

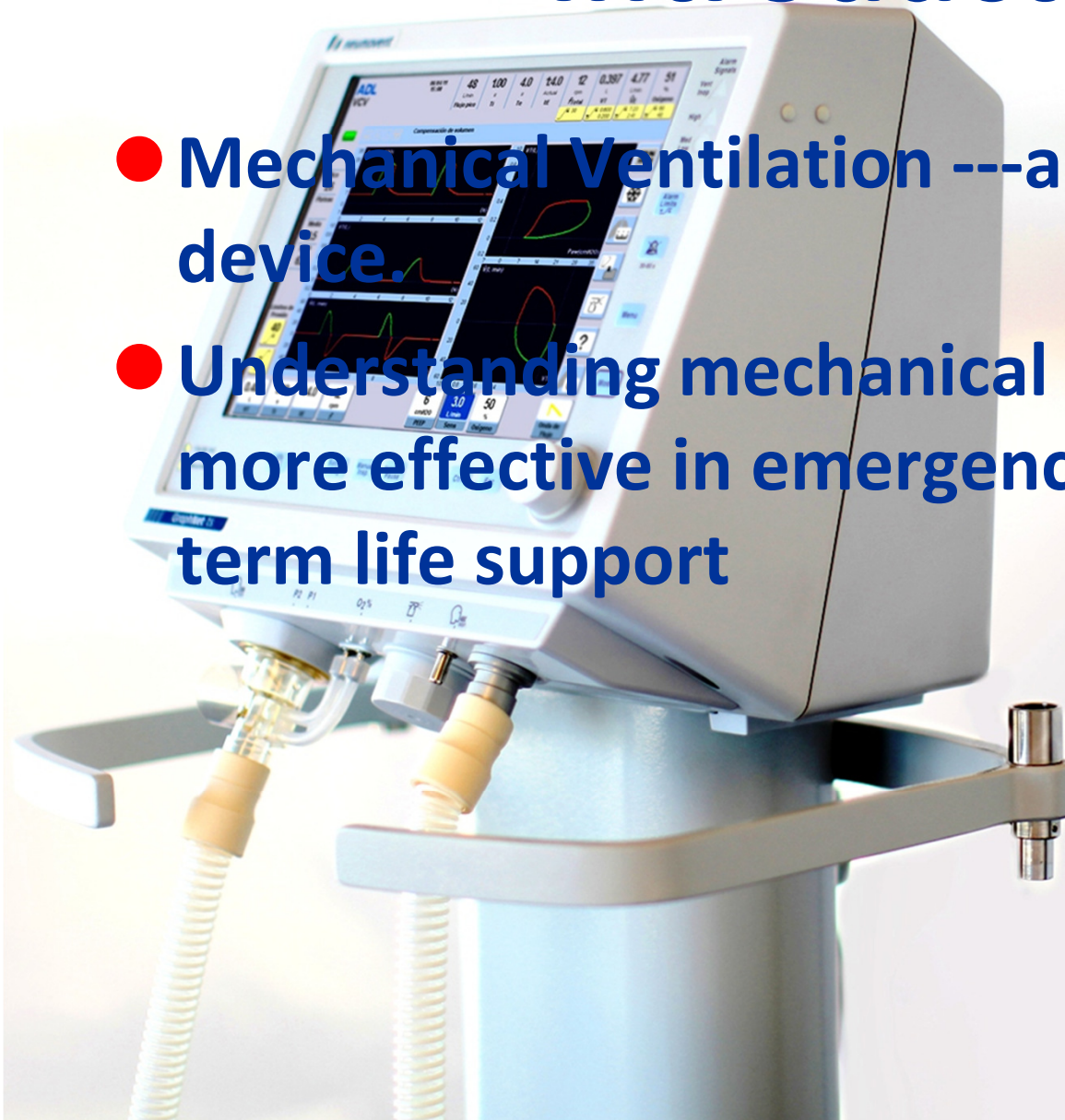
Invasive Positive Pressure Ventilation

CND KWH
APN Tsang Wai Yan



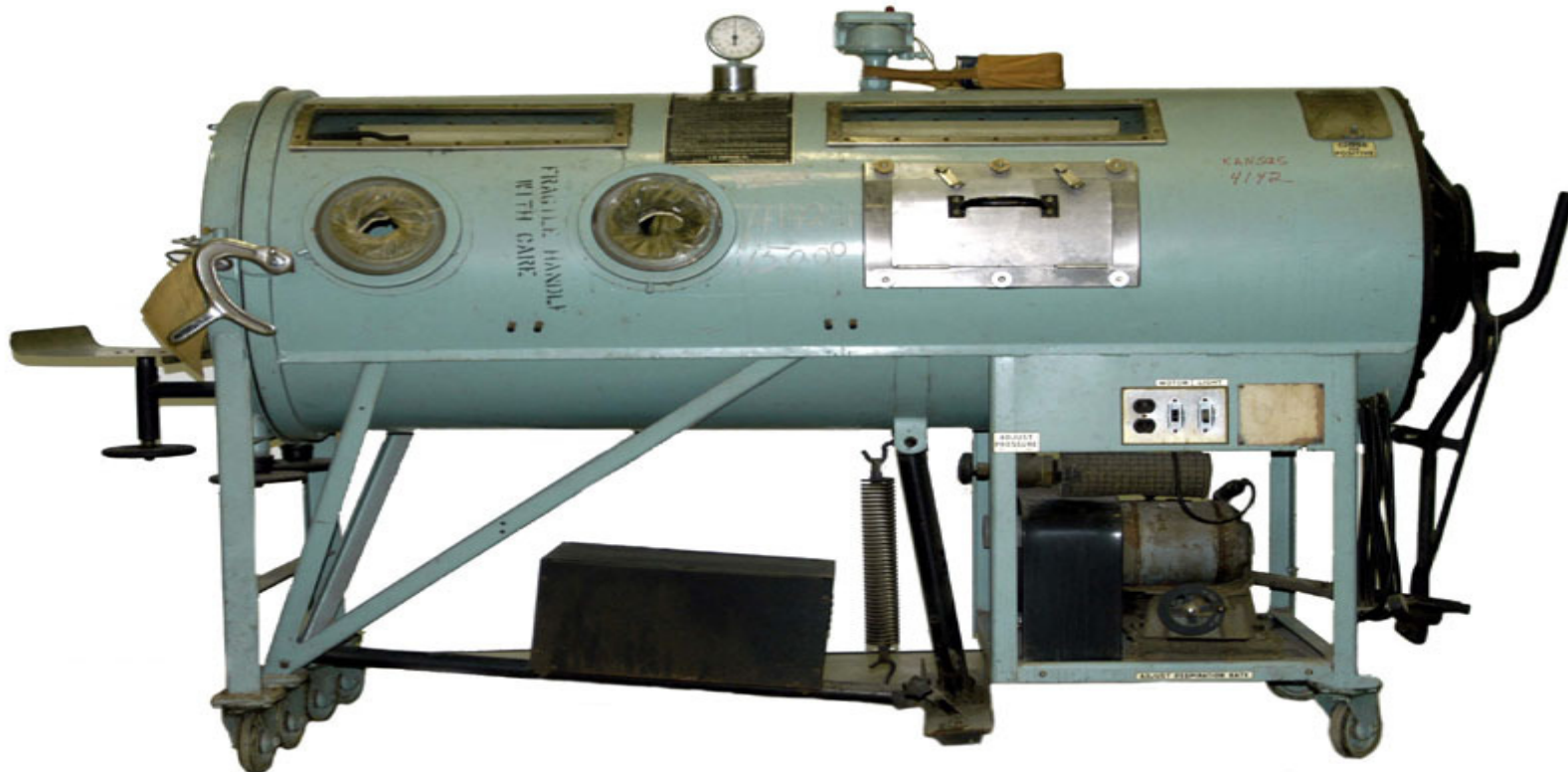
Introduction

- **Mechanical Ventilation ---a life supportive device.**
- **Understanding mechanical ventilators ---- more effective in emergency, acute and long-term life support**



