Mechanical Ventilation

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Objectives

- Describe indications for mcvent
- Describe types of breaths and modes of ventilation
- Describe compliance and resistance and how this affects ventilation
- Describe ventilator troubleshooting
Indications for McVent

- Oxygenation abnormalities
  - Refractory hypoxemia
  - Need for positive end expiratory pressure (PEEP)
  - Excessive work of breathing
Indications for McVent – cont’d

- Ventilation abnormalities
  - Respiratory muscle dysfunction
    - Respiratory muscle fatigue
    - Chest wall abnormalities
    - Neuromuscular disease
  - Decreased ventilatory drive
  - Increased airway resistance and/or obstruction
Modes of Ventilation

- ASV, APRV, AV, AutoMode, Bilevel, BiPAP, EPAP, Fluid Logic, HFJV, HFOV, IPPV, IPAP, MMV, NEEP, PAV, PCV+, PCIRV, PCSIMV, PRVS, PRVC, PV, VCIRV, IRV, VS, etc, etc, etc!!!
Types of Ventilator Modes

- **Mandatory**
  - Operator sets RR
  - Operator sets start, stop, and everything in between
  - Patient can trigger extra mandatory breaths

- **Spontaneous**
  - Patient sets RR
  - Patient controls start, stop
  - Patient triggers all breaths
Types of Ventilator Breaths

- **Mandatory**
  - Volume Breath
    - Flow set
    - Volume cycled
  - Pressure Breath
    - Pressure set
    - Time cycled

- **Spontaneous**
  - Pressure supported breath
    - Pressure set
    - Patient insp flow cycled
Choosing a Mode

- Consider trial of NPPV
- Determine patient needs
- Identify goals
  - Adequate ventilation and oxygenation
  - Decreased work of breathing
  - Patient comfort and synchrony
  - Remove vent asap
Spontaneous Ventilation
Continuous Positive Airway Pressure (CPAP)

- No machine breaths delivered
- Allows spontaneous breathing at elevated baseline pressure
- Patient has complete control over RR and tidal volume

Spontaneous Ventilation with Continuous Positive Airway Pressure (CPAP)
Pressure Support

- RR triggered by patient
- Preset level of inspiratory support delivered
- Cycles to expiration when inspiratory flow slows to preset level
- VT depends on compliance, resistance, pressure level, and patient effort
Pressure Support – cont’d

- **Advantages**
  - Patient comfort
  - Decreased work of breathing
  - May enhance patient-ventilator synchrony

- **Disadvantages**
  - Variable volumes
  - Inappropriate support
  - Relies on apnea backup
  - Leaks may interfere with cycling
Assist-Control (Volume)

- Set RR, set tidal volume, insp pressure variable
- Patient triggers extra breaths with full tidal volume
- Advantages: guarantees minute ventilation
- Disadvantages: hyperventilation, hemodynamic effects, ‘breath stacking’
Assist-Control (Pressure)

- Set RR, set insp pressure, tidal volume variable
- Patient triggers extra breaths with full pressure
- Advantages: limits pressure
- Disadvantages: hyperventilation, hemodynamic effects, ‘breath stacking’
Synchronized Intermittent Mandatory Ventilation (SIMV)

- **Mandatory breaths** – volume or pressure breaths
- **Spontaneous breaths** – pressure support
SIMV – cont’d

- **Advantages**
  - Less hemodynamic effects
  - Less inappropriate hyperventilation
  - Guarantees some minute ventilation

- **Disadvantages:**
  - Not physiological
Measurements

- Compliance
- Resistance
- Peak airway pressure
- Plateau pressure
Compliance

- Measures compliance of the lung and thorax
- Tidal volume / Plateau-PEEP
- Units = ml/cmH\textsubscript{2}O
Resistance

- Measures airway resistance
  - Length
  - Viscosity
  - Flow
  - Radius$^4$

- Peak-plateau / Flowrate
- Units = cmH$_2$O/Lps
Peak and Plateau Pressures

■ **Peak airway pressure reflects**
  - Baseline (PEEP)
  - Pressure due to compliance (L+T)
  - Pressure due to resistance

■ **Plateau pressure (breath hold) reflects**
  - Baseline (PEEP)
  - Pressure due to compliance (L+T)
  - (alveolar distending pressure)
Waveform

Assist-Control Ventilation with PEEP
Troubleshooting
Mechanical Ventilation 2

Fundamentals of Critical Care Support
Objectives

- Initiation of mcvent
- Monitoring
- Improving oxygenation
- Improving ventilation
- Obstructive Lung Disorders
- Restrictive Lung Disorders
- Pediatric considerations
Initiation of McVent

- Choose your mode
- Set minute ventilation for pH
  - RR
  - VT (8-10 ml/kg)
  - I:E
- Set oxygenation for SpO2 or SaO2
  - PEEP
  - FiO2
- Trigger level
Initiation cont’d

- Set sedation, analgesia, NM blockade
- Monitors
  - ECG, SpO2, Vitals, Observation
- Alarms
  - Hi/Low pressure
  - Low volume
  - Apnea
- Humidification
Initiation cont’d

- **Evaluation**
  - CXR
  - Peak/plateau
  - Exhaled VT and RR(TOT)
  - Patient-Ventilator synchrony
  - Autopeep
  - SpO2, ABG
  - Hemodynamics
Improving Oxygenation

- FiO2
- Mean Airway Pressure
  - PEEP
    - Recruit lung
    - Improve compliance
    - Redistribute lung water/blood
  - Insp pressure
  - Inspiratory time
- Goal Sp02 >92%, FiO2 <0.50
Improving Ventilation

- **Tidal Volume**
  - Watch Plateau

- **Respiratory Rate**
  - Watch for Autopeep

- **Goal pH = normal**
Obstructive Lung Disorders

- Asthma/COPD
  - Inflammation
  - Bronchoconstriction
  - Inc. mucous prod/Dec. clearance
  - Decreased expiratory flowrates
    - Autopeep
    - Hemodynamic compromise
    - Barotrauma
Obstructive Lung Disorders - Ventilator Strategies

- Decrease RR
  - Sedation to decrease drive
- Permissive Hypercapnia
  - pH >7.25
  - Contraindications Heads, Hearts
- Plateau <30cmH20
Restrictive Lung Disorders

- **Intrapulmonary**
  - ARDS
  - CHF
  - Pneumonia
  - Fibrosis

- **Extrapulmonary**
  - Obesity
  - Pregnancy
  - Ascites
Restrictive Lung Disorders – Ventilatory Strategies

- **Intrapulmonary**
  - Recruit collapsed lung
    - High PEEP
    - Increase TI
  - Prevent overdistension
    - Plateau <30cmH20
    - VT 4-6 ml/kg
  - Goal FiO2 <0.50?

- **Extrapulmonary**
  - Same as above, with Plateau <40cmH20
Pediatric Considerations

- Infants (<5 kg)
  - Time-cycled, pressure limited modes
  - Start Peak pressure 18-20 cmH20
  - TI .5-.6 sec
  - VT to chest expansion or 8 ml/kg
  - PEEP 2-4
Pediatric Considerations – cont’d

Children

- SIMV mode
- VT 8-10 ml/kg
- TI
  - Infants - .5-.6 sec
  - Toddlers - .6-.8 sec
  - Older - .8-1.0 sec
- RR < 18-20
- Peep 5
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