BASIC OF MECANICAL VENTILATION

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Objectives

- Understand indications for mechanical ventilation
- Learn ventilator settings & modes
- Recognize complications
- Review weaning strategies

- Mechanical ventilation is a technique used to assist or replace spontaneous breathing.

- It is a cornerstone of modern anesthesia, intensive care, and critical emergency support.

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Goals

To provide adequate oxygenation.

To remove carbon dioxide.

To decrease the work of breathing.

To allow time for treatment of the underlying condition.

- Oxygenation: exactly that, the transfer of oxygen from the air we breathe to the blood.
- Ventilation: the transfer of CO2 from the blood to the alveoli and out of the body An normal breathing is a negative-pressure phenomenon;
- mechanical ventilation is POSITIVE pressure ventilation.

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why?

1. Airway protection (this is not ‘respiratory failure’: this implies no derangements in gas exchange, but a CNS or mechanical loss of airway protection/patency)

2. Hypoxic respiratory failure $pO_2 < 50$ on 100% NRB Decreased ambient FiO_2, Increased pCO_2, Diffusion block, V/Q mismatch, Right-to-left shunt

3. Hypercarbic respiratory failure $pH < 7.30$. $pCO_2 > 50$ Acute versus chronic; Won’t

Volume control

Pressure control

Positive vs Negative Pressure

Positive Pressure: pushes air into lungs (most common)

Negative Pressure: sub-atmospheric chest pressure (rare)

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Essential Ventilator Settings

Tidal Volume (VT): 6–8 mL/kg (lower in ARDS: 4–6 mL/kg).

Respiratory Rate (RR): 12–20 breaths/min.

FiO_2: Start high, then titrate to SpO_2 > 92%.

PEEP (Positive End-Expiratory Pressure): Prevents alveolar collapse.

I:E Ratio: Normally 1:2, adjust in obstructive/restrictive disease.

Trigger Sensitivity: Controls patient–ventilator synchrony.

- Inspiratory time / I:E ratio.
- Peak flow.
- Flow pattern (square, descending ramp, ascending ramp, sine wave).
- Upper pressure limit.

Monitoring & Alarms

- **Monitored parameters:** SpO_2, $EtCO_2$, ABG, airway pressures.
- **Peak Inspiratory Pressure (PIP):** High → obstruction or resistance.
- **Plateau Pressure:** Reflects alveolar pressure.

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PEAK and PLATEAU PRESSURES

- PEAK: this is dynamic compliance and reflects resistance from conducting airways -

PLATEAU: this is static compliance and reflects resistance from stiff parenchyma --

- High Peak, Normal Plateau: kink in tubing, patient biting ET tube, aggregated secretions, mainstem bronchus intubation, asthma, COPD.

- High Peak, High Plateau: pulmonary edema, pneumonia, ARDS, hemorrhage - Remember extra-parenchymal processes as well (e.g., eschar formation in massive chest wall burn victims).

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Alarms:

- High pressure → obstruction, coughing, bronchospasm.
- Low volume → leak, disconnection.
- Apnea → no spontaneous breaths.

Mode of ventilation

- It is the specific set of rules or algorithms a mechanical ventilator uses to deliver breaths by controlling how **pressure, volume, and flow** are managed throughout the respiratory cycle.
- These modes dictate the **type** of breath (controlled, assist, spontaneous), the **cycle** variable (volume-cycled, pressure-cycled), and the sequencing of breaths to support or replace a patient's own breathing efforts and ensure proper gas exchange.

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Ventilation Modes Overview

- CMV – full control, no spontaneous breathing
- AC – patient triggers preset volume
- SIMV – combines mandatory + spontaneous breaths
- PSV – supports spontaneous effort
- PCV – pressure limited, variable VT

Assist-Control Ventilation

Patient-triggered; delivers preset VT

Useful for fatigued patients

Risk of respiratory alkalosis

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SIMV + Pressure Support

- Combines mandatory & spontaneous breaths
- Reduces work of breathing
- Ideal for weaning

Pressure-Control Ventilation

- Fixed inspiratory pressure, variable VT
- Preferred in ARDS
- Reduces barotrauma risk

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Advanced Modes

- IRV: inverse I:E improves oxygenation
- APRV: spontaneous breathing at high PEEP
- HFJV/HFO: tiny VT at high frequency

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Complications of Mechanical Ventilation

Barotrauma: Pneumothorax, subcutaneous emphysema.

Volutrauma: Alveolar overdistension.

Atelectrauma: Repeated alveolar collapse/reopening.

Ventilator-associated pneumonia (VAP).

Hemodynamic compromise (reduced venous return due to high intrathoracic pressure).

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Troubleshooting (DOPE Mnemonic)

- **D**isplacement of tube.
- **O**bstruction (secretions, kink).
- **P**neumothorax.
- **E**quipment failure.

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weaning

Weaning" implies the gradual reduction of ventilatory support (increased work by the patient), either through decreasing the number of machine breaths on IMV or by decreasing the amount of pressure support on PSV.

Weaning begins when we believe that the patient has recovered adequately from acute respiratory failure.

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Criteria for starting weaning:

- Stable hemodynamics
- Adequate gas exchange
- Improving disease

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Spontaneous Breathing Trial (SBT): Using T-piece or low PSV.

Extubation: Only if patient can protect airway and breathe spontaneously

THANK YOU

ANY QUESTION???