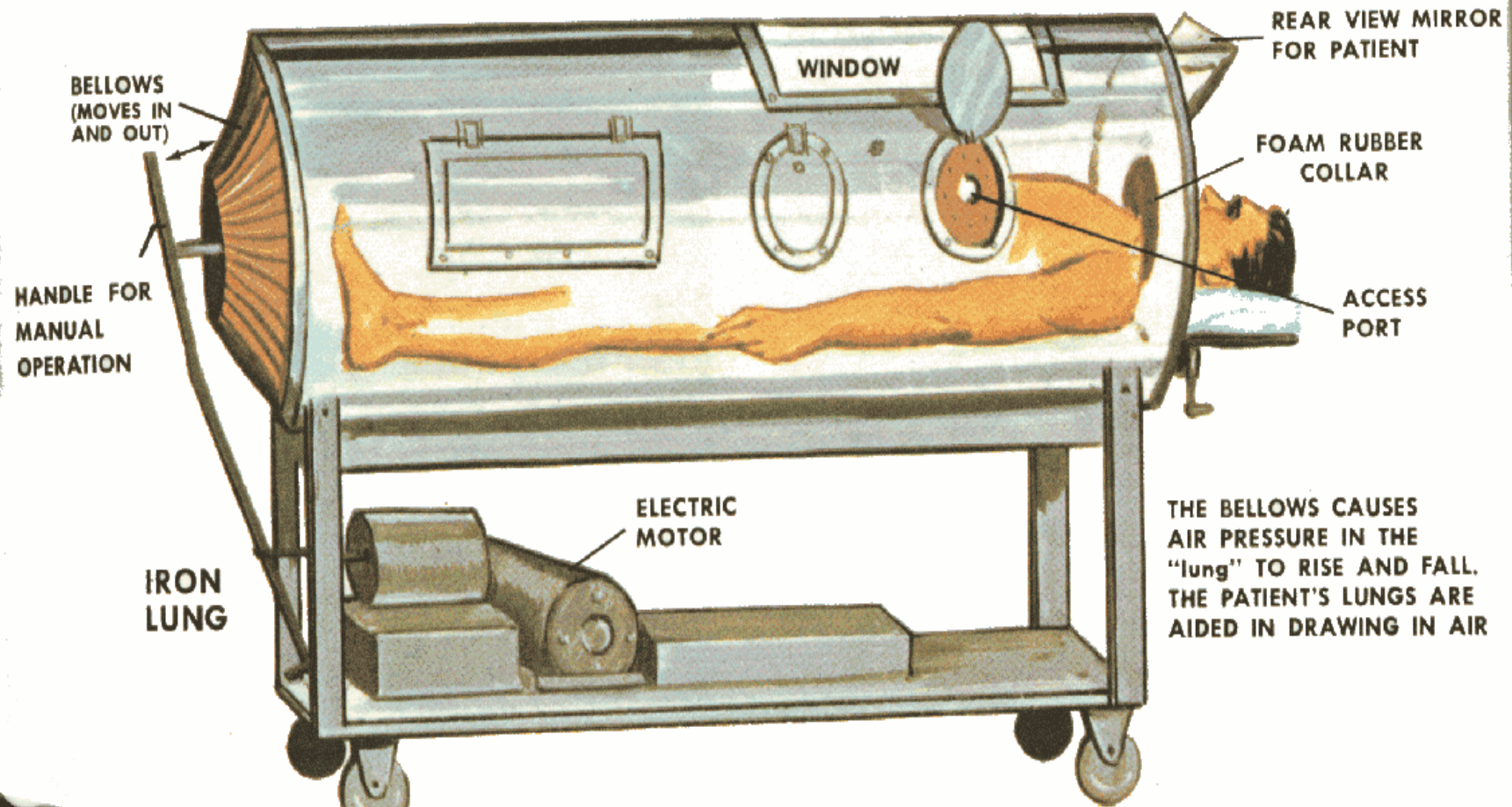
History

- Late 1920s into 1950s for polio patients in USA
- Iron Lung--Negative pressure principle

