Mechanical Ventilation

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22-11-2021

- A mechanical ventilator is a machine that helps a patient breathe (ventilate) when he or she cannot breathe on his or her own for any reason
- The purpose of mechanical ventilation is to support the respiratory system until the underlying cause of respiratory failure can be corrected
- Most ventilatory support requires an artificial airway however, it may be applied without an artificial airway and is called noninvasive ventilation


VIASYS
SPRINTPACK

intubation & MV is indicated for:

1. Ventilation

PaCO2 more than 50 mm Hg, with a pH of 7.25 or less

2. Oxygenation

PaO2 less than 60 mm Hg on a FiO2 greater than 0.5

3. Increased work of breathing (WOB) -use of accessory muscles, abnormal breathing Patterns, dyspnea

4. Keep airway patency

Obstructive Lung Disease

- Obstruction can occur when inflammation and swelling cause the airways to become narrowed or blocked, making it difficult to expel air from the lungs. This results in an abnormally high volume of air being left in the lungs
- Common obstructive diseases include COPD asthma, bronchitis, emphysema and Cystic fibrosis (CF).

Restrictive Lung Disease

- The compliance of the lung is reduced, which increases the stiffness of the lung and limits expansion

- Common causes of decreased lung compliance are ARDS ,pulmonary fibrosis, pneumonia and pulmonary edema

ARDS

- Diagnosis criteria for ARDS – Berlin definition (all 4 components must be present)

1. Acute onset (1 week or less)
2. Hypoxemia (PF ratio < 200 mmHg with a minimum of 5 cmH2O PEEP (or CPAP))
3. Pulmonary edema (bilateral opacities on CXR)
4. Non-cardiogenic (not caused by cardiac failure)

ARDS Severity	PaO2/FiO2*	Mortality**
Mild	200 – 300	27%
Moderate	100 – 200	32%
Severe	< 100	45%
*on PEEP 5+; **observed in cohort		

https://lifeinthefastlane.com/ccc/acute-respiratory-distress-syndrome-ards-definitions/

Positive-Pressure Ventilation

- Force air into the lungs via an artificial airway
- Movement of gases into the lung through the use of positive pressure is the opposite of spontaneous breathing
- Many of the complications of mechanical ventilation are related to air being forced into the lungs under positive pressure.

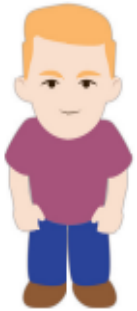
Mechanical ventilation

What is mechanical ventilation?

