MECHANICAL VENTILATION

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RESPIRATORY ACID

BASE ABNORMALITIES

❖ **Respiratory acidosis " alveolar hypoventilation ":**

- **Failure of the lung to eliminate metabolically produced carbon dioxide for what ever reason.**

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Causes

- **CNS: Depression of respiratory center.**
- **Neuromuscular condition**
- **Guillian – Barre syndrome, Mysthenia Gravis.**
- **C.O.P.D. → Br. Asthma.**
- **Drugs such as narcotics, anesthetics, and sedatives**
- **A.R.D.S.**
- **C.H.F. with pulmonary edema.**
- **Mechanical ventilation**

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Clinical picture (Resp. Acidosis)

- **Hypercapnia : Too much carbon dioxide in the blood.**
- **Acute hypercapnia usually associated with hypoxemia which dominate the clinically present:-**
  - **Altered neurological function; restlessness, irritability, headache (related to ↑ blood flow due to vasodilatation of cerebral vasculature to hypercapnia), drowsiness, confusion, coma.**
- **Weakness and tremors. Tachypnea and dyspnea.**
- **Cardiac dysrrhythmia.**
- **ABGs shows: pH < 7.35, $PaCO_2$ > 45mm Hg & HCO_3 ≥ 26mEq/L**

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Management (Resp. Acidosis)

- Treatment of respiratory acidosis is designed to correct the underlying source of alveolar hypoventilation, it may include:

  - Mechanical ventilation.
  - Dialysis to remove toxic drugs.
  - Oxygen as indicated by ABGs analysis.
  - $NaHCO_3$ to correct acidosis.
  - Close monitoring of electrolytes.

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RESPIRATORY ALKALOSIS

" Alveolar Hyperventilation "

- It is caused by a process that reduces the **CO2** in the blood,
- decreasing it's **hydrogen** ion concentration with consequent **↑ PH > 7.45** .

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CAUSES

- **CNS → Dysfunction of respiratory center :**
  - **Head trauma , Fever, and Aspirin toxicity**
  - **Altered pulmonary function**
  - **Pneumonia, and Pulmonary embolism**
  - **Mechanical ventilation and Hypoxia.**
  - **Sepsis.**

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CLINICAL PICTURE (RESPIRATORY ALKALOSIS)

- **Acute hypocapnia manifested by the following:**
  - **Deep, rapid breathing, possibly exceeding 40 breaths/m.**
  - **Dizziness (↓cerebral blood flow)**
  - **Muscle weakness.**
  - **Seizure (sever respiratory alkalosis)**
  - **Carpopedal spasms (spasms in wrist and foot)**
  - **ABGs shows: PH < 7.35, $PaCO_2$ > 45mm Hg, & $HCO_3 \geq 26mEq/L$**

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MANAGEMENT
(Respiratory alkalosis)

- **Treatment seeks to eradicate the underlying condition (correct the cause) it may include:**
  - **Removal of ingested toxins.**
  - **Treatment of CNS disease.**
  - **Treatment of fever or sepsis.**
  - **Oxygen to correct hypoxia.**
  - **In sever alkalosis: having the patient breathe into a paper bag, which helps relieve acute anxiety and increases Co2 level.**

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Metabolic acidosis

" Increase hydrogen ion concentration with decreased bicarbonate ion concentration, resulting in a **decrease** in **pH < 7.35** "

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CAUSES OF METABOLIC ACIDOSIS

- 1. Diabetic ketoacidosis
- 2. Chronic Alcholism
- 3. Shock & cardiac arrest
- 4. Salicylate poisoning
- 5. Renal Failure
- 6. Diarrhea (intestinal fluid has high HCO3 content)
- 7. Diamox therapy
- 8. Pancreatic drainage

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CLINICAL PICTURE (METABOLIC ACIDOSIS)

- Headache, change in level of consciousness, drowsiness, confusion and coma.
- Depressed cardiac function and dysarhythmia, decreased peripheral vascular resistance with hypotension, shock and hypoxia.
- Deep rapid breathing, evident when HCO < 15 mEq/L.
- Nausea, vomiting and anorexia.
- ABGs shows: pH < 7.35, $PaCO_2$ ↓ or normal , HCO_3< 20 mEq/L

