Orientation

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**Mechanical ventilation**

**Revision:**
- why give o2 to patient ??
  - v/q mismatch or pulmonary shunting
- mechanical ventilator work:
  - a-assist: لما الرئة تكون شغالة لكن الأكسجين يقل
  - b-restore: إذا بطل المريض يتنفس بالمرة

* Caring for the Patient on Mechanical ventilator:

The nurse must be able to do the following:

1. Identify the indications for mechanical ventilation.
2. List the steps in preparing a patient for intubation.
3. Determine the FIO2, tidal volume, rate and mode of ventilation on a given ventilator.
   Tidal volume: volume of air in ml in one breath
   Calculated \( TV = 5-8ml/kg \)
   Ex: patient 80 kg \( TV = 5*40 - 8*40 \) \( TV=200-320ml/breath \)
4. Describe the various modes of ventilation and their implications.
5. Describe at least two complications associated with patient’s response to mechanical ventilation and their signs and symptoms.
6. Describe the causes and nursing measures taken when trouble-shooting ventilator alarms.
7. Describe preventative measures aimed at preventing selected other complications related to endotracheal intubation.
8. Give rationale for selected nursing interventions in the plan of care for the ventilated patient.
9. Complete the care of the ventilated patient checklist

* **Definition:**
  - **Ventilation:** Is the movement of a volume of gas into and out of the lungs
  - **Respiration:** Is the exchange of oxygen and carbon dioxide across a membrane either in the lungs or at the cellular level
  - **Pulmonary shunting**
    Pathological condition which results when the alveoli of the lungs are perfused with blood as normal, but ventilation (the supply of air) fails to supply the perfused region

**Mechanical ventilator**
Definition:
Is the use of a mechanical device (machine) to inflate and deflate the lungs.

Purpose:
- To maintain or improve ventilation, & tissue oxygenation.
- To decrease the work of breathing & improve patient’s comfort.

Indication:
- Airway protection
- Hypercapnia respiratory failure
- Hypercapnia respiratory failure
- Hypoxemic respiratory failure
- Cardiovascular distress
- Hypoxemic respiratory failure
- Cardiovascular distress
- Neuromuscular disorders

Criteria for institution of ventilator support:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ventilation indicated</th>
<th>Normal range</th>
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<tbody>
<tr>
<td>A- Pulmonary function studies:</td>
<td></td>
<td></td>
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<tr>
<td>• Respiratory rate (breaths/min)</td>
<td>More than 35</td>
<td>12-20</td>
</tr>
<tr>
<td>• Tidal volume (ml/kg)</td>
<td>Less than 5</td>
<td>5-7</td>
</tr>
<tr>
<td>• Vital capacity (ml/kg)</td>
<td>Less than 15</td>
<td>65-75</td>
</tr>
<tr>
<td>B- Arterial blood Gases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PH</td>
<td>Less than 7.25</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>• PaO2 (mmHg)</td>
<td>Less than 60</td>
<td>75-100</td>
</tr>
<tr>
<td>• PaCO2 (mmHg)</td>
<td>More than 50</td>
<td>35-45</td>
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</tbody>
</table>

Intubation equipment:
Laryngoscope
- Endotracheal (ET) tube
- Stylet

- Syringe, 10 mL (to inflate ET tube balloon)
- Sterile gloves
- Stethoscope

- Suction catheter (eg, Yankauer)
- Oral and nasal airways
- Ambu bag and mask attached to oxygen source

- Endotracheal attachment device (E-tad) or tape
- Call for chest x-ray to confirm position of endotracheal tube

Types of Mechanical ventilators:
1-Positive Pressure: Ventilators deliver gas to the patient under positive-pressure, during the inspiratory phase

2-Negative Pressure

(Iron lungs.): The patient’s body was encased in an iron cylinder and negative pressure was generated
Used in polio militias

Four stage of mechanical ventilator:
1-Trigger phase
The initiation of an inhalation which is triggered by an effort from the patient or by set parameters by the mechanical ventilator.