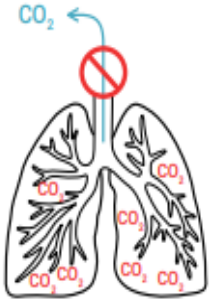
All
Full respiratory support

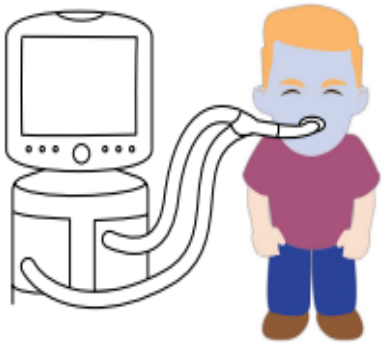
OR

Some
Partial respiratory support

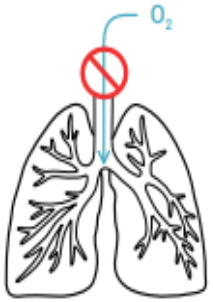


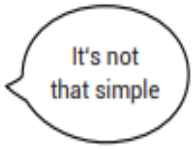
Ventilation

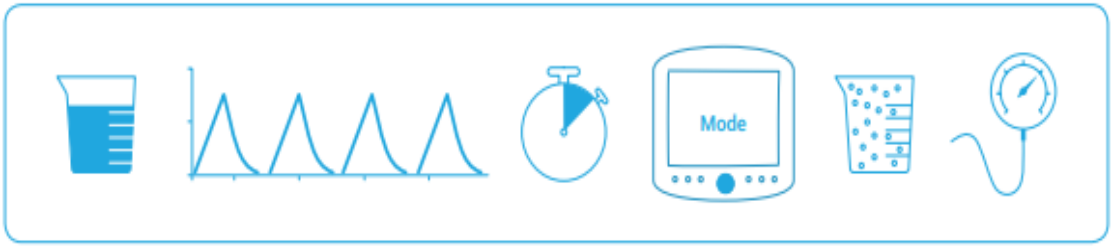




Oxygenation







Ventilator Settings

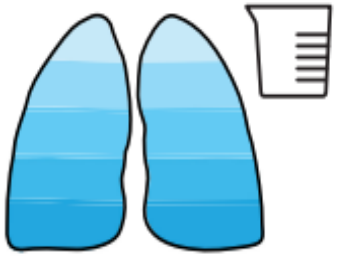
- Fraction of Inspired Oxygen
- Tidal Volume
- Respiratory Rate
- Inspiratory-to-Expiratory Ratio
- Inverse Inspiratory-to-Expiratory Ratio
- Flow rate
- Positive End-Expiratory Pressure
- Peak Inspiratory Pressure and plateau airway pressure (Pplat)

Which settings are available for my patient?

Parameters	
1. Tidal volume (V_T)	L or mL
2. Respiratory rate (RR)	breaths/min
3. PEEP	cmH_2O
4. FiO_2	%
5. Flow	L/min

Parameters

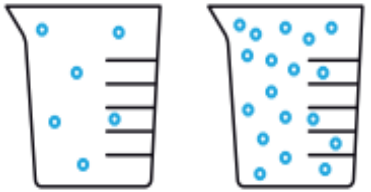
1. Tidal volume (V_T)



2. Respiratory rate (RR)

3. PEEP

4. FiO_2



5. Flow

What are the initial values for each parameter?

Parameters	Initial values
1. V_T	6–8 mL/kg
2. RR	10–20 breaths/min
3. PEEP	0–5 cmH_2O
4. FiO_2	100%
5. Flow	40–60 L/min

6–8 mL/kg x 65 kg = 390 mL ≈ 400 mL

10–20 breaths/min — 15 breaths/min

0–5 cmH_2O — 5 cmH_2O

100% — 100%

40–60 L/min — 60 L/min

Initial values

1. Tidal volume (V_T)

Use ideal body weight based on gender and height, not actual weight.

6–8 mL/kg

2. Respiratory rate (RR)

10–20 breaths/min

3. PEEP

0–5 cmH_2O

4. FiO_2

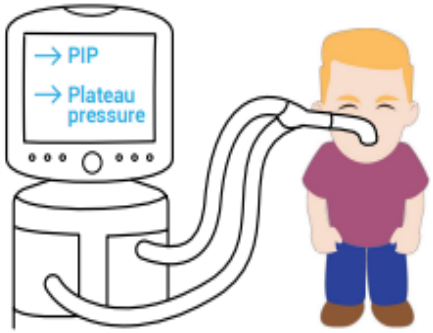
100%

5. Flow

40–60 L/min

PIP and plateau pressure monitoring

How do I monitor and measure pressure inside the lungs?



PIP	< 35 cmH_2O
Plateau pressure	< 30 cmH_2O

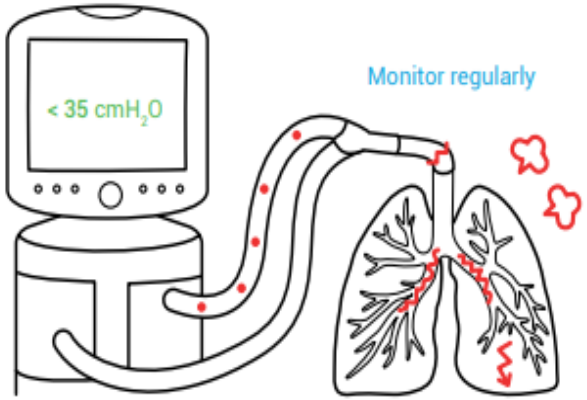
Correct by
1. Checking for causes of resistance
2. Reducing V_T
3. Changing mode.

PIP = Peak inspiratory pressure

PIP is the highest level of pressure applied to the lungs during inhalation.

