Choosing Between A Mask Or A Tube: Invasive vs. Non-Invasive Mechanical Ventilation

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Objectives

- Discuss identified patient populations who may benefit from management of respiratory failure with non-invasive mechanical ventilation
- List criteria which demonstrates failure of non-invasive mechanical ventilation and need for invasive mechanical ventilation

Respiratory Failure

- Respiratory Failure is a general term used to describe the inability of the respiratory system to maintain an adequate amount of:
- (1) oxygen exchange between the alveoli and pulmonary capillaries, or
- (2) carbon dioxide removal out of the lungs
- (3) a combination of both
- ABG criteria for respiratory failure in the normal individual are an arterial pressure of oxygen (PaO_2) less than 60 mmHg, or an arterial partial pressure of carbon dioxide ($PaCO_2$) greater than 50 mmHg or a mixture of both
- Life-threatening condition

Major Anatomical Alterations of Lung

- Major anatomical alterations of the lung that can result in respiratory failure:
- Atelectasis
- Alveolar consolidation (e.g. pneumonia)
- Increased alveolar-capillary membrane thickness (e.g. ARDS, pulmonary edema)
- Bronchospasm (e.g. asthma)
- Excessive bronchial secretions (e.g. chronic bronchitis)
- Distal airway and alveolar weakening (e.g. emphysema)

Classification

- Respiratory failure is commonly classified as:
- (1) Type I: Hypoxemic Respiratory Failure (Oxygenation Failure)
  - Alveolar hyperventilation associated with hypoxemia
- (2) Type II: Hypercapnic Respiratory Failure (Ventilatory Failure)
  - Major pathophysiologic mechanisms:
  - (1) alveolar hypoventilation
  - (2) increased dead-space disease
  - (3) V/Q mismatch

The Primary Causes of Hypoxemia

- Ventilation/Perfusion (V/Q) mismatch
- Shunt (intracardiac or intrapulmonary)
- Alveolar hypoventilation
- Diffusion impairment
- Decreased FiO_2
- Venous admixture (physiological shunt)

Noninvasive Positive Pressure Ventilation

- Two methods of providing non-invasive positive pressure ventilation support:
- Continuous positive airway pressure (CPAP)
  - Effective method to improve oxygenation
  - Accepted use to treat obstructive sleep apnea and acute COPD or asthma exacerbation, cardiogenic pulmonary edema without hypercapnia
- Non-invasive positive pressure ventilation (NIV, NPPV)
  - Has been successfully used to treat patients with respiratory failure caused by various neuromuscular disorders, chest wall deformities, COPD, and acute cardiogenic pulmonary edema with hypercapnia

Non-Invasive Positive Pressure Ventilation (NIPPV)

- NPPV should be attempted before intubation:
- a. Dyspnea/ respiratory distress
- b. Acute exacerbation of COPD without other indicators
- c. Acute hypoxemia in immunocompromised patients
- d. Cardiogenic pulmonary edema

Rule of Thumb

- All patients with an acute COPD exacerbation should be evaluated for NIV as an alternative to intubation and invasive mechanical ventilation. NIV is the standard of care in these patients.
- CPAP of 8 to 12 cmH20 with 100% O2 should be considered first-line therapy in acute pulmonary edema. NPPV should be used only when hypercapnia is present.

Indications and Contraindications of NIV in Acute Care Setting

INDICATIONS

- A. Gas Exchange
  - Acute or acute on top of chronic ventilatory failure ($PaCO_2$ >50 mmHg)
  - pH < 7.35
  - Hypoxemia (use with caution with P/F ratio <200 mmHg)
- B. Bedside Observation
  - Increased dyspnea (moderate to severe)
  - Tachypnea
  - Signs of increased WOB, accessory muscle use and abdominal paradox

