VENTILATION
MECHANICAL VENTILATION(MV)
INVASIVE VENTILATION
NON-INVASIVE VENTILATION(NIV)

BY

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Some important topics

1. Airway resistance physiology:

*Flow
* Airway size
*Airway length

2. Total cycle time (TCT):

It's the time of inspiratory phase and expiratory phase (I time + E time = TCT).
What is the TCT if the R.R equal to 10b/min on A/C mode?
60s÷10b= 6 second and this equal to TCT.
Or if the rate is 20b/min the TCT is 3 second
But if we are in **pressure control** and the I time was 1 second and I: E ratio is 1:2 it mean the E time equal to 2 second and TCT is 3 second, in this case the rate is 20b/min.

Settings of Mechanical Ventilation

Mechanical Ventilator Settings regulates the rate, depth and other characteristics of ventilation.

Settings are based on the patient's status (ABGS, Body weight, level of consciousness and muscle strength)

phase variables

- There are four distinct phases of ventilator breath

Phase	Variable
Expiration – Inspiration	• Trigger
Inspiration	• Limit, Control
Inspiration - Expiration	• Cycle
Expiration	• Baseline

- Four parameters can be controlled or manipulated during each phase: Volume, Pressure, Flow, Time.

TRIGGER

TRIGGERING

- The ventilator needs to know when to start a breath. This is known as triggering. A ventilator breath may be triggered (initiated) by the patient (when breathing spontaneously) or triggered by the ventilator (after a set time)
- Ventilators use signals from various sites from within the ventilator circuit. The trigger signal can be sensed at the proximal endotracheal tube, in the inspiratory limb, and in the expiratory limb of the circuit. The trigger signal can be pressure, flow, time and neural signal.

- *Pressure triggering*: This requires the patient to generate a small negative inspiratory pressure (generally negative 1–3 cm H2O). This negative pressure is sensed by the ventilator, causing the ventilator to start inspiration and deliver the next breath.
- *Flow triggering*: In this a minimum of flow around 10 L/m is always present in the ventilator circuit (Bias Flow). Flow triggering occurs when a flow transducer in the patient/ventilator systems senses a change in flow i.e. flow moves in to airway opening. Usually flow trigger is kept at 2 L/m. This is the preferable triggering mode in spontaneously breathing patient.

- *Time triggering*: A breath is time triggered when the patient does not initiate a breath and ventilator delivers a breath after a set time (depends on the set respiratory rate).This is the default setting in patient who do not have spontaneous breathing effort (e.g. on neuromuscular blocker).
- *Neural triggering*: It is currently developed to minimise the delay interval between the generation of the signal to breathe in the brain (sensed by diaphragmatic muscle signals) and the actual delivery of flow from the ventilator.

LIMIT OR INSPIRATORY PHASE

This is the phase of the ventilator delivered breath that begins with the initiation of the breath, and ends when the ventilator stops inspiratory flow. Inspiratory valve is open and the expiratory valve is closed. During the inspiratory phase, air flow is determined by variables called limit variables which could be either pressure or flow. The limit variable does not terminate the inspiration; it allows inspiration to continue till the cycling criterion is reached.

CYCLING: CHANGEOVER FROM INSPIRATION TO EXPIRATION

This is known as 'cycling.' Cycling defines how the ventilator recognizes that the inspiratory phase is over, and expiration starts with opening of the expiratory valve. Ventilators may cycle (changeover to expiration) when a certain tidal volume (set inspiratory tidal volume, volume cycled), inspiratory time (time cycled), flow rate (flow cycled). Pressure controlled ventilation is time cycled, volume controlled ventilation without pause is volume cycled and Pressure support mode is flow cycled.

PARAMETERS OF MECHANICAL VENTILATION

- RESPIRATORY RATE (F) :-NORMALLY 10-20B/M
- TIDAL VOLUME (VT) :-5-15ML/KG
- OXYGEN CONCENTRATION (FIO2):-21-90%
- I:E RATIO:-1:2
- FLOW RATE:-40-100L/MIN
- SENSITIVITY/TRIGGER:- Such as 0.5-1.5 CM H2O
- PRESSURE LIMIT:-10-25CM H2O
- PEEP - USUALLY, 5-10 CMH2O
- PRESSURE MAX : USUALLY 40 H2O

Modes of Mechanical Ventilation

- Controlled Mandatory Ventilation (CMV)
- Asst-Control Mandatory Ventilation (ACV)
- Synchronized Intermittent Mandatory Ventilation(SIMV)
- Continuous Positive Airway Pressure (CPAP)
- Pressure Support Ventilation (PSV)

Controlled mandatory ventilation(CMV)

the ventilator delivers

► preset tidal volume (or pressure) at a time triggered (preset) respiratory rate.

► As the ventilator controls both tidal volume (pressure) and respiratory rate, the ventilator "controls" the patients minute volume

Controlled mandatory ventilation(CMV)

- ► Patient can not breath spontaneously
- ► Patient can not change the ventilator respiratory rate
- ► Suitable only when patient has no breathing efforts
  - ➤ Disease or
  - ➤ Under heavy sedation and muscle relaxants

Controlled mandatory ventilation (CMV)

► Asynchrony and increased work of breathing.