Resistance anywhere along the path from the ventilator to the lungs can cause an increase in PIP.

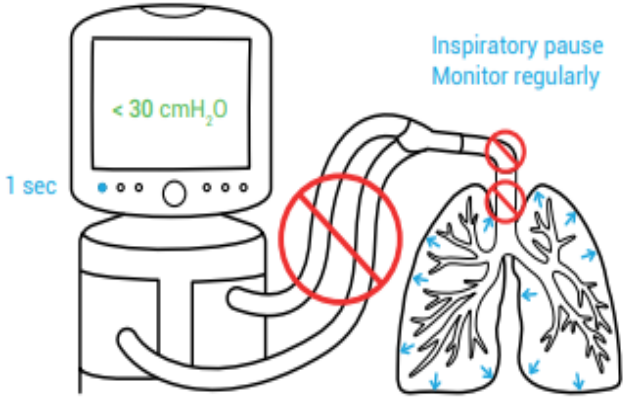
PIP should be kept below 35 cmH_2O.

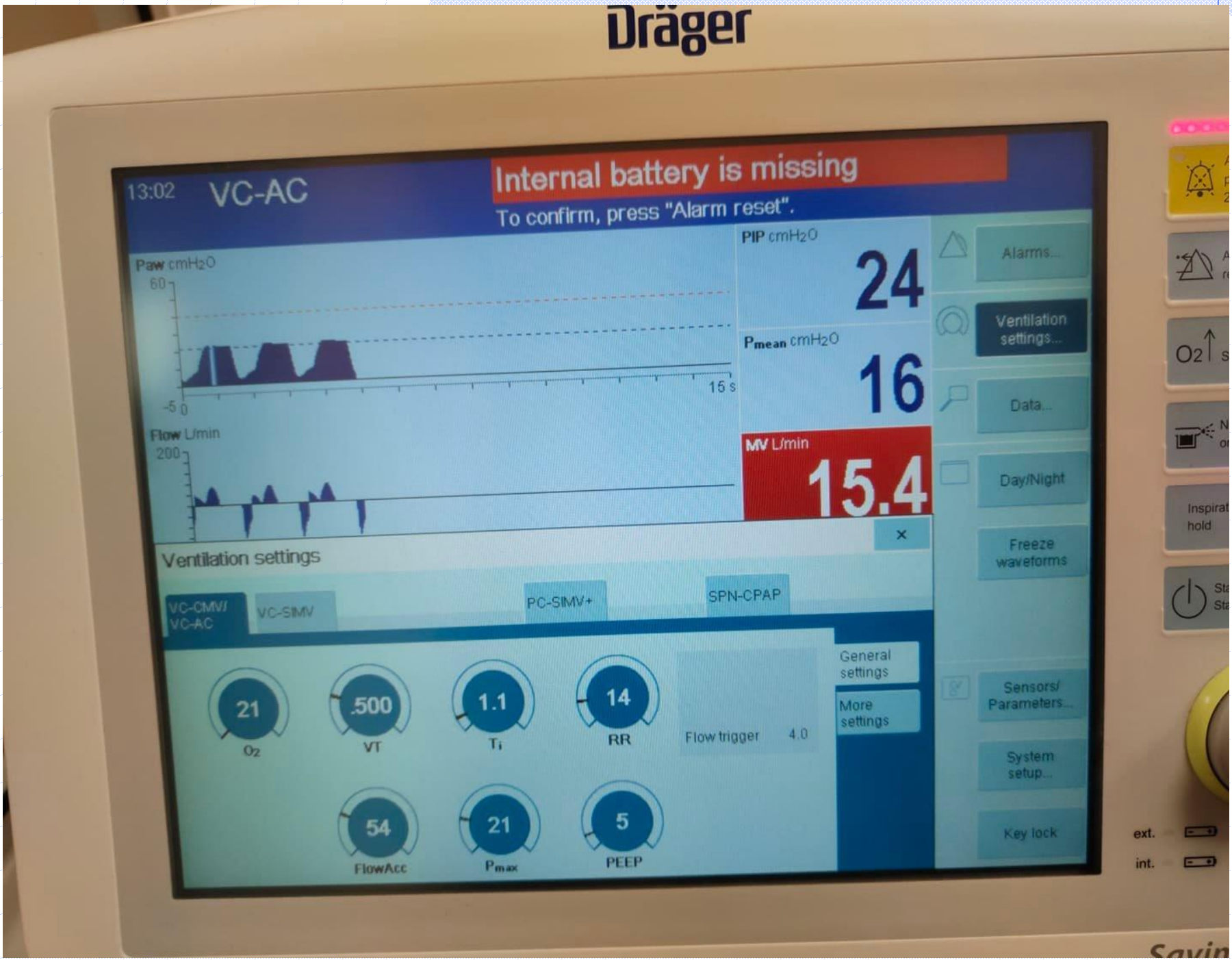


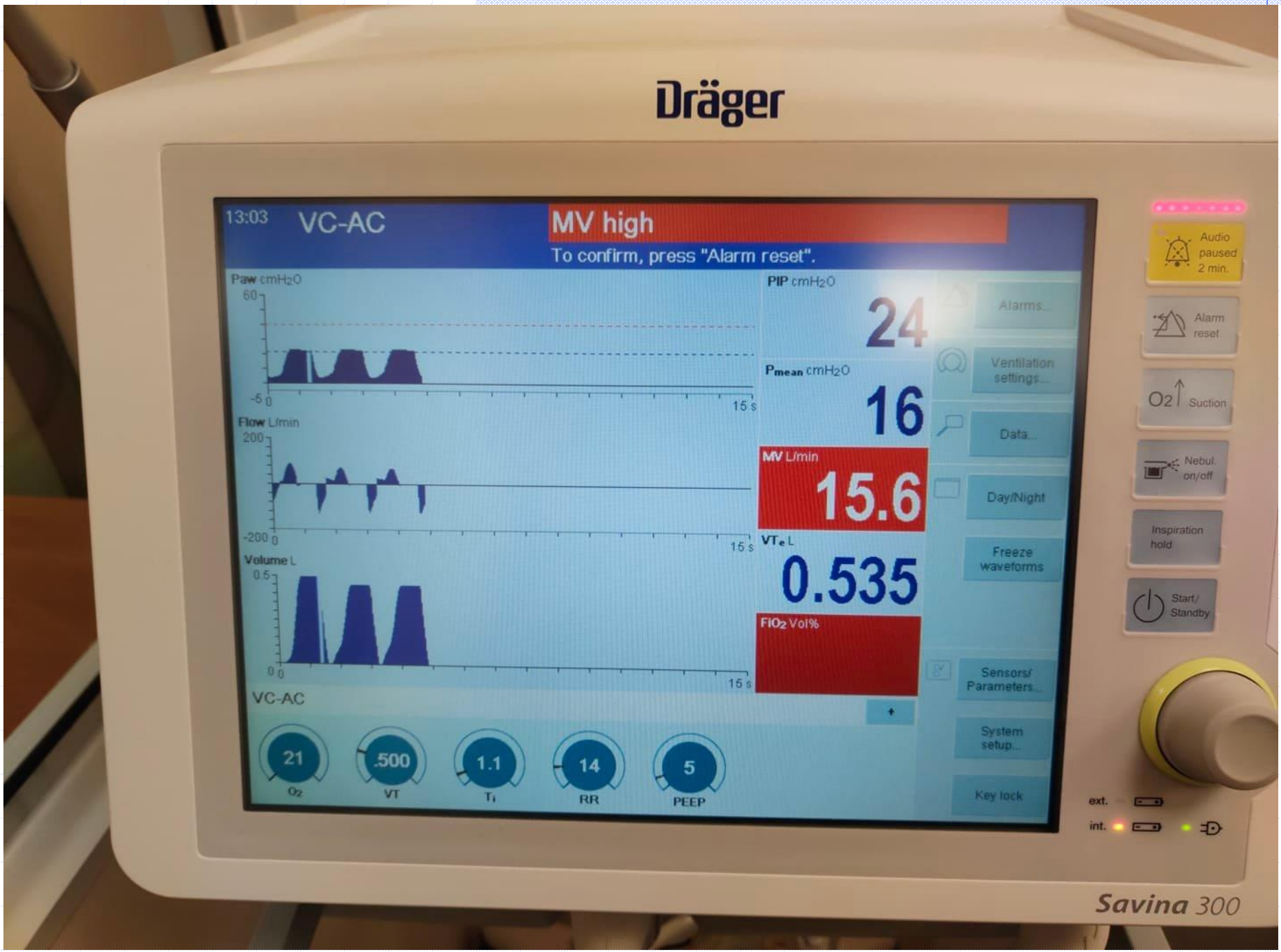
Plateau pressure

Plateau pressure is the pressure in the lungs during peak inspiratory hold.