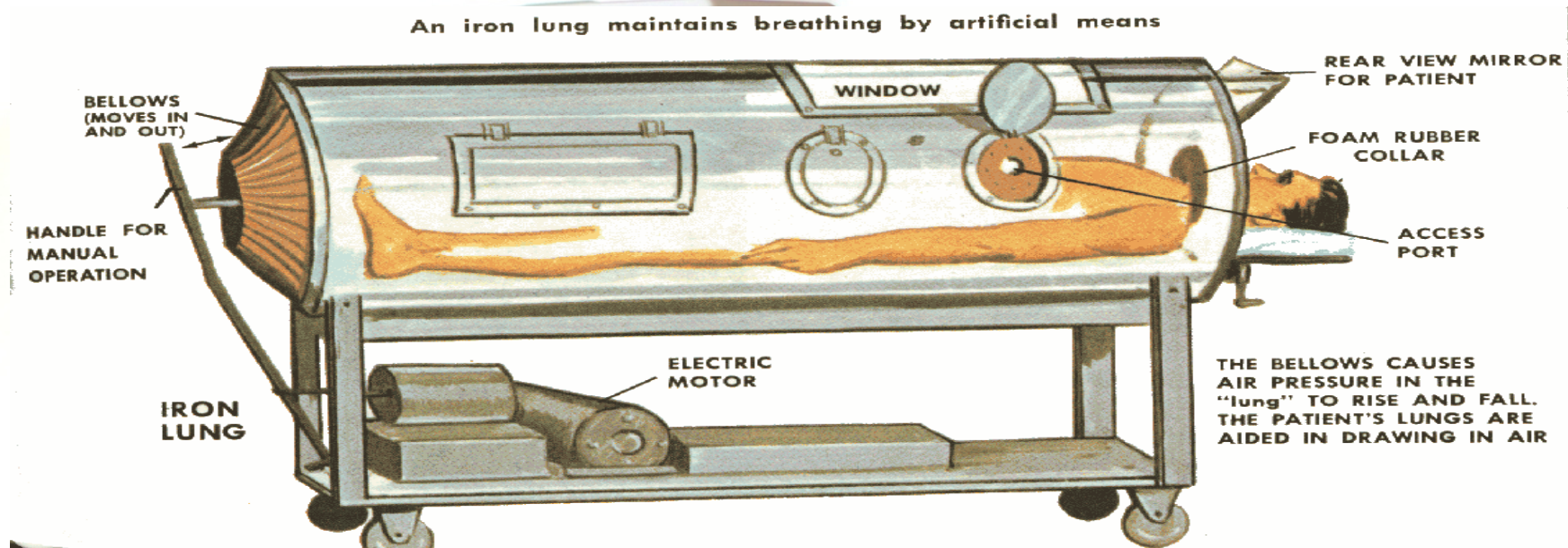


Negative Pressure Ventilator Iron Lung

An iron lung maintains breathing by artificial means



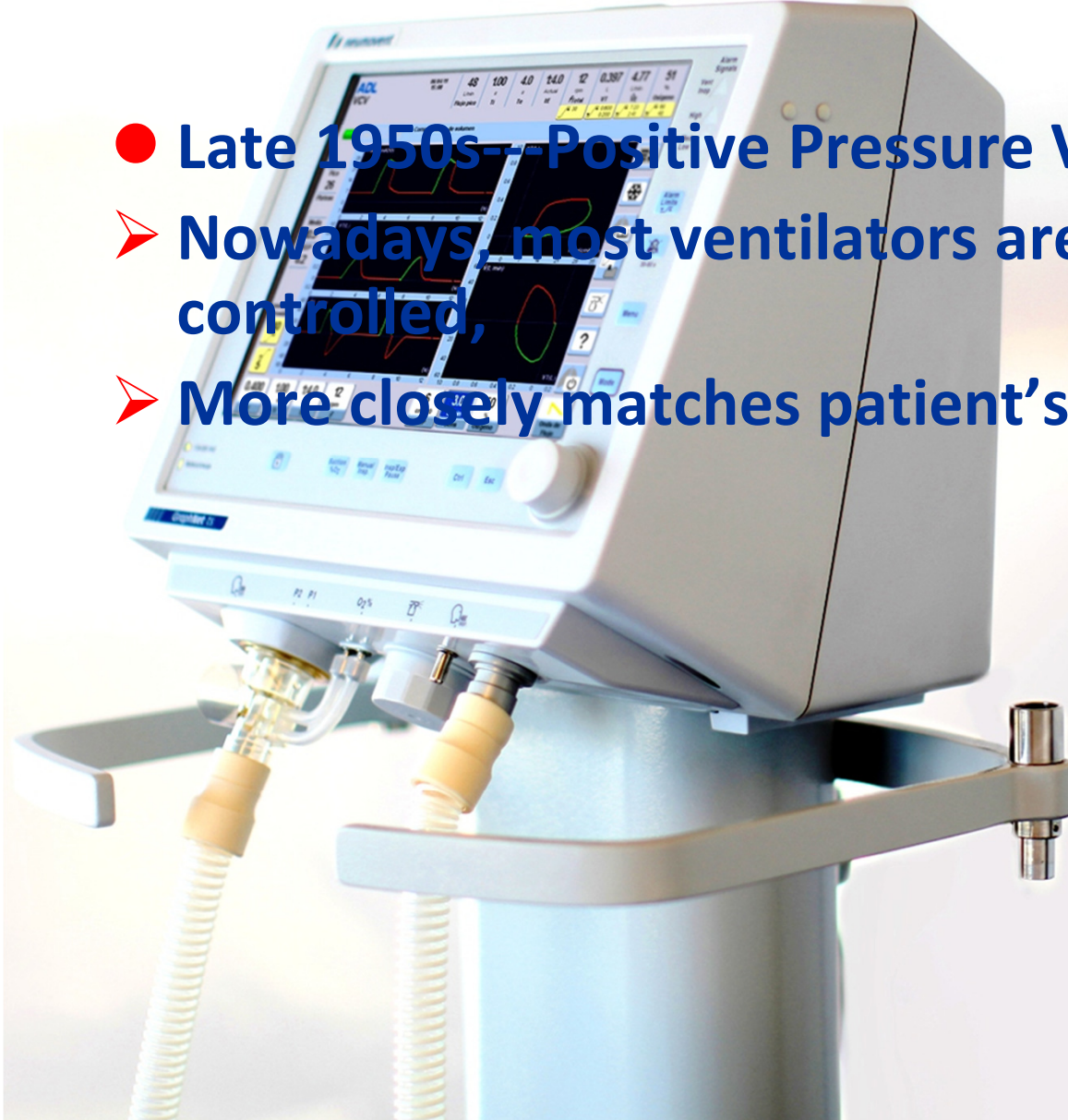
Iron Lung



-
- No artificial airway
 - Noisy
 - Difficult in nursing care
 - Restrict patient movement
 - Reduce quality of life.

Positive Pressure Ventilator

- Late 1950s-- Positive Pressure Ventilators
- Nowadays, most ventilators are computer-controlled,
- More closely matches patient's breathing needs.



