MAGDI YACOUB
HEART FOUNDATION
ASWAN HEART CENTRE

Basic Of Ventilator Modes

Presented by:

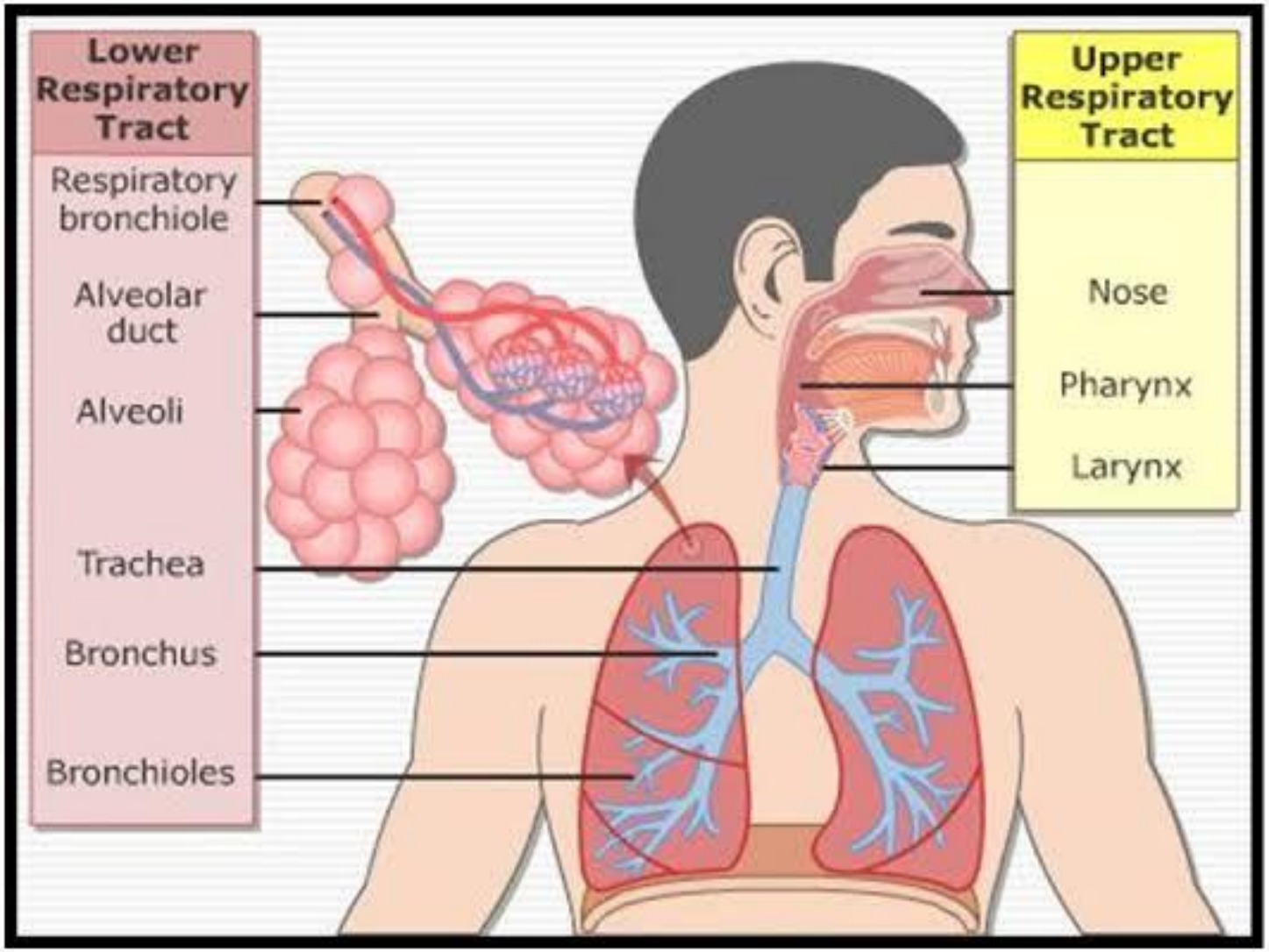
Mohamed Abdallah

ACICU staff nurse

Outline:

- Anatomy and physiology.
- Introduction.
- Indications.
- Ventilator settings.
- Ventilator modes.
- Ventilation complications.
- Patient care.
- VAP bundle.
- Troubleshooting.