Plateau pressure should be kept below 30 cmH_2O.




Dräger
13:02
VC-AC
Internal battery is missing
To confirm, press "Alarm reset".
Paw cmH2O
60
-5 0
15 s
Flow L/min
200
PIP cmH2O
24
Pmean cmH2O
16
MV L/min
15.4
Alarms...
Ventilation settings...
Data...
Day/Night
Freeze waveforms
Sensors/ Parameters...
System setup...
Key lock
Ventilation settings
VC-CMV/ VC-AC
VC-SIMV
PC-SIMV+
SPN-CPAP
21
O2
.500
VT
1.1
Ti
14
RR
Flow trigger 4.0
54
FlowAcc
21
Pmax
5
PEEP
General settings
More settings
ext.
int.


Dräger
13:03
VC-AC
MV high
To confirm, press "Alarm reset".
Paw cmH2O
60
-5
0
15 s
Flow L/min
200
-200
0
15 s
Volume L
0.5
0
0
15 s
VC-AC
PIP cmH2O
24
Pmean cmH2O
16
MV L/min
15.6
VTe L
0.535
FiO2 Vol%
21
O2
.500
VT
1.1
Ti
14
RR
5
PEEP
Alarms...
Ventilation settings...
Data...
Day/Night
Freeze waveforms
Sensors/ Parameters...
System setup...
Key lock
Audio paused 2 min.
Alarm reset
O2 Suction
Nebul. on/off
Inspiration hold
Start/ Standby
ext.
int.
Savina 300

Modes of Mechanical Ventilation

- Modes of mechanical ventilation describe how breaths are delivered to the patient. Modes of ventilation are classified as volume, pressure, or dual modes.

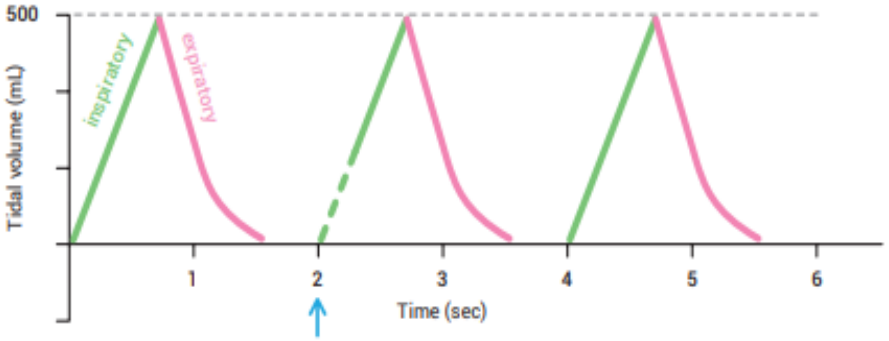
Volume Ventilation

- Assist/control (A/C)
- Synchronized intermittent mandatory ventilation (SIMV)

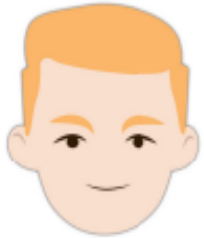
AC versus SIMV

Which initial mode of ventilation should I use?