► Not suitable for patient who is awake or has own respiratory efforts

► Can not be used during weaning

Advantages	Disadvantages
Predictable regulation of TV, MV	Higher incidence of barotrauma, volutrauma and VILI esp in ARDS and ALI
Better control over PaCO2 than PC	During assisted breath, flow rates may be insufficient leading to dys- synchrony and auto PEEP

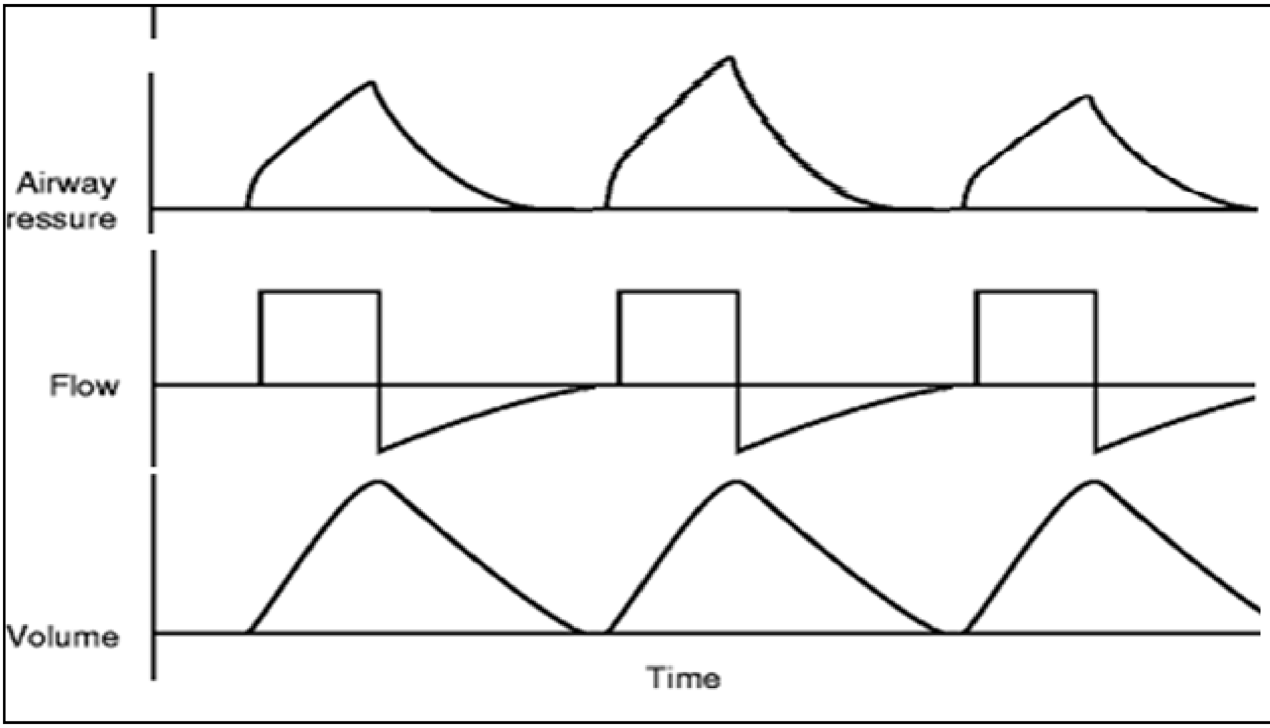
- ❖ Ventilator-induced lung injury (VILI)
- ❖ Acute respiratory distress syndrome (ARDS)
- ❖ Acute lung injury (ALI)
- ❖ Positive end-expiratory pressure (PEEP)

VOLUME CONTROL

- Settings:
  - V_T , RR, Flow/ Time and FiO2.
  - V_T set at 6 – 12 ml/kg IBW
- RR = 10 – 15 bpm
  - FiO2 lowest possible to achieve oxygenation
- I:E – 1:2 – 1:4
  - Flow rate is a measure of I:E, can be set separately in some models.

Monitoring and alarms:

- PIP relates to resistance and P_{Plat} relates to compliance.
- High pressure alarm
- Low pressure alarm 5 – 10 cm H20 below ventilating pres.
- Low pressure and volume alarms signify leak in system.



