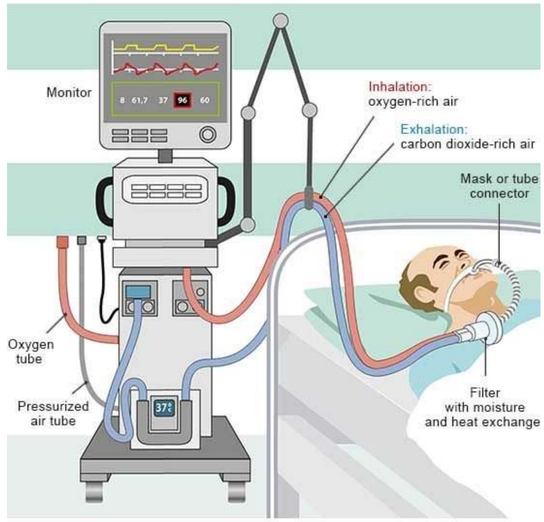

Basic Mechanical Ventilation

Bruce MacNeil Jr. BS, RRT-ACCS

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Controlled (Rate) or Spontaneous

Since positive pressure is the current standard, the first step is to decide whether to place the patient on a controlled mode or a spontaneous one.

This begins with a patient assessment.

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Controlled (Rate) or Spontaneous

Is the patient able:

To breathe spontaneously?

To maintain a stable blood gas and SpO_2?

Exhibiting a normal work of breathing?

If yes, spontaneous ventilation is encouraged.

Prevents breathing muscle atrophy

More comfortable/less sedation

Can change settings or place on a controlled mode if not tolerating.

3

Spontaneous Mode

- Simple to initiate:
  - PEEP
    - Start at 5 cmH20 or higher depending on oxygenation
  - Pressure support
    - Titrated to WOB, start @ 5-10 and adjust as needed.
    - High PS is fine.
  - FiO2 to keep SaO2 above 92%. (Should be < 0.6)

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Spontaneous Mode

A single pressure is CPAP/PEEP/EPAP

i.e., 0/5 or 5 cmH20

Affects oxygenation

Maintains FRC

A bi-level pressure is

Bipap/PSV/CPAP+PS

5/5, 10/5

Affects ventilation

Augments spontaneous breathing

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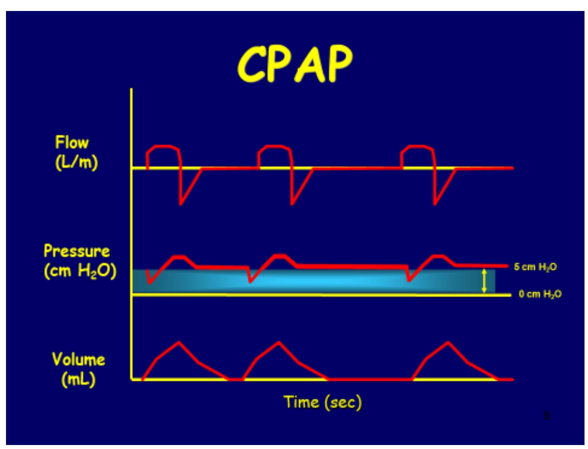
CPAP- maintains a single pressure



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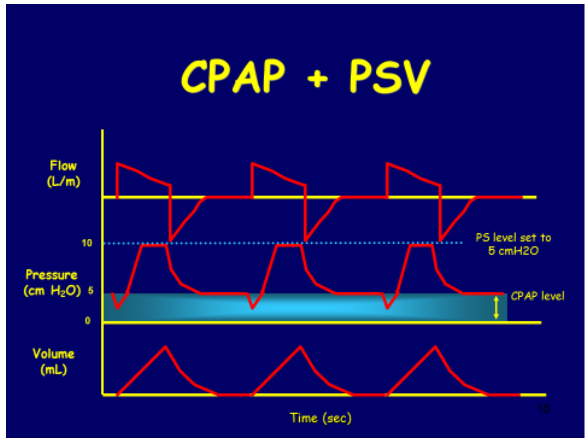
BiPAP- Two (bi) Pressures



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Is the patient:

- Not breathing spontaneously?
- Sedation/NMBA?
- Unable to maintain a stable blood gas and SpO_2?
- Exhibiting an increased work of breathing?
- Breathing in a way that is dangerous to the lungs?

A Controlled mode is indicated.