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Management (Metabolic acidosis)

- Mechanical ventilation to ensure adequate respiratory compensation (in sever case).
- In sever condition (pH < 7.2) require sod. Bicarb. IV to ↑ pH > 7.2 and HCO3 level > 15 mEq/L.
- In DKA cases, watch for secondary changes due to hypovolemia "↓ BP" to prevent complication of hypoperfusion.
- Watch for signs of excessive K:
- weakness, flaccid paralysis and arhythmias possible leading to cardiac arrest.

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Metabolic Alkalosis

- " Caused by a process that increasing bicarbonate ions concentration or decrease hydrogen ion concentration with consequent ↑ in pH >7.45 ".

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CAUSES

- **Fluid loss of U.G.I.T.:**
- **Vomiting.**
- **Contineous N.G.T. suction.**
- **Rapid correction of chronic hypercapnea.**
- **Diuratic therapy (loss of K+, H+, Na+ ions > HCO3).**
- **Alkali administration.**
- **There is no specific s & s to this disorder.**
- **A history of vomiting, diuretic usage and complaints of weakness may provide important clues.**

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MECHANICAL VENTILATION

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MECHANICAL VENTILATION

- **M.V.** can maintain ventilation automatically for the prolonged period of time. It is indicated when the patient is unable to **maintain** safe level of **oxygen** and **carbon dioxide** by spontaneous breathing even with the assistance of the oxygen delivery device.

- A ventilator is a life support device -- a system of essential elements designed to augment or totally support cardio-respiratory function (i.e., **ventilation, oxygenation, and CO2 excretion**) in a pre-determined manner for an indeterminate amount of time.

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Goals of mechanical ventilation

- The basic effects of mechanical ventilation are improved oxygenation and carbon dioxide elimination
- Maintaining alveolar ventilation (i.e. Co2↓).
- Give the oxygen therapy.
- Administered gas under pressure to increase lung volume and reduce area of atelectasis
- Maintain elective PEEP to prevent closure or collapse of small airway.
- Reducing the work of breathing.

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INDICATIONS FOR M.V.

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1. Respiratory Failure

- **Apnea / Respiratory Arrest**
- **Inadequate ventilation (acute vs. chronic)**
- **Inadequate oxygenation**
- **Chronic respiratory insufficiency.**

- ***Patients are often (ideally) intubated before they reach the point of respiratory failure.***
- ***Respiratory distress can be due to inadequate ventilation, oxygenation or a combination thereof.***

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2. Cardiac Insufficiency

- **Eliminate work of breathing**
- **Reduce oxygen consumption**
- ***Not every patient who is intubated has a primary pulmonary pathology.***
- ***For patients in cardiogenic shock or with CHF, the demands of the respiratory system may precipitate cardiovascular collapse.***
- ***Supporting the patient with mechanical ventilation can reduce the demands on the heart, allowing it to recover.***

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3. Neurologic dysfunction

- **Central hypoventilation/ frequent apnea**
- **Patient comatose, GCS ≤ 8**
- **Inability to protect airway**

- ***Intubation can also serve to protect the airway for those who cannot do it themselves.***
- ***Mechanical ventilation offers the option of hyperventilation for patients with intracranial hypertension.***

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Process of Ventilation

- Movement of the diaphragm
- Changes in the transpulmonary pressure
- Lung compliance
- Airway resistance

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Modes of ventilation

- Controlled Mandatory Ventilation (CMV)
- Assisted Controlled Ventilation (ACV)
- Intermittent Mandatory Ventilation (IMV)
- Synchronized Intermittent Mandatory Ventilation (SIMV)
- Positive end-expiratory pressure (PEEP)
- Continuous positive airway pressure (CPAP)

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Phase Variables

- **Trigger (start)- begins inspiratory flow**
- **Who initiate breathing??**

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Controlled Mandatory Ventilation (CMV)

❖**CMV:** The ventilator delivers the predetermined volumes at the present rate without any participation of the patient.

