Classification of Mechanical Ventilators

Kacmarek's " 12 Point Classification "

- Positive/Negative Pressure
- Powering Mechanism
- Driving Mechanism
- Single or Double Circuited
- Modes of Ventilation
- Cycling Parameter

Kacmarek's " 12 Point Classification "

- Limits
- Flow Patterns
- Pressure Patterns
- Internal Resistance
- Auxiliary Maneuvers
- Alarms

Positive or Negative Pressure

Most Ventilators are positive pressure

- Not physiological
- May cause “side effects” of PPV
- Above ambient pressure created at mouth
- Intra-alveolar pressure is ambient
- Creating a positive intrapulmonary pressure

Positive or Negative Pressure

Negative Pressure

- Physiological
- Pressure gradient atmospheric to subatmospheric
- No Intubation needed
- Difficult to work with patient
- Usually used at home or rehab.
- Less control over patient settings/parameters
- Examples; Iron Lung & Chest Cuirass

Powering Mechanism -Electric

- Only delivers 21% without addition of O2
- Uses high pressure oxygen for FiO2 over 21%
  - MA1
- Need electrical generator for power outages

Powering Mechanism -Pneumatic

- Plugged into high pressure gas source
- Uses 2 gas sources air and oxygen at 50 psi
- Uses reducing valves to lower pressure
- Examples Bird Marks and Bennett PR’s

Powering Mechanism -Combined

- Both pneumatically and electronically controlled
- BEAR ventilators
- Puritan Bennett 7200
- Nellcor Puritan Bennett 840

Driving Mechanism

Pneumatics

- Clutch & Valve = Bennett PR
- Servo = Siemens,Servo and Baby Bird
  - Solenoids = Bourns Bear, BP200
  - Regulator = Bourns Bear, BP200
- Fluidics = Monoghan225, Ohio550

Driving Mechanism

Piston

- Linear = Bourns,LS104-150,Gill 1
- Rotary = Morch, Emerson, Engstrom

Single or Double Circuited

- Single Circuit

A single circuit is one in which the gas supply that powers the ventilator is the same gas that is delivered to the patient

- Examples = Bennett 7200 and Bear

Single or Double Circuited

- Double Circuit

A double circuit has a gas source that powers the unit by compressing a bag or bellows containing the gas that will go to the patient

- Examples = MA1,Monohan

Modes of Ventilation

Control Mode

The Ventilator is responsible for the initiation and delivery of each tidal volume.

The Ventilator sets both rate and volume no spontaneous breaths delivered.

Ventilator does all the work of breathing for patient.

Modes of Ventilation

Assist

The patient is totally responsible for initiation of the inspiratory phase, but the ventilator delivers the volume.

Patient totally sets rate.

Modes of Ventilation

Assist/Control

Ventilator functions in the assist mode unless the patient's rate falls below a preset rate, at which time the ventilator converts to the control mode.

All volumes are ventilator delivered, patient sets rate.

Modes of Ventilation

IMV

Patient can breathe spontaneously from the ventilator via a demand valve, ventilator has a preset rate in which it functions in the control mode and delivers that rate to the patient at a set volume.

Can cause stacking of breaths.

Modes of Ventilation

SIMV

Patient can breathe spontaneously from the ventilator via a demand valve, ventilator has a preset rate in which it functions in the control mode and delivers that rate to the patient at a set volume. The rate is synchronized with patient assist preventing stacking of breaths.

Modes of Ventilation

MMV

A minimum minute volume is set on the ventilator.

The patient may receive this volume by, spontaneous breaths, by being mechanically ventilated or a combination of both if spontaneous minute volume falls below set amount ventilator would make up difference.

Modes of Ventilation

IPS

The patient's inspiratory effort is assisted by the ventilator which functions as a constant pressure generator up to a preset level of pressure or until inspiratory flow rates decrease to 25% of peak flow. This mode can only be used with modes that allow spont. breaths & volumes. Ex SIMV, Independently or CPAP.(CPAP not mode of vent.)

Cycling Parameter's

- All ventilation is a function of flow,time pressure or volume
- Cycling is what ends inspiration and starts exhalation
- Volume, Pressure or Time can end inspiration
- What ever ends inspiration and starts exhalation determines the type of ventilator. (note a ventilator may have more then one cycling parameter)

Limits

- Any other than normal cycling are limits
  - Example: When a pressure limit is set on a volume ventilator it will not allow the ventilator to exceed that limit even though the volume has not been delivered, the ventilator would cycle into expiratory phase.

Flow Patterns

- Square Wave or Rectangular = constant flow,depending on internal resistance to determine if it changes with back pressure

- Example: MA1, Bear

Flow Patterns

- Sine or Sinusoidal = gradually increasing flow until mid-inspiration,due to action of rotary piston. Best distribution of gas.
  - Example: Emerson

Flow Patterns

- Accelerating or Ascending = gradually accelerates to peak and then levels off
- Example: Engstrom

Flow Patterns

- Decaying or Descending = reaches peak flow immediately, then gradually decelerates
  - Example: Bennett PR2

Pressure Patterns

Pressure is determined by flow pattern

- Rectilinear = due to square wave
  - Sigmoidal = due to sine wave
- Exponential = due to accelerating
  - Parabolic = due to decaying

Internal Resistance

Determines how well the flow pattern is maintained and thus the pressure pattern will be maintained in the face of back pressure

- High = will adhere to flow pattern even with high back pressures
- Moderate/Medium = have some deceleration of flows due to back pressure
- Low = back pressure drastically effects the flows

Auxiliary Maneuvers

- PEEP = positive pressure remains in the lungs at all times to keep open alveoli
- Inspiratory Hold = better distribution of gas throughout lung fields, best V/Q match
- Sigh = for prevention of atelectasis, simulate normal breathing, 1.5 times set Vt
- Expiratory Retard = simulates pursed lip breathing

Alarms

- Oxygen Disconnect
- High/Low Pressure
- High/Low Volume
- Fail to Cycle
- High/Low PEEP
- Time (I:E Ratio)
- Apnea