal intubation and invasive ventilation if not improving.
Clinical Scenarios For NIPPV

• Cardiogenic Pulmonary Edema/Acute Respiratory Failure (CPE/ARF)
  • Mechanism of disease
    • Pulmonary vascular congestion
    • Interstitial edema
    • Alveolar edema
  • Mechanism of NIVPP in CPE
    • CPAP > BiPAP
    • Increases alveolar recruitment
    • Decreases shunting
    • Decreases preload to heart
    • Augments compliance of respiratory mechanics
Clinical Scenarios For NIPPV

- Benefits in ARF with cardiogenic pulmonary edema
  - Decreases the need for intubation
  - Improves respiratory parameters (e.g., heart rate, dyspnea, hypercapnia, acidosis)
  - Beneficial to patients with hypercarbia
  - Improves hospital mortality
  - No further association noted with CPAP and Myocardial Infarction

- ERS/ATS guidelines
  - Recommend either bilevel NIV or CPAP for patients with ARF due to cardiogenic pulmonary edema. (Strong recommendation, moderate certainty of evidence.)

Clinical Scenarios For NIPPV

- Acute hypoxic respiratory failure
  - De Novo ARF - A complicated situation
    - Definition
    - Role of NIV in ARF
  - A mixed bag
    - Limitations of NIV in ARF
    - Complications with NIV in ARF
  - To use or not to use?
    - Looking at the evidence
Clinical Scenarios For NIPPV

• Acute hypoxic respiratory failure
  • Pneumonia
    • Benefits seen in selected patient population groups
      • Decreased ICU mortality (18 versus 39 percent)
      • Decreased intubation rate (25 versus 52 percent).
      • Improved oxygenation.
  • Acute Respiratory Distress Syndrome (ARDS)
    • Limited data
    • Pilot study
    • Not recommended currently

Clinical Scenarios For NIPPV

• Acute hypoxic respiratory failure
  • Role of High Flow Oxygen via nasal cannula (HFNC)
    • Benefits
      • Better tolerance
      • Decreased dead space
    • Two major meta-analysis
      • Lower rate of intubation
      • No benefits with reduction of mortality or length of stay.
    • When to use?
Clinical Scenarios For NIPPV

• Neuromuscular disease states
  • When to utilize?
    • Symptomatic alveolar hypoventilation is the primary indication for ongoing nocturnal ventilatory assistance.
  • Effective alternative to tracheostomy
  • Long term results
    • Duchenne Muscular Dystrophy
    • Post-Polio
    • Spinal Muscular Atrophy
    • Spinal Cord tetraplegia
Cough Assistance

• The mechanism of a cough

• Inability to clear secretion → hypoxemia

• Increased risk for respiratory failure following a respiratory infection.
Cough Assistance

- Mechanical options
  - Historical perspective
    - Mechanical Insufflation-exsufflation
      - Improves VC and SpO2 in the setting of mucus plugging.
      - No serious complications
      - Insufficient evidence
  - Manual Option
    - Quad Coughing

Bach JR. Mechanical insufflation-exsufflation. Comparison of peak expiratory flows with manually assisted and unassisted coughing techniques. Chest. 1993;104(5):1553
A word on Hypercapnic Encephalopathy

- Traditional approach
- Responsiveness to NIV
- Studies examining strategies for NIV in hypercarbic respiratory failure.
- Newer approaches for NIPPV
Thank you
References


References

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