❖ **Advantages**

- Assured minute ventilation or peak pressure

❖ **Disadvantages**

- No patient interaction. The patient can not initiate a breath.

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Assisted Controlled Ventilation (ACV)

- ACV allow the patient to control the rate of breathing.
- Patient initiating breath while assuring that the preset rate and volume are delivered.
- The patient negative aspiratory effort causes the machine to cycle & deliver the preset tidal volume.
- Thus assisting the breathing.

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Intermittent Mandatory Ventilation (IMV)

- IMV assures the patient of a preset number of mechanical breathing of the preset volume while allowing the patient to take breaths at his own rat and volume between the mandatory intervals.
- Pt. breaths spontaneous at any tidal volume between the mechanical breaths.
- Primary disadvantage is chance for breath stacking, therefore care should be taken to set high pressure limit properly to reduce risk of barotrauma.

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Synchronized Intermittent Mandatory Ventilation (SIMV)

- The ventilator delivers a pre-determined V_T (volume or pressure targeted) at a preset frequency and allows the patient to take spontaneous breaths between ventilator breaths. Spontaneous breaths may be augmented with pressure support.

- A mode in which the vent. delivers mandatory breaths to the pt. at or near the beginning of a spontaneous breath, mandatory breaths are synchronized with the pt.'s spontaneous efforts to avoid breath stacking
- Advantage: Preserves muscles of breathing.

- "synchronized window" refers to the time just prior to time triggering in which the vent. is responsive to the pt.'s effort

(0.5 sec is typical).

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Continuous Positive Airway Pressure (CPAP)

- **CPAP increase the amount of air remaining in the lungs at the end of expiration in the spontaneous breathing patient.**

- **CPAP is simply a spontaneous breath mode, with the baseline pressure elevated above zero.**

- **Advantages:**
  - **Improves oxygenation**
  - **Increased lung compliance**

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TYPES OF VENTILATORS

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A) Negative Pressure Ventilators

- **Applies negative pressure** around the chest wall. This causes intra airway pressure to become negative. Thus drawing air into the lungs through the patients nose and mouth.
- **No artificial airway is necessary** – patient must be able to control and protect own airway.
- Indication *Selected patient with neuromuscular problems.
- **Negative pressure ventilators** are simply to use and do not require intubation of the airway.

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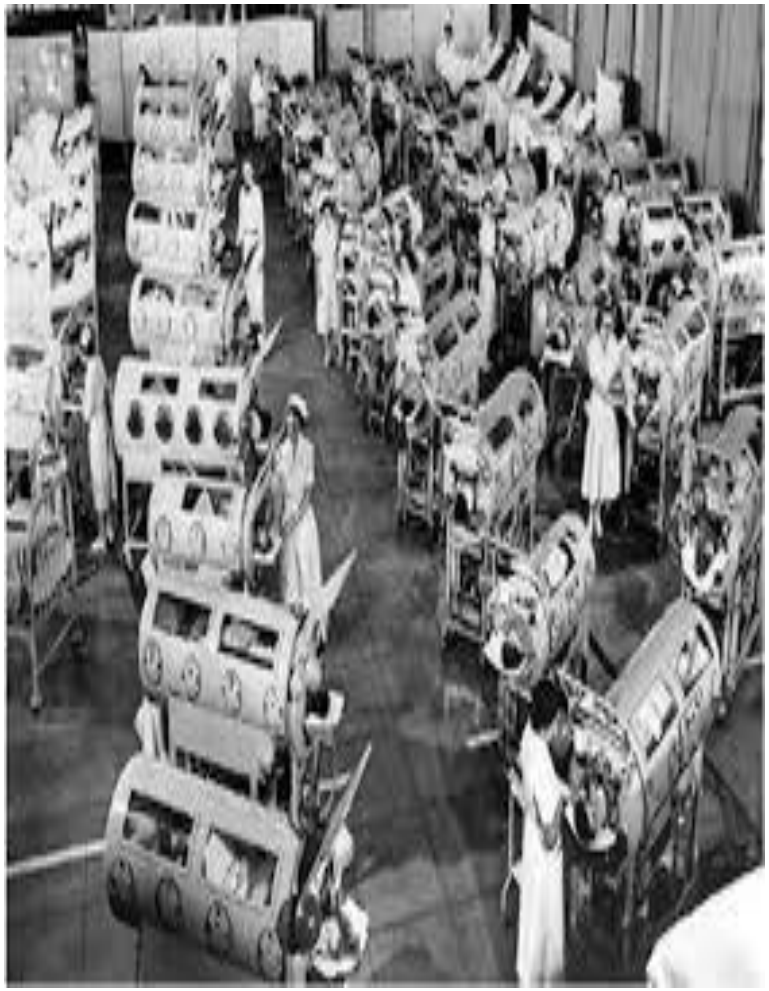