RESPIRATORY SYSTEM: UPPER AND LOWER



Anatomy and physiology

a) Conducting Airway structures (Cartilage):
   - Nose, pharynx, larynx, and trachea.
   - Bronchi: Lobar, Segmental and Sub segmental bronchi.

Functions: Warming, Humidification and Remove foreign particles.

b) Gas exchange airways:

- Bronchioles:

  which are considered to be the transitional passageways between the conducting airways and the gas exchange airways.

- Alveoli.

Introduction

- Mechanical ventilator is a machine that generates a controlled flow of gas into patient`s airway.





Oxygen Therapy (devices)

- Nasal cannula .....(1-6)LPM.....(24-44%)
- Simple face mask....(5-10) LPM.....(35-60%)
- Non-Rebreather mask....(10-15)LPM..up to 90%
- Ventouri mask (3-15) LPM.....24-60 %
- **HFOT(high flow Oxygen Therapy)**

1. *Flow ..(10-60) LPM.* >>>WOB
2. *FIO2 ..(21-100%)* hypoxic
3. *Humidifier.* **Very Very important**
4. **Stop and shift to NIV& Intubation**

(*high RR , High WOB, >>>max flow 60 +fio2 60%*



Non-Invasive Ventilation

Definition

the delivery of mechanical ventilation to the lungs using techniques that do not require an **endotracheal** airway.

Goals of Non-Invasive Ventilation

- Avoid Invasive Ventilation
- Reduce patient WOB
- Optimize patient Comfort
- Adequate pulmonary Gas Exchange
- Minimize the risk of Lung Injury

Advantages

- Avoids artificial airways with its complications (airway trauma, VAP, ….)
- Preserves airway defense, speech, and swallowing mechanisms >>> decreased risk of aspiration
- Reduces requirements for heavy sedation
- Reduces need for invasive monitoring
- Shorter hospital stay
- Lower mortality rate
- Lower health care costs

Disadvantages/ Complications

- Gastric Distension & Areophagia
- Facial Pain & Skin Pressure ulcers,
- Dry Nose
- Mask Leaks & Eye Irritation (Conjunctivitis)
- Discomfort, Claustrophobia
- Poor Sleep

Indications

- Post operative Atelectasis
- Pulmonary edema
- Post-extubation in difficult to wean patients
- Moderate to severe acidosis: pH, 7.25 to 7.30; $PaCO_2$, 45 to 60 mm Hg
- Use of accessory muscles
- Obstructive sleep apnea
- Acute respiratory distress syndrome (ARDS)
- Pneumonia
- Acute Asthma

Contraindications of NIV

- Respiratory arrest
- Cardiac arrest
- Cardiovascular instability (hypotension, severe dysrhythmias,)
- Inability to protect the airway &/or high risk of aspiration
- Uncooperative patient (Agitation, impaired mental status)
- Facial or head surgery or trauma
- Patent tracheoesophageal fistula

Equipment Required for NIV

- Ventilator
- Interfaces or masks (with fixator)
- Humidifier

Steps for Initiating NIV

- Upright Or Sitting Position. Carefully Explain the NIV procedure including goals and possible complications
- Make sure a mask is chosen that is the Proper Size And Fit
- Hold or allow the patient to hold the mask gently to the face until the
- patient becomes comfortable with it. Encourage the patient in proper breathing technique.

Cont..

- Secure the mask to the patient. Do Not make the straps Too Tight.
- Monitor Respiratory Rate, heart rate, level of dyspnea, O2 saturation,minute ventilation, and exhaled tidal volume

When to switch from NIV to Invasive Ventilation ??