Indications

- Pre and Post operation
- Acute respiratory failure
- Respiratory fatigue
- Secretion/Airway control failure
- Apnea
- Respiratory Arrest



Respiratory Terminology

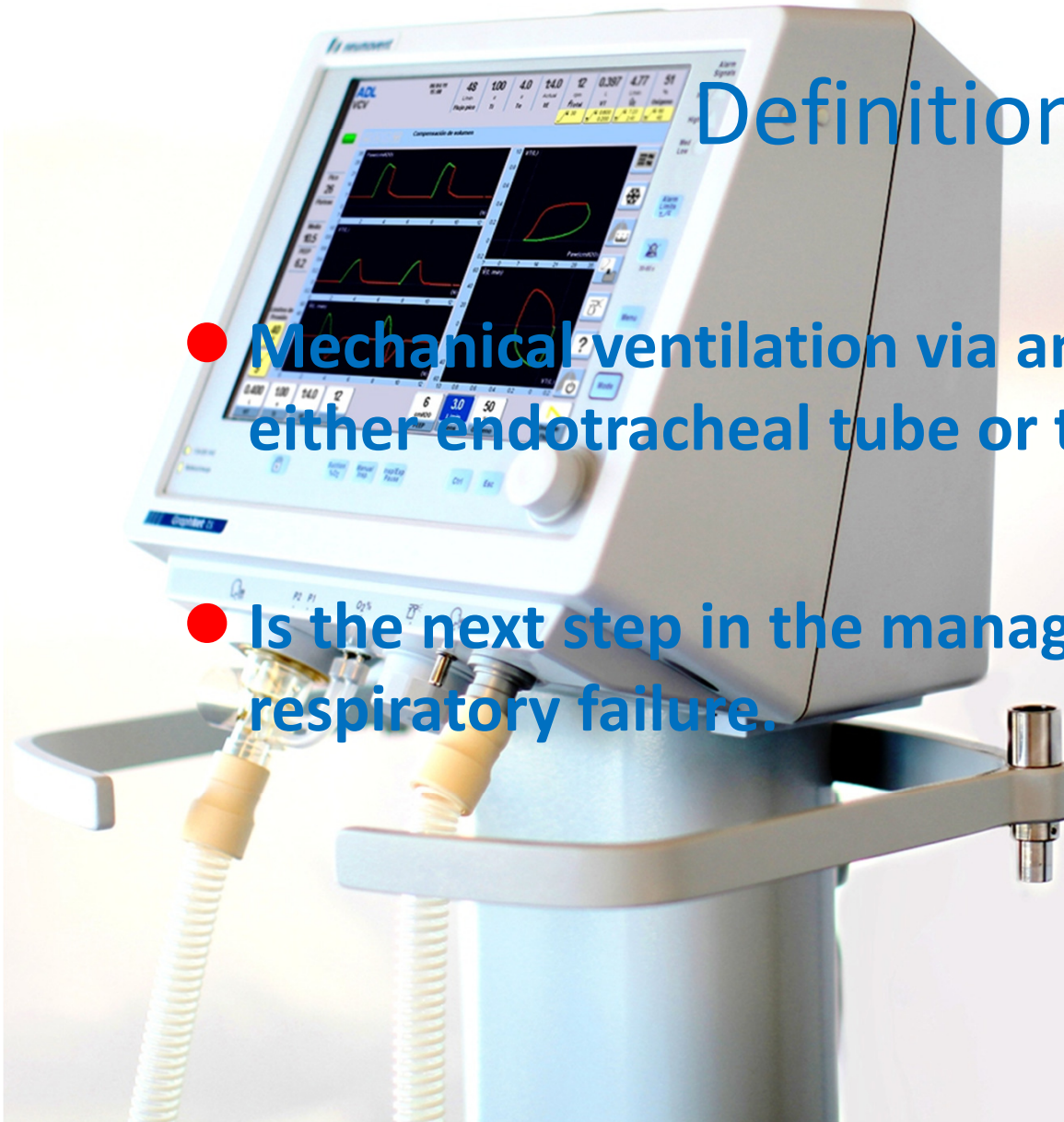
- **Respiratory Arrest:** cessation of breathing.
- **Respiratory Failure:** inadequate gas exchange by the respiratory system, result in arterial blood gas O₂ and/or CO₂ levels out of normal ranges
 - **Type 1:** hypoxaemia without hypercapnia
 - **Type 2:** hypoxaemia with hypercapnia