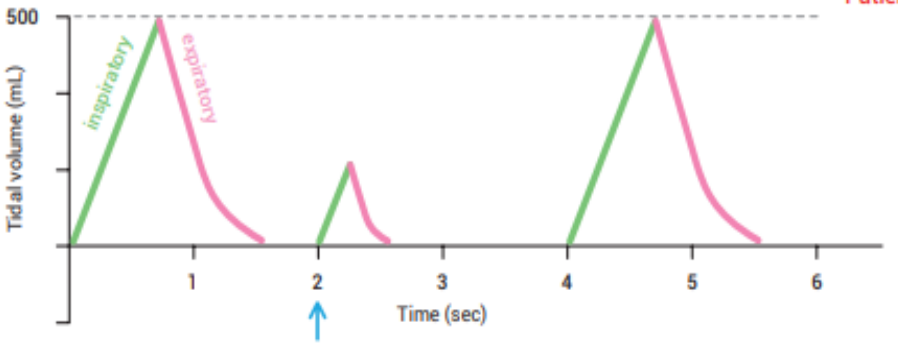
AC mode



Ideal for muscle recovery
Ventilator does work



SIMV mode



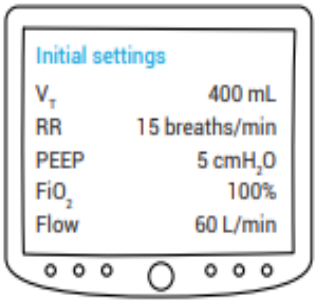
Patient responsible for breath
Hypoventilation

Respiratory rate (RR) = 15 breaths/min
Tidal volume (V_T) = 500 mL

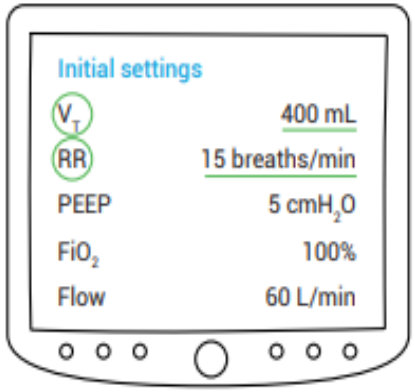
Reference:
Esteban A, Ferguson ND, Meade MO, et al. Evolution of mechanical ventilation in response to clinical research. *Am J Respir Crit Care Med*. 2008. **177**: 170–177.

Assessing ventilation

How do I assess for adequate ventilation?



65 kg



Ventilation = Removal of CO_2

Minute ventilation

= 400 mL x 15 breaths/min

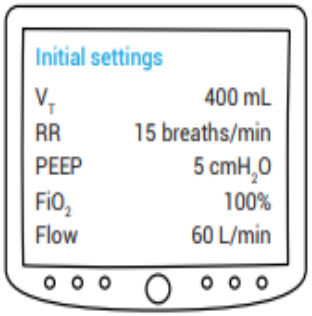
= 6 L/min → Is this adequate removal of CO_2?

Check $PaCO_2$ on ABG

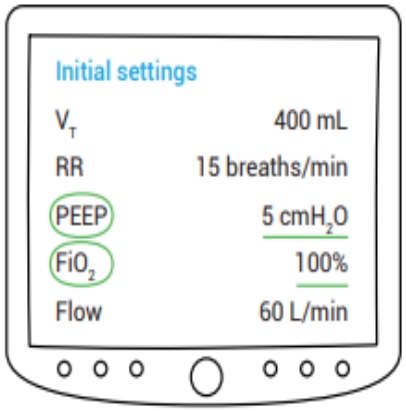
ABG results ($PaCO_2$)	Interpretation	Recommendation
35–45 mmHg	Acceptable range	Maintain settings
<35 mmHg	Hyperventilating	Decrease minute ventilation (V_T or RR)
>45 mmHg	Hypoventilating	Increase minute ventilation (V_T or RR)

Assessing oxygenation

How do I assess for adequate oxygenation?



65 kg



Is this adequate intake of O_2?

Check PaO_2 on ABG

ABG results (PaO_2)	Interpretation	Recommendation
80–100 mmHg	Acceptable range	Maintain settings
<80 mmHg	Hypoxemia	Increase FiO_2? Increase PEEP
>100 mmHg	Hyperoxemia	Reduce FiO_2

Pressure Ventilation

- In pressure ventilation the ventilator is set to allow air to flow into the lungs until a preset inspiratory pressure has been reached.
- The VT the patient receives is variable and depends on lung compliance and airway and circuit resistance

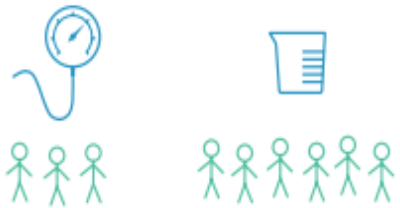
Volume versus pressure

Why volume ventilation and not pressure ventilation?