- Effectively manages ventilation and oxygenation
- Can safely manage lung pressures and volumes
- Controls respiratory rate, pressure, volume and FiO2

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Controlled Mode: Pressure or Volume

- Pressure Controlled Ventilation

Pros-

- Flow is variable
- Better patient response, more comfortable
- Safe pressure control/limiting

Cons-

- Cannot target a volume
- Volutrauma in overly compliant lungs
- Continuous barotrauma if set too high
- May result in Vt too large or small

- Initial pressure should be set between 15-20 cmH2O and closely monitored for titration to achieve a tidal volume between 6-8 ml/kg IBW

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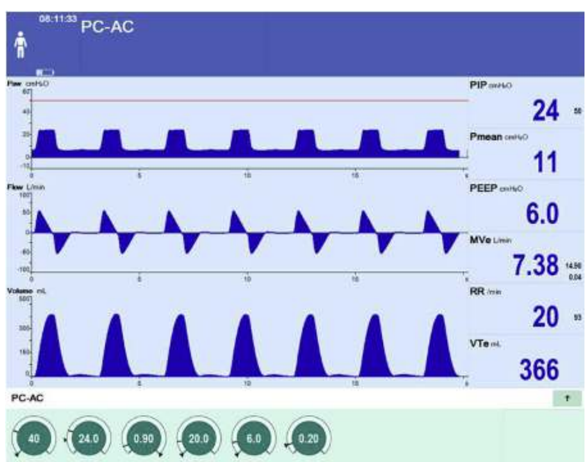
Pressure Control Normal Graphics



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Controlled Mode: Pressure or Volume

- Volume Control

Pros-
- Can target specific volumes and flows
- Can manually increase or decrease flow
- Ensures a safe tidal volume

Cons-
- Pressure not guaranteed safe
- Continuous Volutrauma if not set correctly
- Patient may not receive necessary flow as flow is fixed.
- Less comfortable

- Tidal Volume should be set initially between 6-8ml/kg of IBW and titrated up or down based on patient presentation

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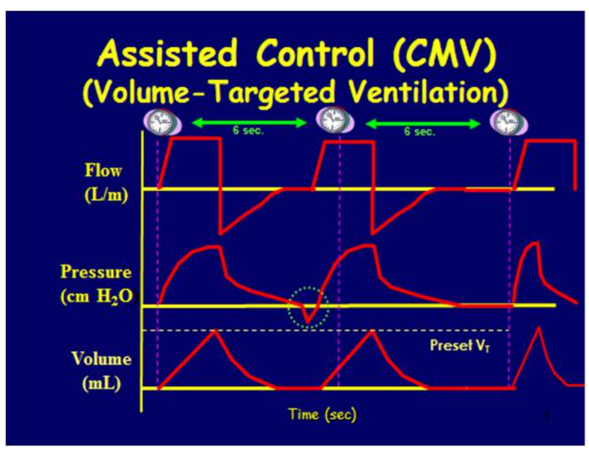
Assist Control (Pressure or volume)



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SIMV (Keep Away)

- SIMV does not effectively reduce WOB.
  - Marini AmRev Respir Dis 1988; 138:1169-1179
- SIMV is associated with failed triggers and increase drive.
  - Leung P Am J Respir Crit Care Med 1997; 155:1940-1948
- SIMV has not been shown to reduce weaning time.
  - Esteban, N Engl J Med 1995; 332: 345
  - Brochard, Am J Respir Crit Care Med 1994; 150: 896

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Hybrid Modes

- PRVC, APVcmv, VC+, CMV Autoflow
- A pressure mode
- Targets a tidal volume
- Adjusts Delta P to maintain target volume with lowest possible pressure.
- Will not exceed set maximum pressure.
- Flow is variable, tolerated better
- Best of volume and pressure with less of the risks of each.

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Hybrid Modes

Concerns:

- Varying Tidal Volume over time
- May reduce flow and pressure during periods of increased WOB
- Troubleshooting:
  - Adjust I-time and/or Ramp time to accommodate increased flow demand.
- Target Tidal Volume should be set initially between 6-8ml/kg of IBW and titrated up or down based on patient presentation

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Making Changes To Vent Settings

- All changes should be made with a clear reason as to why
- No adjustments should be arbitrarily made
- If changes to rate or Vt are required, what data supports the need for the change and what process was used to determine the what was changed and by how much?
- There should be a clear plan for identifying the problem, the required action and how it will achieve the desired results.

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Emergent Vent Placement

- Sometimes, as in an emergent intubation or trauma, it may become necessary to get a patient on a vent quickly.
- There are some “standard” settings that can safely be used initially until more personal, patient specific settings can be determined.
- Tidal Volume:
  - Average male and female height is 5”9” and 5”4” respectively. So, given that we want to start somewhere in the area of 6-8 ml/kg of IBW a good rule of thumb is 500ml for men and 400ml for women.
- Respiratory Rate:
  - Normal rate is between 12-20 BPM, 16 BPM is a safe place to start.
- FiO2:
  - Start at 100% and titrate quickly based on oxygen saturation and ABG results.
- PEEP:
  - Start at 5 cmH2O and titrate up from there.