PRESSURE CONTROL

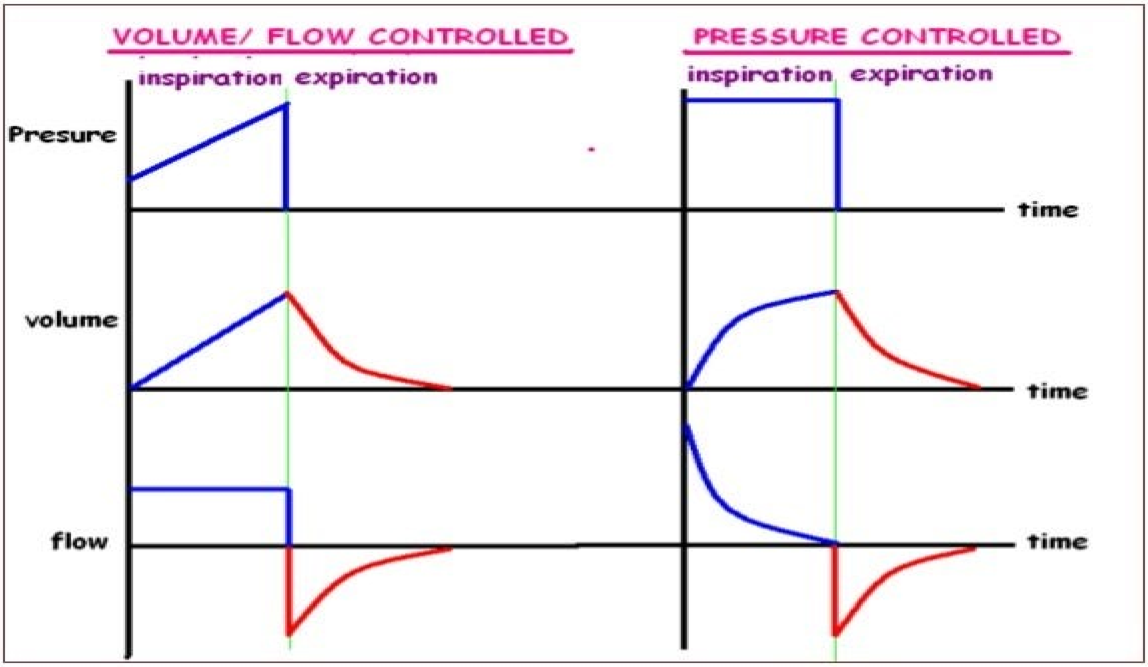
- Settings
  - Pressure - <30 cm H2O
  - RR – 10-15 bpm
  - I:E ratio: 1:2 - 1:4
  - Inspiratory time and flow rate depend on I:E ratio and RR

Advantages	Disadvantages
Avoids over distention and VILI, especially in ALI/ARDS	V_T and MV are variable, decrease in worsening conditions
Adequate flow: less flow dys- synchrony & auto PEEP	May promote hypoventilation
Time cycled: recruitment of alveoli	May cause increase in PaCO2

•Monitoring and alarms:

•Low Volume alarm: Set at the minimum acceptable V_T for the patient, signifies increased resistance or decreased compliance

•Low pressure alarm: Set at ~10 cm H2O below patients ventilation pressure, signifies leak in the system.



Important definitions:

Barotrauma: injury resulting from high airway pressure.

Volume trauma: injury resulting from high volume inside the lungs

Exhaust valve: valve in a ventilator with a bellows that allows driving gas to exit the bellows housing when it is open.

Expiratory flow time: time between the beginning and end of expiratory gas flow.

Expiratory pause time: time from the end of expiratory gas flow to the start of inspiratory flow.

Expiratory phase time: time between the start of expiratory flow and the start of inspiratory flow. It is the sum of the expiratory flow and expiratory pause times.

Con…

Inspiratory phase time: time between the start of inspiratory flow and the beginning of expiratory flow. It is the sum of the inspiratory flow and inspiratory pause times.

Inspiratory: expiratory phase time ratio (i:e ratio): ratio of the inspiratory phase time to the expiratory phase time.

Minute volume: sum of all tidal volumes within 1 minute.

Peak pressure: maximum pressure during the inspiratory phase time.

Plateau pressure: resting pressure during the inspiratory pause. Airway pressure usually falls when there is an inspiratory pause. This lower pressure is called the plateau pressure.

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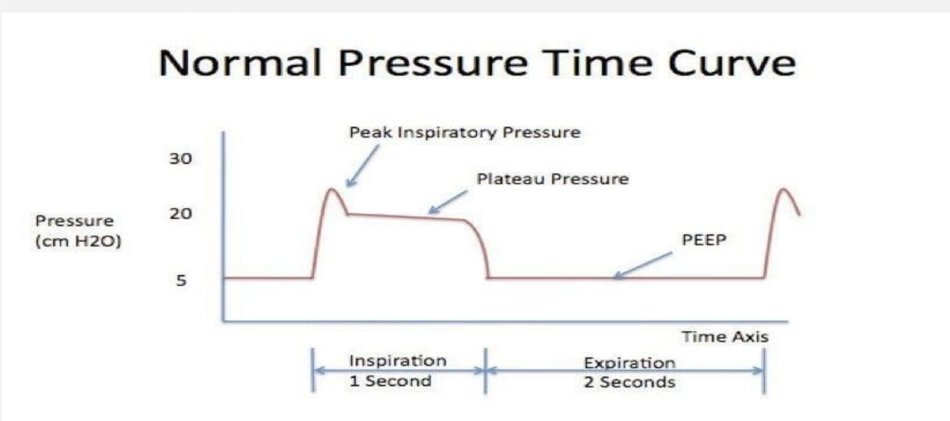
Positive end-expiratory pressure (peep): airway pressure above ambient at the end of exhalation. This term is commonly used in reference to controlled ventilation.



Thank you