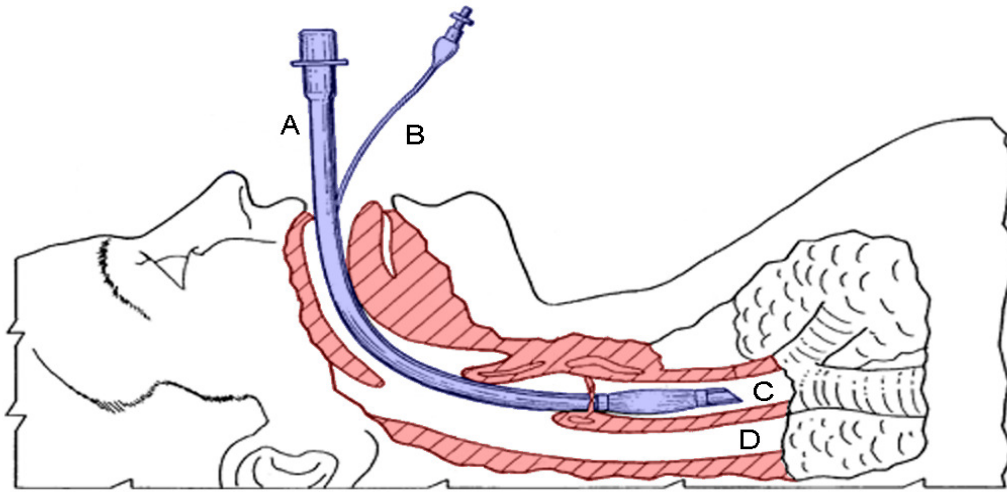
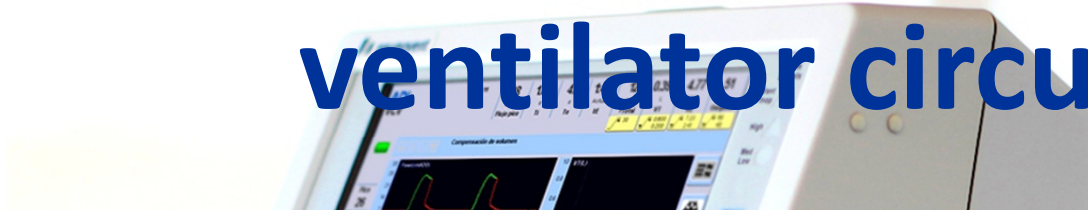
Invasive Mechanical Ventilation (

Definition:

- Mechanical ventilation via an artificial airway either endotracheal tube or tracheostomy tube
- Is the next step in the management of respiratory failure.



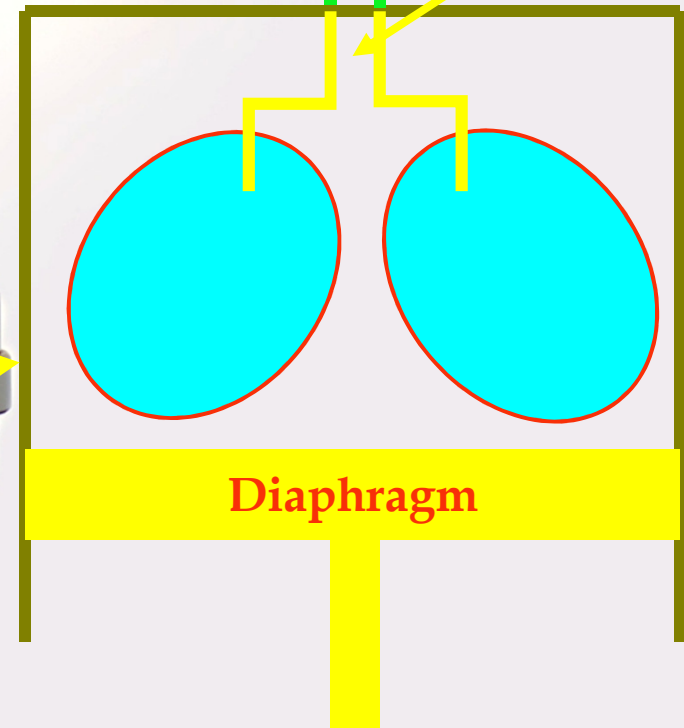
Understanding the basic ventilator circuit diagram