- **Failure of NIV**

1. *Respiratory rate >30-35 breaths/min*
2. *Severe dyspnea with use of accessory muscles and possibly paradoxical breathing*
3. *Life-threatening hypoxemia: (SpO_2) less than 90%, PaO_2 <60 mm Hg /FIO_2 100%*
4. *Persistent/Worsening Severe acidosis (pH <7.25) and hypercapnia ($PaCO_2$ >60 mm Hg)*

Cont…

- **Appearance of“ Contraindications of NIV**

1. ***Respiratory arrest***
2. ***Cardiovascular complications (hypotension, shock, heart failure)***
3. ***impaired mental status***
4. ***Inability to clear secretion***
5. ***Inability to tolerate interface***

Indications invasive intubation

- ✓ Failure of Airway Protection:

  An absent gag reflex and a Glasgow Coma Scale (GCS) <8, Inability to swallow.

- ✓ Failure of Ventilation: airway obstruction, muscular weakness, or drug-induced hypopnea

- Conditions/Disorders:
  - Cardiogenic/ no cardiogenic pulmonary edema.
  - ARDS,
  - Pulmonary hemorrhage.
  - Pulmonary thromboembolism
  - Chronic obstructive pulmonary disease.
  - Severe asthma.
  - Respirator muscle dysfunction
  - Septic shock,
  - Severe metabolic acidosis

Ventilator settings

- **Fraction of Inspired Oxygen (FiO2)**

Concentration of oxygen in the inspired air.

- **Tidal Volume (Vt)**

Volume of gas exchanged with each breath (6-8 mL/kg of ideal body weight).

- **Minute Ventilation (MV)**

Volume of gas exchanged per minute = respiratory rate x tidal volume (5-10 L/minute).

- **Positive End Expiratory Pressure (PEEP)**

Pressure remaining in the lungs at end expiration. Used to keep alveoli open and to improve oxygenation for patients. (3-10 cm H2O).

- **Pressure Support (PS)**

Provides additional pressure during inspiration to ensure a larger Vt with minimal patient effort (8-20 cm H2O).

- **Peak Inspiratory Pressure (PIP)**

Highest proximal airway pressure reached during inspiration. Target PIP is < 35 cm H2O.

- **Trigger**

Breaths can be triggered by: Time, Patient effort.

- **Inspiratory: Expiratory (I:E) Ratio**

Normal: longer expiratory phase than inspiratory phase.

- **Frequency (f)**

Set number of ventilator breaths per minute (10-20 breaths/min).

Types of breathing in MV

Mechanical Ventilator Breaths & Pull-Ups







Controlled Breath	Assisted Breath	Supported Breath
No Work	Start Work	Able to do Some or Most of Work
Ventilator Does All the Work	Ventilator Takes Over Work	Ventilator Assists to Finish Work (i.e. Pressure Support)

Ventilator Modes:

Volume modes (Examples: CMV, VC/AC, SIMV)	Pressure modes (Examples: BIPAP-CPAP)
Volume: constant. Inspiration: Terminates when preset VT delivered PIP: Variable.	Volume: variable. Inspiration: Terminates when preset pressure reached PIP: Fixed

Volume controlled ventilation

CMV

(continues mandatory ventilation)

The ventilator delivers a pre-set respiratory rate & pre-set tidal volume regardless of lung resistance and compliance.

Ventilator perform all Work of breath, patient effort is not triggered.

- Settings: Freq, Vt,

VC-AC

(Volume control- Assist control)

- Each breath is either an assist (patient-initiated) or control (ventilator-initiated) breath with certain tidal volume.
- Patient receives full ventilator support for all spontaneous breaths.
- Sensitivity is set , patient effort is triggered
- Settings: Freq, Vt.

SIMV
(Synchronized intermittent mandatory ventilation)

- Applies breaths at a set rate but permits the patient to breathe between the set breaths at their own tidal volume and peak flow.
- The ventilator attempts to synchronize the mandatory breaths with the patient initiated breaths.
- May be used to wean patient from ventilator.

Pressure controlled ventilation

BIPAP

(Bi-level positive airway pressure)

High pressure PIP

Low pressure peep

- Pressure cycled mode: inspiration phase ends after PIP reached.
- In this mode patients can breathe spontaneously at both pressure levels.
- Settings: Freq, PIP

CPAP

(Continuous positive airway pressure)

- At end of expiration to prevent alveoli collapse.
- Spontaneous mode: no set Vt or f (RR), and PS overcomes work of breathing through tubing.