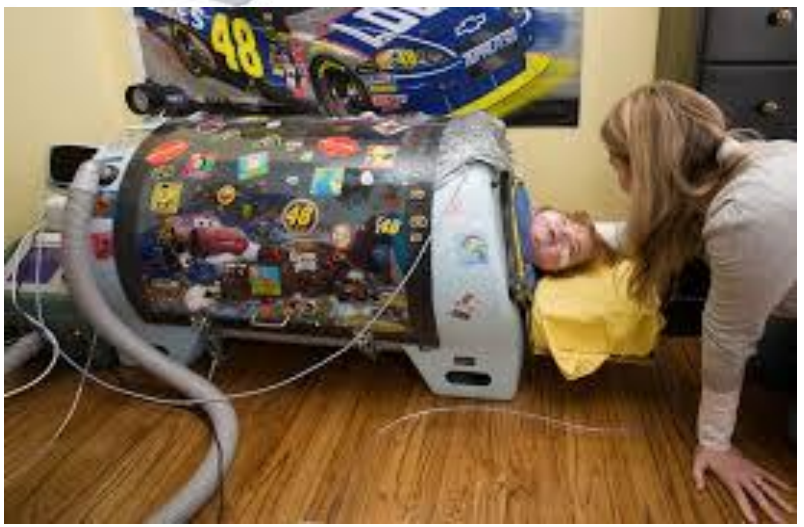

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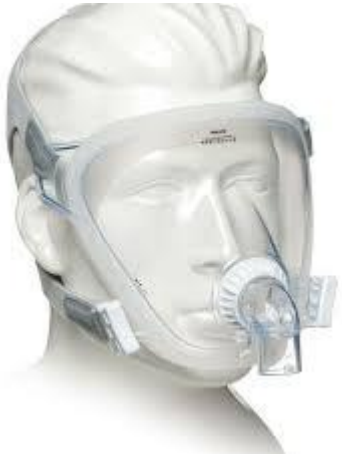
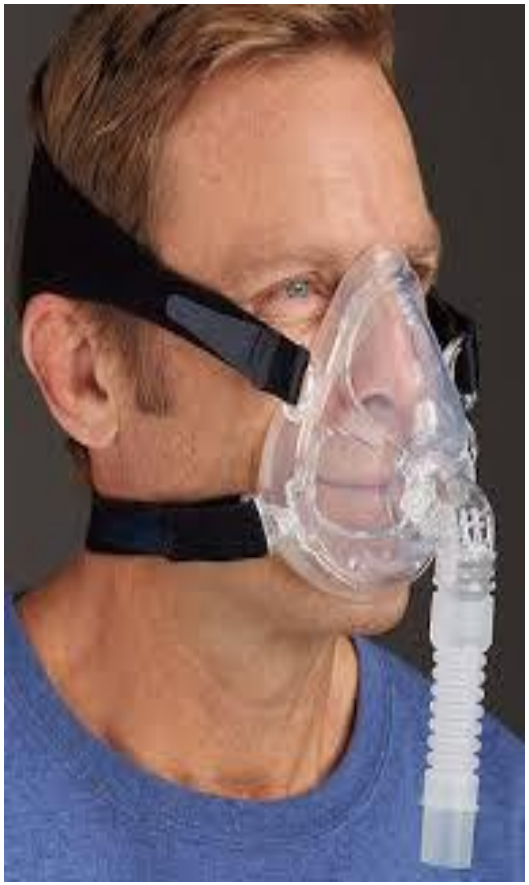
CPAP Mask