P_{aw}
Airway pressure

ET Tube

airways



Chest wall

Diaphragm

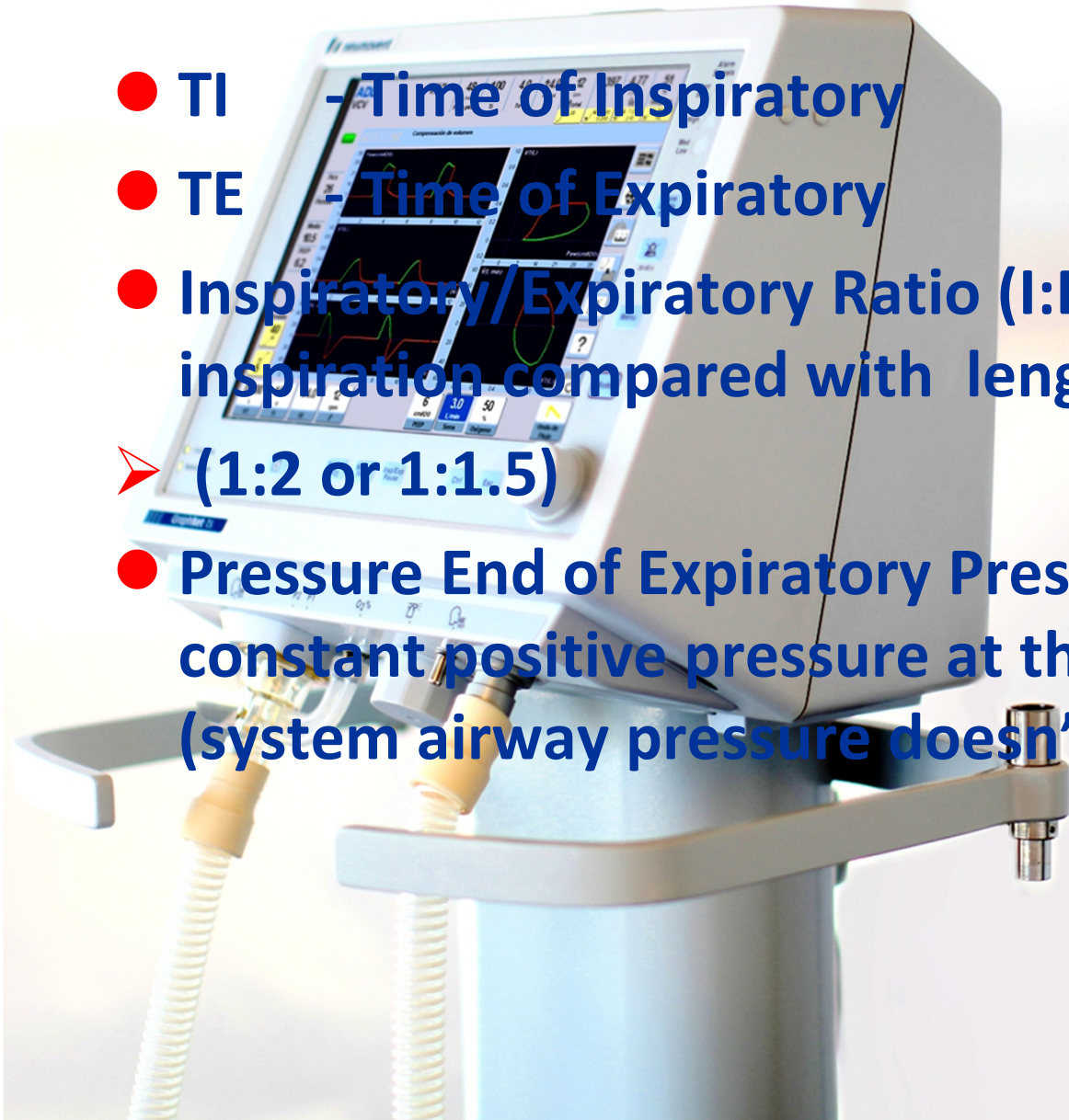
Ventilator Control setting

- Mode: Ventilator breathing mode
- Fractional Inspired Oxygen (FiO₂): % of oxygen delivery (0.21 to 1)
- Respiratory Rate setting (RR): breaths delivery per minute
- Tidal Volume setting (TV): Volume of gas (ml) delivery in each breath.
 - IBW 7-10ml/kg (~400ml)



Ventilator Control setting

- TI - Time of Inspiratory
- TE - Time of Expiratory
- Inspiratory/Expiratory Ratio (I:E) – length of inspiration compared with length of expiration
 - (1:2 or 1:1.5)
- Pressure End of Expiratory Pressure (PEEP): a constant positive pressure at the end of expiratory (system airway pressure doesn't return to zero)




Advantage of PEEP

- **↑ functional residual capacity (FRC)**
- **↑ improves oxygenation**
- **Prevents and recruits collapsed alveoli**
- **Redistributes lung fluid from alveoli to perivascular space e.g. APO**