2-Inspiratory phase
The inhalation of air into the patient

3-Cycling phase
The brief moment when inhalation has ceased but before exhalation has begun

4-Expiratory phase
The passive exhalation of air from the patient

*types of positive pressure ventilation:
1- **Volume Ventilators**
- Commonly used in critical care settings.
- Designated volume of air is delivered with each breath.
- RR, inspiratory time, and TV are selected for the mechanical breaths.

2- **Pressure Ventilators**
- Increasing used in critical care units.
- Delivers a selected gas pressure to the patient early in inspiration, and sustains the pressure throughout the inspiratory phase.
- Exhaled tidal volume is the variable to monitor closely.

*Classification of positive pressure ventilation:*

(According to how the inspiratory phase ends)

1- **Volume cycled ventilator**
- Inspiration is terminated after a preset tidal volume has been delivered.

2- **Pressure cycled ventilator**
- Inspiration is terminated when a specific airway pressure has been reached.

*Modes:

1- **Volume Mode**
- A/C assisted control
- SIMV synchronizes intermittent mandatory ventilation
- CMV control mandatory ventilation

2- **Pressure Mode**
- Pressure-support ventilation (PSV)
- *Continuous* positive airway pressure (CPAP)
- Pressure that give in inspiration = pressure that give in expiration
- Positive end expiratory pressure (PEEP):
  - Noninvasive bi level positive airway pressure ventilation (BiPAP)
- Give pressure in inspiration differ from pressure in expiration

*Volume Modes:

a- **Assisted Control (A/C)**
- Provides the patient with a pre-set tidal volume at a pre-set rate.
- Patient may initiate a breath on his own.
- Ventilator assists by delivering a specified tidal volume to the patient.
- Client can breathe at a higher rate than the preset number of breaths/minute.
Total respiratory rate is determined by the number of spontaneous inspiration initiated by the patient plus the number of breaths set on the ventilator.

- Often used as initial mode of ventilation

- Disadvantages: hyperventilation
  - بخلا المريض يحاول يوخذ و هو مثلما لو الحد المطلوب هو 400 مل اذا حاول المريض التنفس واخذ مثال 200 مل بتنيجي الالة يتكمله ل 400 و يعطى بس 200 وهكذا وفي حال ما أخذ المريض ولا مل يعطى ال 400 كامليين

\[ \text{Total} = 400 \text{ml} \]

b-Control mandatory ventilation (CMV)
- completely provided by the mechanical ventilator with a preset tidal volume, respiratory rate and oxygen concentration
- Ventilator totally controls the patient’s ventilation

- Client does not breathe spontaneously.
- Client cannot initiate breathe
- disadvantage: ي يؤدي الى الاعتماد
- no effort from patient
- I:E ration 1:2
- In hypercapnea we must increase expiration 1:3

\[ \text{Total} = 400 \text{ml} \]
c-Synchronizes Intermittent Mandatory Ventilation (SIMV)
-Provides the patient with a pre-set number of breaths/minute at a specified tidal volume and FiO2.
-In between the ventilator-delivered breaths, the patient is able to breathe spontaneously at his own tidal volume and rate with no assistance from the ventilator.
-Any breaths taken above the set rate are spontaneous breaths taken through the ventilator circuit.
-Adding pressure support during spontaneous breaths can minimize the risk of increased work of breathing.
-Breaths are synchronized with the patient spontaneous breathe.
-Used to wean the patient from the mechanical ventilator

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*pressure mode:
1-Pressure Support Ventilation (PSV)
-The patient breathes spontaneously while the ventilator applies a pre-determined amount of positive pressure to the airways upon inspiration.
patient’s spontaneous breaths with positive pressure boost during inspiration
- Helps to overcome airway resistance and reducing the work of breathing
- Indicated for patients with small spontaneous tidal volume and difficult to wean patients.
- The inspired tidal volume and respiratory rate must be monitored closely to detect changes in lung compliance.