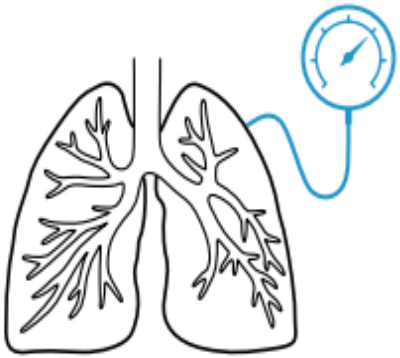
Key:
amount of CO_2 exhaled

Minute ventilation
V_T x RR

Note
Some people will still benefit from pressure, but more will benefit from volume ventilation.



Pressure



RR = 14 breaths/min
V_T = ?

Minute ventilation

= V_T x 14 breaths/min

= ?

We can't calculate minute ventilation without V_T!

Volume

RR = 14 breaths/min
V_T = 600 mL

Minute ventilation

= 0.6 L x 14 breaths/min

= 8.4 L/min

We can calculate minute ventilation to ensure enough CO_2 is exhaled.

Pressure modes

- Continuous positive airway pressure(CPAP)

-The patient must have a reliable respiratory drive and adequate VT because no mandatory breaths or other ventilatory assistance is given. The patient performs all the WOB.

-CPAP provides pressure at end expiration, which prevents alveolar collapse and improves the functional residual capacity and oxygenation.

