Mechanical Ventilation

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Definition of ventilation
- It's the term for the movement of air into and out of the alveoli.

Mechanism of Breathing
- Air moves from high pressure to low pressure area.
- Respiratory muscles are controlled by the nervous system.
- The respiration centers are in the pons and medulla oblongata.
- The main respiratory muscles are the diaphragm inferior to the lungs and the external and internal intercostal muscles between the ribs.
- Accessory muscles of respiration are used during exercise and times of respiratory distress and these include sternocleidomastoid, scalene muscles and abdominal musculature.

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Definition of Mechanical Ventilator

It's a machine that helps people breathe when they are not able to breathe enough on their own.

Benefits
1. Forced / Enhanced lung expansion.
2. Improve gas exchange (Oxygenation).
3. Decrease work of breathing.

Mechanical Ventilation can be delivered via:
1. An Endotracheal tube → invasive
2. A Tracheostomy tube → invasive
3. A Nasal or face mask → non-invasive
   CPAP / BiPAP

Indications
1. Respiratory Failure \([\text{SaO}_2 < 60\%]\)

   - Hypoxemia
   - Central cyanosis

   Increase work of breathing → Tachypnea
   Hypoventilation with respiratory acidosis → Bradypnea

2. Airway trauma
3. Exacerbation of COPD
   ← al-akhraz ṭaṣṣā ḥarūs → narrowing of the airway
4. Head injuries, cerebrovascular accident or Coma "GCS < 8"

   • Edema
   • Brain Edema
   • Respiratory Centers
   • Acute acid-base disturbance
   • Coma

   - Patient will be intubated and placed on mechanical ventilation.

5. Neurological disorders [autoimmune disease]

   "Multiple sclerosis, Myasthenia gravis, Guillain Barre's Syndrome" Chronic
   - Exacerbation

6. Obstructive sleep apnea.

7. Respiratory support while:
   - Under general anesthesia.
   - Heavy sedation.
   - Muscle relaxant.
Types of positive pressure Ventilators:

1. Pressure Cycled Ventilators
   - Pressure or Resistance
   - Narrowing

2. Time Cycled Ventilators
   - Physician
   - Released

3. Volume Cycled Ventilators
   - Passively
   - 3 cycles in expiration

Ventilator Settings:

1. Tidal Volume (VT)
   - The amount of air inhaled in one inspiration
   - 6 to 8 ml/kg
   - 5 to 7 ml/kg
2. Fraction of inspired oxygen (\(F_{102}\))
   - The percent of oxygen in each inspired breath (%).
   - According to patient condition
   - ABG
   - \(F_{102}\) increases
   - \(O_2\) decreases

3. Respiratory Rate
   - The number of breaths per minute that the ventilator delivers to patient.
   - 1 min normal 16
   - Bradypnea
   - Tachypnea

4. Minute Ventilation
   - The total amount of air moving in and out of the lung in one minute equal to:
   - \((Tidal\;Volume \times \text{Respiratory Rate})\)
5 Positive End-Expiratory Pressure (PEEP)
- Residual air in the alveoli after expiration to keep it open and prevent collapsed alveoli.

2 - 6 mmHg most Common

Expiration

6 Inspiration to Expiration Ratio (I/E)
- Length of inspiration when it compared with Expiration. [I/E 1:2]

Inspiration | Expiration
1 sec | 2 sec
2 | 4
4 | 8
8 | 16
Modes of Mechanical Ventilator

1. Controlled Mechanical Ventilation (CMV)
   - Machine controls rate of breathing. Delivery of preset Volume "TV" and rate regardless of patient's breathing pattern. Sedation or paralyzing agent usually required.
   - The machine is totally controlled on patient.
   - The patient is totally dependent on machine.

   أولاً نقع تدفق الهواء (إطبار)
   - مبسط فتحات الزراعة للمرتين القضاء إلى الفرناني مفصل ياما نفسه
   - يستعمل على مية ما زالت مفتوح الأعداد

   في فم الالات

1. Deep Coma
2. Under general anasthesia
3. Muscle Relaxant

   حي الله أولاً مفصليا للكريات إشارة إلى الفرن
   - لو الحرفية فان وحاسات ينفق أطبار مبسط فتحات في الحالة دى
   - الفرن في ميد مع كرير مصلح راكون

1. Sedation
2. Change modes

يفهم حالة الفرن

With You Step By Step
Assist - Control (A/C) Ventilation

Provides full ventilatory support by delivering a preset tidal volume and respiratory rate. If the patient initiates a breath between the machine's breaths, the ventilator delivers at the preset volume.