2-Noninvasive Bilateral Positive Airway Pressure Ventilation (BiPAP)
- noninvasive form of mechanical ventilation provided by means of a nasal mask or nasal prongs, or a full-face mask
- allows the clinician to select two levels of positive-pressure support (inspiration pressure + expiration pressure)

3-(CPAP) and (PEEP)
- Constant positive airway pressure during spontaneous breathing
- Positive pressure applied at the end of expiration (PEEP)
- CPAP can be used for intubated and non-intubated patients
- used as a weaning mode and for nocturnal ventilation
- Prevent atelectasis or collapse of alveoli
- Improve gas exchange & oxygenation
- Treat pulmonary edema (pressure help expulsion of fluids from alveoli)

**Common Ventilator Settings parameters/ controls**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
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| **Fraction of inspired oxygen (FiO2)** | - The percent of oxygen concentration that the patient is receiving from the ventilator. (Between 21% & 100%)  
  - Initially a patient is placed on a high level of FiO2 (60% or higher).  
  - Subsequent changes in FiO2 are based on ABGs, PaO2 and the SaO2  
  - An FiO2 of 100% for an extended period of time can be dangerous (oxygen toxicity) but it can protect against hypoxemia  
  - after cpr give 100% for short time  
  - don’t give higher than 60% for long time because this cancel surfactant that lead to baratoma تكبر الحويصلة وتفجر |
| **Tidal Volume (VT)** | - Volume of air delivered to a patient during a ventilator breath.  
  - The amount of air inspired and expired with each breath.  
  - The large tidal volumes may lead to (volutrauma) aggravate the damage inflicted on the lungs  
  - Tidal volume targets (5 to 8 mL/kg) are now recommended |
| **Peak Flow/ Flow Rate** | - The speed of delivering air per unit of time, and is expressed in L/M  
  - The higher the flow rate inspiration, the shorter the inspiration  
  - The lower the flow rate, the longer the inspiration |
### Respiratory Rate
- The number of breaths the ventilator will deliver/minute (10-20 b/m).
- Total respiratory rate equals patient rate plus ventilator rate.
- In case acidosis increase RR to decrease CO2
- In case alkalosis decrease RR to increase CO2

### Minute Volume (VE)
- Minute volume is the amount of gas inhaled or exhaled from a person’s lungs in one minute.
- \[ \text{min volume} = \text{TV} \times \text{RR} \]

### I:E Ratio
- The ratio of inspiratory time to expiratory time during a breath (Usually = 1:2)

### Sigh
- A breath that has a greater volume than the tidal volume.
- It provides hyperinflation and prevents atelectasis.

### Peak pressure
- In adults if the peak airway pressure is persistently above 45 cmH2O, the risk of barotrauma is increased

### Sensitivity (trigger Sensitivity)
- The sensitivity function controls the amount of patient effort needed to initiate an inspiration

### Complications of Mechanical Ventilation

<table>
<thead>
<tr>
<th>Airway Complications</th>
<th>Mechanical complications</th>
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<tbody>
<tr>
<td>- Aspiration</td>
<td>- Hypoventilation with atelectasis with respiratory acidosis or hypoxemia.</td>
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<tr>
<td>- Decreased clearance of secretions</td>
<td>- Hyperventilation with hypocapnia and respiratory alkalosis</td>
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<tr>
<td>- Nosocomial or ventilator-acquired pneumonia</td>
<td>- Barotrauma</td>
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<tr>
<td></td>
<td>- Closed pneumothorax,</td>
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<td></td>
<td>- Tension pneumothorax,</td>
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<td></td>
<td>- Pneumomediastinum,</td>
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<td>- Subcutaneous emphysema.</td>
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<td>- Alarm “turned off”</td>
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<td>- Failure of alarms or ventilator</td>
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<td>- Inadequate nebulization or humidification</td>
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<td>- Overheated inspired air, resulting in hyperthermia</td>
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</table>
### Physiological Complications
- Fluid overload with humidified air and sodium chloride (Na Cl) retention
- Decrease cardiac function and hypotension
- Stress ulcers
- Paralytic ileus
- Gastric distension
- Starvation
- Dyssynchronous breathing pattern

