1. Ventilator Management

Indications for Mechanical Ventilation

- Apnea
- Ventilatory insufficiency
  - Increase in PaCo2 and decrease in ph
- Refractory hypoxemia

Complications Associated with Mechanical Ventilation

- Hypotension
- Increased intrathoracic pressure decreases venous return to the heart
- Increased risk of ventilator associated pneumonia (VAP)
  - Keep HOB at $\geq$ 30
  - Maintain frequent, good oral care
- Problems with endotracheal tube
  - Mucous plugging
  - Tube my become dislodged
  - Kinking or biting of tube
  - Cuff rupture
- Pneumothorax

Initial Ventilator Settings—parameters to be clarified

- Type of ventilation
- Mode of ventilation
- Tidal volume or peak inspiratory setting
- Respiratory rate
- FiO2
- PEEP (Positive End Expiratory Pressure)

Types of Ventilation

- Volume Cycled Ventilation(VCV)
  - A pre-selected tidal volume is delivered at the pressure required. *Tidal volume* guaranteed.
  - Peak inspiratory pressure will vary depending on airway resistance and lung compliance.
- Pressure Control Time-Cycled Ventilation (PCV)
  - Operator selects inspiratory pressure and inspiratory time
  - Breath is terminated when inspiratory time is reached

- Inspiratory pressure is guaranteed; tidal volume is dependant on airway resistance and lung compliance
- Pressure Support (PSV)
  - Requires intact respiratory drive
  - Operator selects inspiratory pressure
  - Patient initiates breath, pressure quickly rises to set pressure and is maintained throughout the inspiratory phase
  - Tidal volume determined by lung compliance and inspiratory effort

Modes of Ventilation

- Assist/Control (A/C)
  - Also called continuous mandatory ventilation (CMV)
    - Patient guaranteed pre-set tidal volume/pressure at pre-set rate
    - May breathe above pre-set rate and will receive pre-set tidal volume/pressure with each breath
- Synchronized Intermittent Mandatory Ventilation (SIMV)
  - Patient guaranteed set volume/pressure at set rate
  - Patient may breathe spontaneously in addition to set rate
  - Pressure support may be added to spontaneous breaths
- Continuous Positive Airway Pressure (CPAP)
  - Spontaneous breathing with a low level of positive pressure throughout the breath

Tidal Volume

- Patients w/o pulmonary process
  - 8-10cc/kg ideal body weight
- Patients with ARDS:
  - 6cc/kg ideal body weight

Respiratory Rate

- Adjust to desired minute ventilation (usually 12-15 bpm)

- FIO2

  - start at 100%; titrate for Spo2 > 90%

Positive End Expiratory Pressure (PEEP)

- Indications for PEEP

  - Maintain alveolar recruitment in ARDS
  - Improve triggering ability in intubated COPD patients on mechanical ventilation
- Used in patients with ARDS to improve oxygenation
- Works by re-establishing FRC and preventing alveolar collapse (de-recruitment)
- May require levels of 8-20 cmH2O
- Complications associated with PEEP
  - Decreased cardiac output

- Should perform “Best PEEP” trial for PEEP > 10 cmH2O
- Goal is to maximize O2 delivery to tissues
- Increased risk of pneumothorax
- Use in unilateral disease may result in over distension of the more compliant lung and cause shunting of blood to the less compliant lung

- Prophylactic PEEP
  - A PEEP of 3 to 5 cmH2O is typically applied to all intubated patients due to the possible loss of physiologic PEEP during intubation
- Intubated COPD patients
  - May improve triggering by patients experiencing auto_PEEP
  - Increasing set PEEP may raise trigger level closer to total PEEP
  - Should not use if set PEEP raises total PEEP

Airway Pressures

- Peak Inspiratory Pressure
  - The pressure required to move air through the endotracheal tube, airways and to the alveoli
  - Difference between plateau and peak pressure determined by resistance
    - Resistance (ETT and airways)
    - Compliance
    - PEEP
    - VT
    - Inspiratory flow
- Plateau pressure
  - A reflection of alveolar pressure – the pressure required to inflate the lung
  - High peak alveolar pressures infer alveolar over distension
  - Should be kept < 30 cmH2O

Ventilator Adjustments

- Hypoxemia
  - Increase FIO2
  - Increase mean alveolar pressure
  - Increase mean airway pressure
    - Increase PEEP
    - Increase I:E Ratio (Inverse Ratio Ventilation)

Respiratory Acidosis – increase minute ventilation

- VCV
  - Increase VT (Pplat < 30 cmH2O)
  - Increase RR
  - If on SIMV, may increase PSV
- PCV
  - Increase inspiratory pressure (Pplat < 30 cmH2O)
  - Increase RR
  - If on SIMV, may increase PSV
- PSV
  - Increase PSV level
  - Switch to VCV or PCV

Respiratory Alkalosis – decrease minute ventilation

- VCV
  - Decrease VT
  - Decrease RR (if patient not assisting)
  - If on SIMV, may decrease PSV
- PCV
  - Decrease inspiratory pressure
  - Decrease RR
  - If on SIMV, may decrease PSV
- PSV
  - Decrease PSV level
  - Mild sedation if necessary (careful not to eliminate drive)

Wrap Up

- Mechanical ventilation is a necessary adjunct to the care of some patients, but not without serious complications.
- Protective ventilation strategies should always be used in patients with ARDS: i.e. low VT, low Plat.
- Always watch for and try to reduce auto-PEEP in patients with COPD: i.e. long expiratory times, short inspiratory times, PEEP to improve triggering if necessary.
- Maintain VAP prevention strategies
- Wean assessment and SBT daily when patient condition improves.

- Start at 100%; titrate for Spo2 > 90%