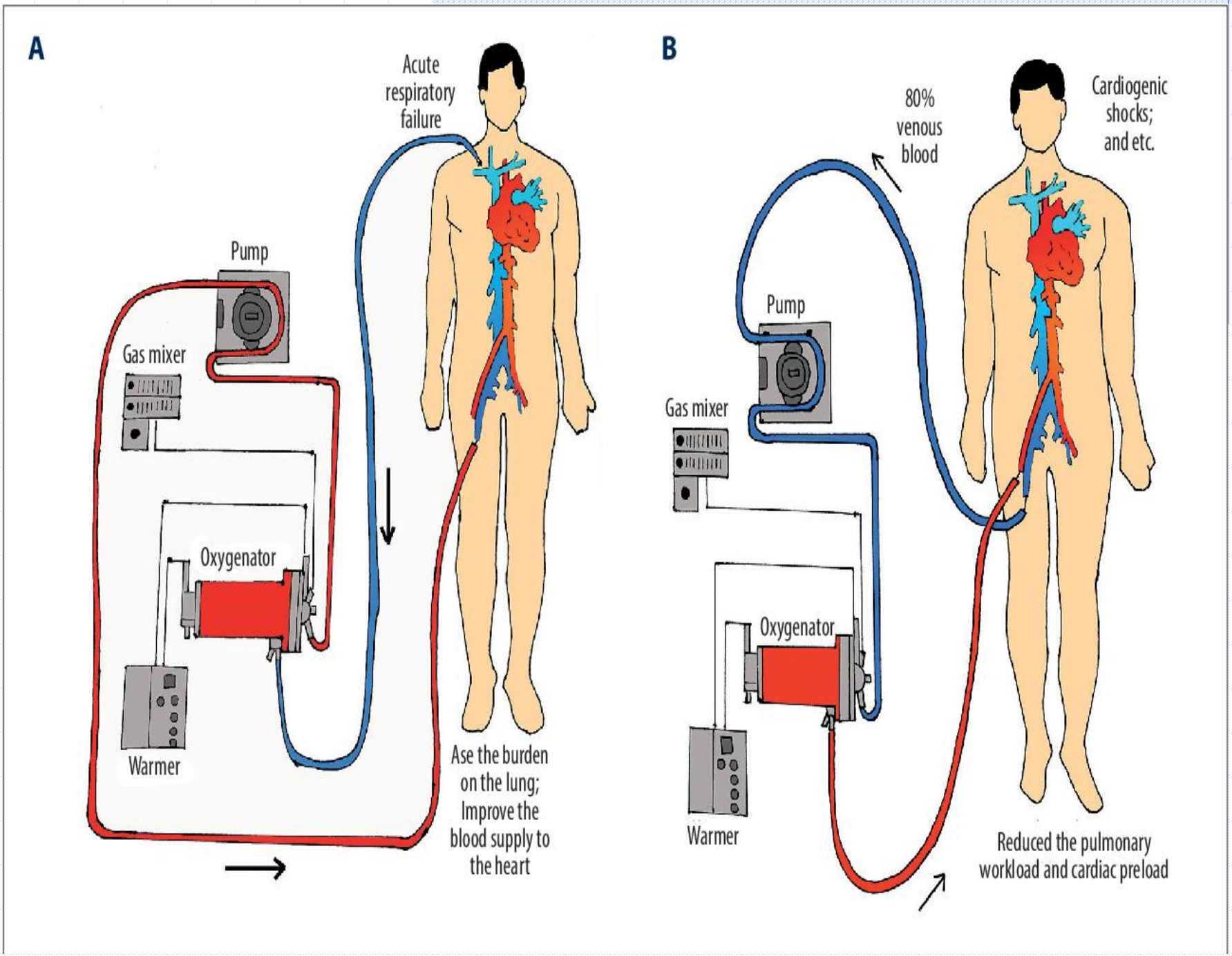
Pressure support

- The patient's spontaneous respiratory activity is augmented by the delivery of a preset amount of inspiratory positive pressure.
- PS may be used as a stand-alone mode or in combination with other modes, such as SIMV, to augment the VT of the spontaneous breaths

-Typical levels of PS ordered for the patient are 6 to 12 cm H2O

Extracorporeal membrane oxygenation

- The ECMO machine replaces the function of the heart and lungs
- ECMO is used to help people whose:
  - Lungs cannot provide enough oxygen to the body even when given extra oxygen
  - Lungs cannot get rid of carbon dioxide even with help from a mechanical ventilator


A
Acute respiratory failure
Pump
Gas mixer
Oxygenator
Warmer
Ase the burden on the lung; Improve the blood supply to the heart
B
80% venous blood
Cardiogenic shocks; and etc.
Pump
Gas mixer
Oxygenator
Warmer
Reduced the pulmonary workload and cardiac preload

Care of the Ventilated Patient

- Including analgesia , sedation & psychological support.
- Humidification.
- Physiotherapy & Tracheal suction.
- Monitoring.

Complication of Artificial Ventilation

- Inability to intubate or dislodgment or blockage of ETT.
- Prolonged intubation may lead to damage the larynx(vocal cord) so Tracheostomy performed with in 14 days and most of the perform percutaneous Tracheostomy earlier.
- VAP
- Cardiovascular problems.
- Barotraumas: effects of high pressures.
- Volume trauma.

Weaning:

- Resolution of the cause (disease) is the **most important** indicator of readiness for discontinuation.
- Level of consciousness.
- Vital signs are stable.
- Arterial blood gases are within acceptable values.

Weaning methods:

- **SIMV:** place patient on SIMV mode and decrease the rate by 2 breaths every 15-20 min or as tolerated until you reach 4-6 breaths/min.

- **CPAP:** place patient on CPAP of 5 cm H2O and pressure support of 10 for 20-30 min. If tolerated by the patient we can go ahead and extubate, otherwise place back on SIMV and attempt weaning the next day.

Spontaneous Breathing Trial (SBT):

- Another weaning method. Remove patient from ventilator and place him/her on a T-piece. Start with 5 min and work up to 20-30 min.
- The contraindication of this method for intubated patients that it increases the patients' **work of breathing**. Tracheostomy patients' can benefit from this method.

General Guidelines for weaning:

- Weaning is preferably done during the day to allow patients to rest during the night; avoid weaning during shift change.
- Do not begin weaning until evidence of significant improvement in the initial precipitating illness.
- Evaluate the ability of the patient to sustain spontaneous breathing.

weaning

- Stop or modify weaning process if distress appear.
- Do not fatigue the patient's ventilatory muscles (do not wean to exhaustion).
- Monitor clinical signs closely.


ANY
QUESTIONS?