### Artificial Airway Complications
- Complications related to Endotracheal Tube
- Tube kinked or plugged
- Cuff failure
- Tracheal stenosis or tracheomalacia
- Laryngeal edema

### Troubleshooting Ventilator Alarms
1. **Low exhaled volume**
   - **causes**
     - Cuff leak
     - Tubing disconnect
     - Patient disconnected
   - **treatment**
     - Evaluate cuff; reinflate prn
     - if ruptured, tube will need to be replaced.
     - Evaluate connections; tighten or replace as needed
     - check ETT placement, Reconnect to ventilator

2. **High pressure**
   - **causes** - Secretions in airway - Patient biting tubing - Tube kinked - Cuff herniation - Increased airway resistance/decreased lung compliance
   - **treatment**
     - Suction patient
     - Reposition patient’s head/neck
     - Deflate and reinflate cuff
     - Auscultate breath sounds
     - Explain all procedures to patient in calm
     - Sedate/medicate as necessary
     - Stabilize tube

3. **Low pressure**
   - **causes**
     - Oxygen malfunction
   - **treatment** - Disconnect patient from ventilator - manually with ambubag - call R.T
Weaning:
Used to describe the gradual process of decreasing ventilator support

mask هو انه أختلي الأنابيب بس اشيل ventilator لينش بهلي النبوي موجود ؟؟ عشان اذا ما زبط ارجعه عطول على ولازم يكون المرض صاحي

Methods of Weaning
1- **T-piece trial**
   - Removing the patient from the ventilator and having him / her breathe spontaneously on a T-tube connected to oxygen source.
   - Goal is to progressively increase the time spent off the ventilator.

2- **Continuous Positive Airway Pressure (CPAP) weaning**
   - Gradually decreasing the number of breaths delivered by the ventilator to allow the patient to increase number of spontaneous breaths.

3- **Synchronized Intermittent Mandatory Ventilation (SIMV) weaning**
   - The patient does all the work of breathing without the aid of a backup rate or tidal volume.

4- **Pressure Support Ventilation (PSV) weaning**
- using the PSV mode the level of pressure support is gradually decreased based on the patient maintaining an adequate tidal volume and a respiratory rate
- PSV weaning is indicated: Difficult to wean patients, Small spontaneous tidal volume

**Weaning readiness Criteria**
- Awake and alert
- Hemodynamically stable,
- Arterial blood gases (ABGs) normalized or at patient’s baseline
- Positive end-expiratory pressure (PEEP) ≤5 cm H2O
- Chest x-ray reviewed for correctable factors; treated as indicated
- Major electrolytes within normal range
- Hematocrit >25%
- Core temperature ≥36°C and ≤39°C
- Adequate management of pain/anxiety/agitation
- Adequate analgesia/ sedation (record scores on flow sheet)

*Role of nursing*

Before:
- Ensure that indications for the implementation of Mechanical ventilation have improved
- Ensure that all factors that may interfere with successful weaning are corrected
- Assess readiness for weaning
- Ensure that the weaning criteria / parameters are met.
- Explain the process of weaning to the patient and offer reassurance to the patient.
- Initiate weaning in the morning when the patient is rested.
- Elevate the head of the bed & Place the patient upright
- Ensure a patent airway and suction if necessary before a weaning trial,
- Ensure patient’s comfort & administer pharmacological agents for comfort, such as bronchodilators or sedatives as indicated.
- Help the patient through some of the discomfort and apprehension.
- Support and reassurance help the patient through the discomfort and apprehension as remains with the patient after initiation of the weaning process

- Evaluate and document the patient’s response to weaning

**During:**

- Wean only during the day.
- Remain with the patient during initiation of weaning.
- Instruct the patient to relax and breathe normally
- Monitor the respiratory rate, vital signs, ABGs, diaphoresis and use of accessory muscles frequently

**After:**

- Ensure that extubation criteria are met
- Documentation