Complications of mechanical ventilation

- **Endotracheal Tube**
  - Laryngeal and tracheal damage
  - Aspiration
  - Infection
  - Discomfort
  - Mucous membrane disruption.
  - Tooth damage and/or dislodgement.

Pulmonary complications:

Barotrauma: (Pneumothorax, subcutaneous emphysema) occurs when a high-pressure gradient between the alveolus and the adjacent vascular sheet causes the over distended alveolus to rupture.

Volutrauma: Alveolar damage that results from high pressures resulting from large-volume ventilation. Volutrauma is different from barotrauma. Volutrauma results in alveolar fractures and flooding.

Atelectasis: This is the collapse of alveoli due to distal obstruction of airway.

Tracheal Damage: The cause of tracheal damage is excessive cuff pressures due to over inflation and reduced tracheal blood flow causing ischemia.

Patient-Ventilator Dysynchrony: May result in increase work of breathing, anxiety and development

of auto-PEEP as a result of insufficient expiratory time.

Auto-PEEP: Auto PEEP occurs when a delivered breath is incompletely exhaled before the onset of the next inspiration.

Cardiac complications:

Intrapleural and intrathoracic pressures can decrease venous return which results in a decreased cardiac output.

Decreased urine output, and decreased blood pressure

Infection complications:

- Ventilator-Acquire Pneumonia (VAP) is defined as a hospital-acquired pneumonia in patients who have been mechanically ventilated for at least 48 hours. The aspiration of bacteria in the oropharynx and lower respiratory tract may be the leading cause. Other causes include bacterial colonization of the oral cavity.

Patient care:



- **Assessment:**

- Assess lung sounds and cuff leaks regularly.
- Assess ventilator settings, alarms, and patient's ability to synchronize breathing with the ventilator.
- Identify the centimeter marking of the ETT at the patient's lip and document every shift.
- Monitor patient for increased heart rate, mental status change, respiratory rate, or other signs and symptoms of increased work of breathing.



Interventions:

- ✓ Maintain equipment at the patient's bedside: complete suction setup, Bag-Mask-Ventilation (BMV) System, endotracheal and tracheostomy tubes of same size and one size smaller.
- ✓ Maintain standard precautions and utilize appropriate PPE. Wear face shields for any procedure which may cause the release of fluids.
- ✓ Continuous analgesia should be strongly considered for patients receiving mechanical ventilation.



- ✓ Head of bed elevated at 30° or greater unless practitioner orders otherwise.
- ✓ Provide frequent mouth care: mouth care every 2 hours, toothbrush utilization every 8 hours.
- ✓ Endotracheal cuff pressures maintained between 22 to 30 cm H2O
- ✓ Positioning at least every 2 hours unless contraindicated.



- ✓ Move ETT from one side of the mouth to the other side of the mouth twice per shift.
- ✓ Suction according to patient need.

VAP Bundle


Head of bed elevation.
Oral care with chlorhexidine.
Stress ulcer prophylaxis.
Deep venous thrombosis prophylaxis.
Daily sedation assessment and spontaneous breathing trials.

Troubleshooting alarms

- **Low Pressure Alarm**
- Usually due to a leak in the circuit.
- **High Pressure Alarm**
- Usually caused by:
  - A blockage in the circuit (water condensation)
  - Patient biting his ETT
  - Mucus plug in the ETT

Low Minute Volume Alarm

- Usually caused by:
  - Apnea of your patient (CPAP).
  - Disconnection of the patient from the ventilator.

– NEVER hit the silence button!

Accidental Extubation

- ✓ Ensure the Ambu bag is attached to the oxygen flowmeter.
- ✓ Attach the face mask to the Ambu bag and after ensuring a good seal on the patient's face; supply the patient with ventilation.

Questions

- **1-**Endotracheal cuff pressure between (.....)?
- **2-** position of ETT must be moved from side to side every (.....)
- 3- nursing care for apnea ventlation....?


Any
questions
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Thank You !