Basics of Ventilation
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Purpose
The purpose of this presentation is to familiarize non-respiratory personnel with some very basic terminology and concepts involved with mechanical ventilation. It is hoped that this presentation will allow you to be more familiar with ventilators that are on your patient and/or allow you to assist a respiratory therapist in the event of a mass casualty ventilation incident.

Respiratory Anatomy
Tidal volume
- The amount of air taken into the lungs per breath
- 3-7 ml/kg (500 ml in a healthy young male)

Anatomic Deadspace
- Airway, trachea, bronchi to level of alveoli
- No gas exchange
- About 20-40% of a normal tidal volume or as much as 40-60% of a mechanical breath

Alveolar ventilation
- Tidal volume – deadspace

Alveolar deadspace
- Ventilation without perfusion
- Non-perfused alveoli

Physiologic Deadspace
- Anatomic + Alveolar

Mechanical deadspace
- From wye to patient

Shunt
- Perfusion without ventilation
- Collapsed alveoli

Goal Of Mechanical Ventilation
Provide sufficient alveolar ventilation to normalize carbon dioxide elimination via the lungs and to normalize oxygen delivery to the tissues.

Forces Opposing Ventilation
Compliance
- Simply put, the stiffness of the lungs
- Expressed in ml/cwp
- Normals 50-100 ml/cwp
- As low as 10-20 in disease

Resistance
- Opposition to flow through a tube
- Determined by:
- Flow, length of tubing, viscosity of gas and airway diameter
- Decrease of 1 unit of size = 4 X increase in resistance

Disease Processes

Obstructive diseases
- COPD (Asthma, Emphysema, Bronchitis)
- Increased resistance
- Overaeration
- Need short inspiratory times
- Auto-PEEP (PEEPi)

Acute Respiratory Distress Syndrome (ARDS) and Acute Lung Injury
- Acute insult to lungs
- "Flooding" the lungs
- Refractory hypoxemia
- No improvement in oxygenation with increased FiO2's
- Very low compliance
- Excessive pressures needed

Neuromuscular Diseases
- Normal compliance
- Normal resistance
- Poor muscle strength
- Diseases
  - Guillain Barre
  - Myasthenia Gravis
  - ALS

Others
- Overdose
- Neurotrauma
- Apnea (anesthetics)
- Ventilation/Perfusion (V/Q) mismatch

Hazards of Positive Pressure Ventilation
- Positive pressure ventilation reverses the normal pressures in the lungs and may cause:
- Barotrauma/volutrauma
- Increased intracranial pressure
- Hemodynamic compromise
  - Decreased venous return
  - Decreased cardiac output
  - Decreased blood pressure
  - Decreased renal function
- Loss of thoracic pump
- Ventilator associated pneumonias
- Stress ulcers

Indication For Ventilation

Apnea
- Respiratory arrest, sedation/anesthesia, overdose

Respiratory Failure
- High $PaCO_2$ with respiratory acidosis

Impending respiratory failure
- Neuromuscular diseases

Hypoxic respiratory failure

Modes of Ventilation

- Assist/Control –(volume control)
  - Set rate, volume, flows, & FiO_2 – patient can inc rate.
- Assist Control (pressure control)
- Set pressure, rate, Insp. Time & FiO_2 (volume variable) – Open lung or Low stretch
- Pressure Regulated Volume Control (PRVC)
  - As A/C but vent uses lowest constant pressure to deliver set volume (Varied flowrate)
- Synchronized Intermittent Mandatory Ventilation (SIMV)
  - Set rate, volume, flow, and FiO_2 – patient breathes spontaneously between Mandatory breaths
  - Can be combined with PS
- Pressure support
  - Breath Boost
  - Can be combined with SIMV
- CPAP
  - Spontaneous breathing with some positive pressure to splint lungs open
- Airway Pressure Relief Ventilation

Ventilator Parameters

- Tidal volumes
  - Normal breath size (5-7 ml/kg)
  - Uncomplicated mechanically ventilated patients (10-15 ml/kg) – now as low as 4-6
  - COPD patients (8-10 ml/kg)
  - ARDS patients (6-8 ml/kg)
- Rate = 10-16
- Flows = 40-80 l/m or 20 – 33% I. time or .8 to 1 sec insp. Time
- FiO_2 = 100% and titrate with SpO_2
- Pressure support/control = (< 35 cwp open lung)
- PEEP = 5 (physiologic) to 20
- About PEEP/CPAP
  - Certain diseases decrease compliance and decrease lung Volume
  - This leads to atelectasis and refractory hypoxemia
  - PEEP and CPAP increase end expiratory volumes to normal levels
- Sensitivity
  - Pressure = -1 to -2 CWP
  - Flow = 3-5 lpm of flow interruption

Rate, Volume and Inspiratory Time/Flow

The actual rate determines cycle time
The amount of time for inspiration and expiration
The tidal volume along with flow or inspiratory time determine the amount of cycle time used for inspiration
The remaining time allows for expiration
Too short of expiration will cause air-trapping (Auto-PEEP)
Increased risk with patients with high resistance
I:E ratio shows relationship between inspiration and expiration
I:E ratios of 1:3 to 1:6 are normal for ventilated patients
Patients with increased airway resistance – closer to 1:6

Ventilation Pressures

Peak Inspiratory Pressure determined by
- Patient compliance
- Airway resistance
- Volumes set
- Flow rate
- End expiratory pressure (PEEP)

Alveolar pressures
- Estimated by pause (plateau) pressure
- Most closely predicts lung damage

Setting Alarms

Alarms prevent/reduce patient injury
Set too close to the actual value = nuisance alarms
Set too far from the actual value = missed events
Examples of alarm settings
- Pressures 10 cwp above or below normal PIP
- 15-25% above or below

Weaning

T-Piece
CPAP trials
SIMV
Pressure Support
Volume Oriented Pressure Support (VOPS)
Augmented Minute Ventilation – Auto-Mode

Monitoring

Discussed in another presentation
Includes patient assessment
Also includes monitoring the ventilator
May include
End Tidal CO2
Arterial blood gases
Pulse Oximetry
Transcutaneous O2/CO2

Conclusion

This presentation covered basic strategies
Institutions or individual physicians may vary strategies
Contact milischr@westerntc.edu if there were any problems with the presentation
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