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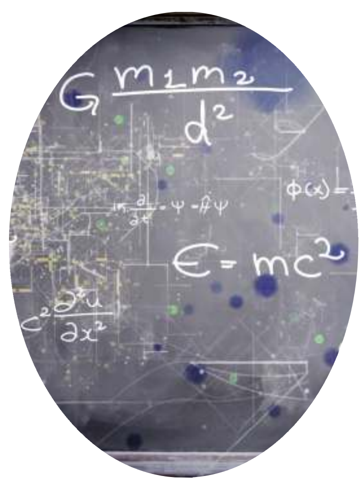
The “Have-Want” Formula

- Using a current blood gas, this formula is an objective way to determine how a change in rate, Vt or MV will affect the CO2 and, by default, the patients pH.
- Current CO2 * Variable (MV, Vt, RR)

  Desired CO2
- We know that for every 10 points CO2 moves in either direction, there is a subsequent move in pH in the opposite direction.
- Ex: If the patients pH is 7.32 and the CO2 is 50, moving the CO2 to 40 will produce (in most cases) a corresponding move in pH to 7.40
- This is an excellent and highly accurate way to determine objectively what changes you should make and why, with a predicted outcome.



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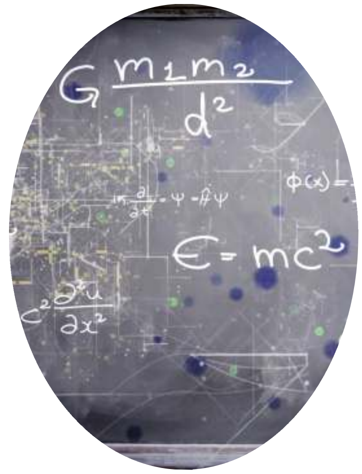
The "Have-Want" Formula

Current CO2*Variable (MV, Vt, RR)

Desired CO2

- The variable (MV, Vt, RR) used will produce a result for that variable and should be plugged in using the current value.
  - Ex: ABG 7.32/50/100
  - Current data- Rate 16, Vt 450, MV 7.2 l/m
  - The formula would look like this-
  - 50*16/40 = 800/40 = 20 (new rate)
  - 50*450/40 = 22,500/40 = 562 (new Vt)
  - 50*7.2/40 = 360/40 = 9 (new MV)



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PEEP Titration

- Like all other ventilator settings, PEEP should be adjusted using an objective test to determine the appropriate level to improve refractory hypoxemia. Any of the following "best PEEP" methods can be used:
  - Decremental PEEP study (preferred over incremental)
  - Incremental PEEP study
  - Slow flow pressure volume loop study
  - Esophageal balloon manometry
  - ARDSnet PEEP/FiO2 tables
    - High PEEP, Low FiO2 table is preferred as PEEP has been proven to be lung protective and high FiO2 is known to cause issues with oxygen toxicity and lung damage.

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Decremental/Incremental PEEP Titration

PEEP	Plateau	DP	Sp02	BP (MAP)
22	38	16	82	64
20	36	14	85	68
18	32	14	88	70
16	28	12	92	78
14	28	14	93	82

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ARDSnet Tables

- If you don't have access to any other tools, this is still considered an acceptable option.
- Note however, this method is a standardized approach and does not personalize the settings to a patient's unique lung properties.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

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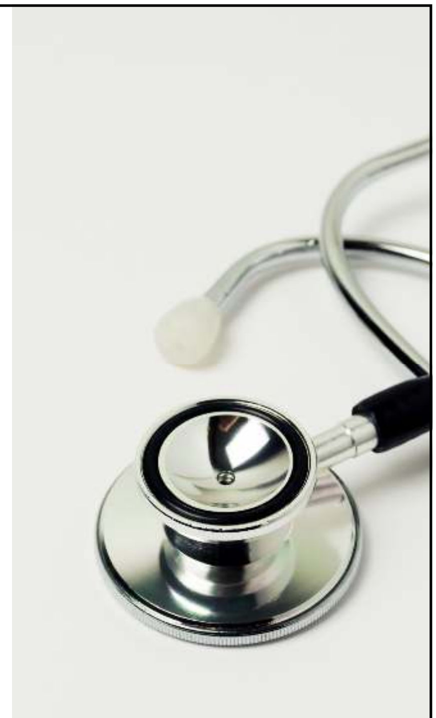
Conclusion

- Choosing an appropriate ventilator mode and settings is key to providing good patient care.
- Changes should be made intentionally with supportive data, never arbitrarily.
- Patient safety and lung protection should be forefront in how we proceed.
- Patient-vent assessments should be done with care and attention to detail, making changes as needed throughout the shift or day. Lung physiology changes continuously and vent settings should reflect that.
- Questions?



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