Controlled

Time trigger

Patient trigger

Expiration

Assisted breath according to Ventilator Settings

1. Sedation
2. Change mode
3. Synchronized intermittent mandatory ventilation (SIMV)
   - سامحة
   - لأول سرطان الجهاز على حسب ما أشاره المراقب (T.V)
   - الوقت الفاصل بين التنفسين (T.I) يحدد المريض
   - كأس على عدد قدرة الجهاز.

4. Assisted breath according to patient's ability
   - لو هو المريض أضا 100، يبقى سرطان 100 والجهاز من هزاز على المريض.
   - Controlled breath is a term used for assisted breath.
   - سماح إلى مساحة تنفس وتهوية صغير (alarms) وصيغة صغيرة لمسار على المريض.
   - لمدة 1 min.

   بعد الدقائق للجهاز هزاز لمسار وتهوية مدة أغلب الأوقات.
   - [low minute ventilation] alarm
   - لو المريض حدا أقل من هذه مدة منخفضة تتطلب صيغة "T.V".
   - ود (R.R) ود (R.R) صيغة صغير للسريع.
   - ترى حاله لو الجهاز عمل "alarms" لكل صيغة.

1. Sedation
2. Change mode

SIMV هذه القضاء إلى ما بقيته من الفرعين تمامًا.
Continuous Positive Airway Pressure (CPAP)

This mode can be invasive or non-invasive. In which maintains positive pressure throughout the respiratory cycle of a spontaneously breathing patient.

Indications of COPD

1. Obstructive sleep apnea.
2. To postpone intubation.
3. To treat acute exacerbations of COPD.

- Tidal Volume
- Respiratory Rate

Airway pressure

- Mild pressure
- High pressure

Continuous pressure

Lo سبأ سبأ CPAP mới المستخدم
Lo ضعيف ضعيف HPB أو بقلة ضعع أغلب LO وضع
- Non-invasive
- invasive

Invasive → CMV
Lo السبأ السبأ ضعع ضعع أغلب LO وضع
- Non-invasive

Lo ضعيف ضعيف HPB أو بقلة ضعع أغلب LO وضع
- Infection

Lo ضعيف ضعيف HPB أو بقلة ضعع أغلب LO وضع
5. Bi-level Positive Airway Pressure (BiPAP)
   - Same as CPAP but settings can be adjusted for both inspiration and expiration.

6. Pressure Support Ventilation (PSV)
   - Patient's inspiratory effort is assisted by the ventilator to a certain level of pressure.
   - Patient initiates all breaths and controls flow rate and tidal volume. Decreases work of breathing.
Complications

1. Trauma
   Barotrauma: (damage to the lungs by positive pressure) can occur due to a pneumothorax, subcutaneous emphysema or pneumomediastinum.

2. Volutrauma: (damage to the lungs by volume delivered from one lung to the other).

2. Oxygen Toxicity
   Oxygen Toxicity can result from high concentrations of oxygen (Typically above 50%), long durations of oxygen therapy (Typically more than 24 to 48 h) or the client's degree of lung disease.

# Nursing Action
   - Monitor for fatigue, restlessness, severe dyspnea, tachycardia, tachypnea, crackles and cyanosis.
   - ABG should be done at least daily.
Hemodynamic compromise
- Mechanical ventilation has a risk of increased thoracic pressure (positive pressure), which can result in decreased venous return.

Venous return ↓ Thoracic pressure ↑

↑ Thoracic pressure → ↑ pressure on Heart

↓ Venous Return → ↓ Cardiac output → ↓ Hypotension → ↑ pulse

# Nursing Action
- Monitor for tachycardia, hypotension, urine output less or equal to 30 ml/hr, cool, clammy extremities, decreased peripheral pulses, and a decreased level of consciousness.

Aspiration
- Keep the head of the bed elevated 45° at all times to decrease the risk of aspiration.

# Nursing Action
- Check residuals every 4 hr, if the client is receiving enteral feedings to decrease the risk of aspiration.
Gastrointestinal Ulceration (Stress Ulcer)
- Gastric ulcers can be evident in clients receiving mechanical ventilation.
- Risk for Stress Ulcer.