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B) Positive Pressure Ventilators:

- **Positive pressure ventilators inflate the lungs by exerting positive to pressure on the airway, forcing the alveoli to expand during inspiration.**
- **Expiration occurs passively, endotracheal intubation or trachestomy is necessary in most cases**
- **These ventilators are widely used in the hospital setting.**
- **There are Three types of positive pressure ventilators:**
  - **Pressure cycled**
  - **Time cycled**
  - **Volume cycled**

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1. Pressure Cycled Ventilation

- **The ventilator cycles on, delivers a flow of air until it reaches a predetermined pressure, then cycles off.**
- **Limitation: volume of air and O2 are vary as the patient airway resistant.**
- **Tidal volume may be inconsistent.**

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2. Time Cycled Ventilators

- **Time cycled ventilators control inspiration after a preset time.**
- **The volume of air patient receives is regulated by the length of inspiration and flow rate of the air.**
- **These ventilators are used in newborns and infant.**

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3. Volume Cycled Ventilators

- **Volume cycled ventilators are by far the most commonly used positive pressure ventilators today.**
- **The volume of air to be delivered with each inspiration is preset. Once the preset volume is delivered to the patient, the ventilator cycles off and exhalation occurs passively.**
- **The volume of air is relatively constant.**

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Ventilator Control
Guidelines for adjustment

- Respiratory rate (RR), Tidal Volume (Vt), and oxygen concentration of inspired oxygen.
- Time relationship between inspiratory and expiratoy phases (I: E ratio).
- Fio_2 Fraction
- Before setting up the machine, a total clinical assessment must be performed to identify indicators for mechanical ventilation and to establish data.
- The patient ventilatory capacity, ABGs values, and laboratory data, together with clinical history and physical examination, all aid in decision making process. `

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VENTILATOR SETTINGS

- FiO_2: Fraction of inspired oxygen
- Respiratory rate
- Tidal volume
- Minute Volume
- Peak flow
- Pressure limit
- Sensitivity

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FRACTION OF INSPIRED OXYGEN (FIO2)

- adjusted to achieve PaO2 more than 60 mmHg them do ABGs
- change by ABG and O_2 saturation

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RESPIRATORY RATE

- the frequency of breaths delivered by the ventilator
- start with a rate that is somewhat normal; i.e., 10-16 breath/m for adolescent/child, 20-30 breath/m for infant/small child.

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MINUTE VOLUME VE

Minute volume = RR X Tidal volume.

Ventilatory Mode

- **CMV, IMV, SIMV, A/C, PCV**
- **Is SIMV better than CMC, AMV?**
- **No, use mode your comfortable with patient**

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Inspiratory: Expiratory Ratio (I : E Ratio)

- **usually set at 1 : 2, may be manipulated to facilitate gas exchange**

❖**Sensitivity**

- **used to determine the patient's effort to initiate an assisted breath (inspiration)**

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SIGH

- may be included as part of the ventilator settings.
- a breath that has a greater volume than the preset V_T , usually 1.5 to 2.0 times the V_T
- The usual sigh rate is established at frequency of 5-10 minutes intervals.

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PEAK INSPIRATORY PRESSURE (PIP)

- Peak pressure registered in the airway during normal ventilation.
- Value used to set high and low pressure alarm limits.

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PRESSURE LIMITS

- High pressure limit is the maximum pressure the ventilator can generate to deliver the preset V_T
- Usually set 10 - 20 cm H_2O above the PIP

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ALARMS

VENTILATOR ALARMS MUST NEVER BE IGNORED OR DISARMED!!!!

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Which parameters need to be adjusted to improve oxygenation?

- Increasing the FiO2
- Increasing the level of the PEEP
- Increasing the I:E ratio

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Which parameters need to be adjusted to improve ventilation?

- **Ventilation (the ability to 'blow off 'CO2) may be improved by**
  - **Increasing the respiratory rate**
  - **Increasing the tidal volume**
  - **Increasing the peak pressure**

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