CONTRAINDICATIONS

- A. Absolute Contraindications
  - Cardiac or Respiratory Arrest
  - Unable to fit mask/interface
- B. Relative Contraindications
  - Non-respiratory organ failure, hemodynamic instability, encephalopathy with GCS<10, cardiac arrhythmias
  - Inability to cooperate/protect airway/clear secretions
  - High risk of aspiration
  - Upper airway obstruction
  - Recent facial trauma, surgery or deformity

Benefits of Non-Invasive Ventilation

- Avoids endotracheal intubation
- Reduces problems associated with intubation (e.g. airway trauma, increased risk of aspiration, and noscocomial pneumonia)
- Maximizes patient comfort
- Decreases mortality
- Increases alveolar ventilation
- Improves alveolar oxygenation and carbon dioxide status
- Opens and/or prevents alveolar collapse
- Reduces WOB
- Decreases oxygen consumption
- Decreases muscle fatigue

Failure of NIV Ventilation

- Clinical status of the patient is the most important factor determining the need for full ventilatory support
  - Worsening of signs/symptoms and vital signs
  - Worsening of LOC, oxygenation and/or acidosis
- Goals of NIV not achieved
- Cardiac or respiratory arrest
- One of the contraindications are present

Standard Criteria for Instituting Mechanical Ventilation

- Apnea or absence of breathing
- Acute ventilatory failure
  - a. Acute hypoxic respiratory failure
  - b. Acute hypercapnia ventilatory failure
- Impending ventilatory failure
- Refractory hypoxemic respiratory failure with increased work of breathing or an ineffective breathing pattern

Criteria For Instituting Mechanical Ventilation and the Primary Type of Respiratory Failure Associated with These Conditions

CRITERIA FOR INSTITUTING MECHANICAL VENTILATION

- 1. Apnea
- 2. Acute Ventilatory Failure
- 3. Impending Ventilatory Failure
- 4. Severe Refractory Hypoxemia

PRIMARY TYPE OF RESPIRATORY FAILURE

- 1. Hypercapnic
- 2. Respiratory Failure
- 3. Respiratory Failure
- 4. Hypoxemic Respiratory Failure

Ventilator Initiation and Management Protocol Continued

- Clinical Conditions That May Require Mechanical Ventilation
- 1. Acute exacerbation of COPD if patient has dyspnea, tachycardia, and acute respiratory acidosis plus at least one of the following:
- 2. Neuromuscular disease with any of the following:
- 3. Cardiac or respiratory arrest
- 4. Postoperative patients requiring ongoing sedation
- 5. Other complex medical conditions leading to impending acute respiratory failure

Most Common Causes of Acute Respiratory Failure Requiring Mechanical Ventilation in U.S. and Canada

Condition	Rank	Percentage
Postoperative respiratory failure	1	17
Sepsis	1	17
Other	2	16
Heart failure	3	13
Pneumonia	3	13
Trauma	3	13
ARDS	4	9
Aspiration	5	3

Modified rom Esteban A, Anzueto A, Alia I, How is mechanical ventilation employed in the ICU? An international utilization review. AM J Respir Crit Care Med 161: 1450, 2000.

Rule of Thumb

- Increased FiO2 and PEEP are the main therapies to treat severe hypoxemia

Proposed ARDS stratification

Parameters	Berlin Definition	SIESTA Definition
Predisposing illness	Within 1 week of a known clinical insult	-
Bilateral pulmonary infiltrates	Yes	Yes
Hypoxemia assessed by PaO_2/FiO_2 ratio:	At ARDS onset with PEEP≥5 cmH_2O	at 24 h of ARDS AECC onset on FiO_2≥0.5 with PEEP≥10
mild	>200 and ≤300 mmHg	>200 mmHg
moderate	>100 and ≤200 mmHg	101-200 mmHg
severe	≤100 mmHg	≤100 mmHg
Need for ETI + MV	Not in mild ARDS	Yes
Origin of edema	Not caused by cardiac failure or fluid overload	Not caused by cardiac failure or fluid overload


Thank You!