# Nursing Actions
- Monitor gastrointestinal drainage and stools for occult blood.
- Administer ulcer prevention medications as prescribed. (Sucralfate, Histamine 2 blockers)

* Nursing Role
1. Preparation of the client
   - Explain the procedure to the patient.
     - Conscious vs. unconscious.
2. Establish a method for client to communicate, such as asking yes or no questions, providing writing materials or lips readings.
3. Prepare Equipment.
   - Sedation
     - Use anesthetic/analgesic orally or low-dose propofol.
     - Use anesthetic inhalation (such as sevoflurane, isoflurane) or propofol drip.
     - Use sugammadex and remifentanil to maintain muscle relaxation.
Ongoing Care

2. Maintain a patent airway

- Assess the position and placement of tube.
- Chest Sound Auscultation

- Listen for breath sounds over the trachea and bronchi. Normal Air Entry heard on auscultation.
- Expiration

- Trachea: Tube is well sited.
- Exudation

- Loosen the securing tubes. Recheck the position of the tube to ensure it is secure and not kinked.
- Semiflex

- Elevate head of bed 45-90 degrees to prevent aspiration.

- Check the chest movement.

- If the chest movement is up and down, and there are no Semiflex, then the tube is secure and not kinked.
- Collapse in lung
Assess Respiratory Status:
- Every 1 to 2 h.

*Note*
- Do not exceed 3 assessment in a row.
- Assess Nerves, Sensation, Circulation (Capillary refill)

⇒ Low Pressure alarm

1. Cuff pressure is too low
2. Leakage in the tube
3. Tube is blocked

⇒ High Pressure alarm

1. Thick secretion
2. Pt biting the tube
3. Coughing
4. Bronchospasm
5. Pulmonary Edema
6. Tube is wrinkled

*Note:
- Treat the Cause
Apnea alarm

\[ \downarrow \text{CO}_2 \rightarrow \uparrow \text{pH} \rightarrow \text{Respiratory alkalosis} \]

2. Oral Care

Mechanical Ventilator: Secretion multiplication, leading to Organisms multiplication, and decreased ventilation.

\[ \text{Mechanical Ventilator} \rightarrow \text{Secretion multiplication} \rightarrow \text{Organisms multiplication} \rightarrow \text{Decreased ventilation} \]

Notes

Explain Procedure:

- Explain the procedure
- Explain the mechanism of the Ventilator
- Explain the role of the Ventilator
- Explain the mechanism behind the device

Muscle relaxation:

- Explain the process of muscle relaxation
- Explain the mechanism of muscle relaxation
- Explain the role of muscle relaxation

Lo: This is a list of steps to follow.
Weaning Criteria

1. Appropriate level of Consciousness. "Cooperative"
   - Fully Conscious.
2. Intact Cough reflex.
   - Ensures clear airway, airway reflexes present.
3. Intact Gag reflex.
4. Good Respiratory Rate.
5. Acid-base Disturbance.

*Weaning Methods*

1. T-tube (T-piece) weaning.
mode

Ventilator

Endotracheal Tube

Tube

ABG

Nursing Care

1. Assess patient for weaning Criteria.

2. Monitor activity level

3. Explain that the patient may feel short of breath initially and provide encouragement as need.
4. Implement the weaning method prescribed: ALC ventilation, SIMV, CPAP or T-piece.

5. Deflate the cuff on the Endotracheal tube and remove the tube during peak inspiration.
   - Deflate of Cuff - damage of Trachea
   - Peak of Inspiration
   - Inflammation of trachea or bronchi of the patient
   - Expiration: Tube is placed to stop the flow of air
   - Inspiration: The patient is given air
   - Inspiration and Expiration
   - Continued with the ventilator
   - After recovery

6. Continuously monitor the client during the weaning process and watch for signs of weaning intolerance.
   - Respiratory Rate greater than 30/min or less than 8/min.
   - Blood pressure or Heart Rate changes more than 20% of baseline.
   - SaO2 less than 90%.
   - Dysrhythmias.
   - Significant decrease in tidal volume.
   - Lung Expansion, Decrease in chest movement.
   - Labor standard respirations, Increase use of accessory muscle and Diaphoresis.
7. Restlessness, Anxiety and decrease level of Consciousness.

8. Have Re-Intubation equipment at bedside.

9. Suction the client's oropharynx and trachea. (Aspiration)

10. Following extubation, monitor the client for signs of respiratory distress or airway obstruction such as ineffective Cough, dyspnea and Stridor.

11. Monitor client's SpO2 and vital signs every 5 min.

12. Encourage Coughing, deep breathing and use of incentive spirometer.

   - Lung Expansion
   - Gas Exchange
   - Secretion

Incentive Spirometer:

- Chest Expansion: Open 3 Cents Closing 3 Cents
- Larynx is Slight Voice
- Voice is Normal
- 3 Times Inhale
- 3 Times Exhale
- Secreration

13. Reposition the client to promote mobility of secretions. (Specially older, adult)