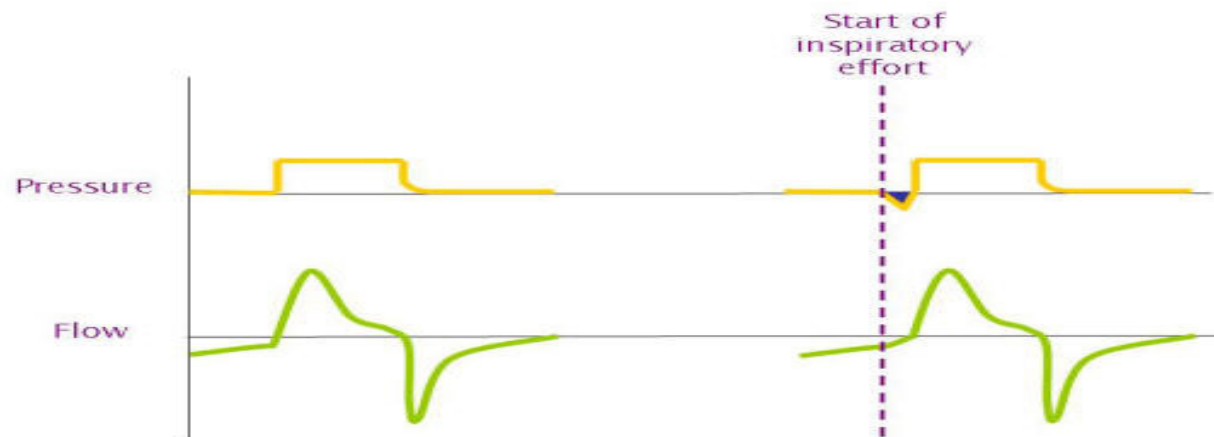
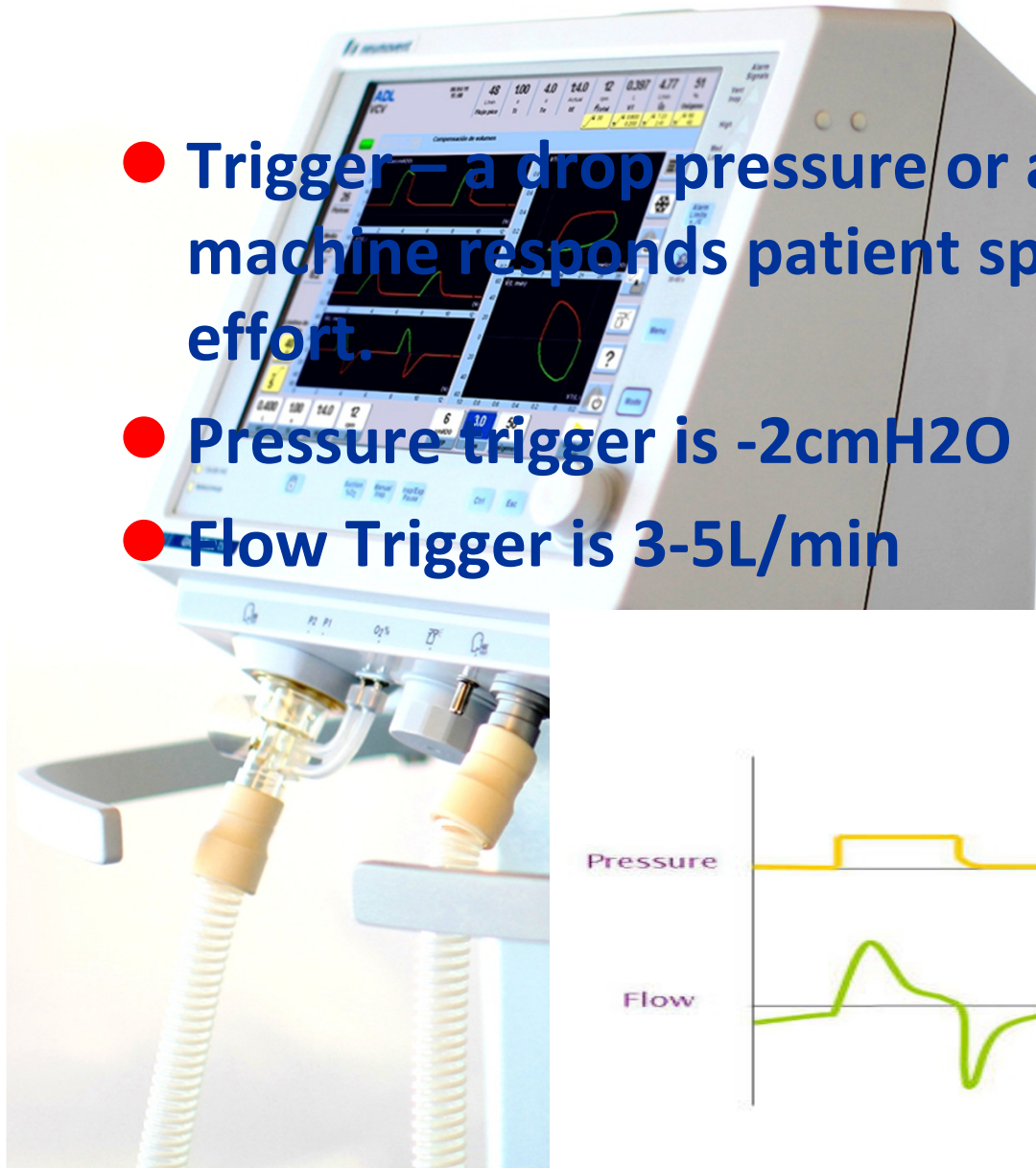


Ventilator Control setting

- 
- **Pressure Support (PS):** level of pressure above PEEP to support each inspiratory. (Normal 10cmH₂O)
 - **Pressure Control (PC):** upper limit pressure to control maximum pressure of lung during inspiratory
 - **ETS – Expiratory Trigger Sensitivity**
 - Inspiratory cycles into expiratory when peak inspiratory flow drop to setting %.
 - **Inspiratory Rise Time** – time taken from PEEP to PS

Ventilator Control setting

- Trigger – a drop pressure or arise air flow trigger machine responds patient spontaneous breathing effort.
- Pressure trigger is $-2\text{cmH}_2\text{O}$
- Flow Trigger is $3\text{-}5\text{L}/\text{min}$



Auto-trigger

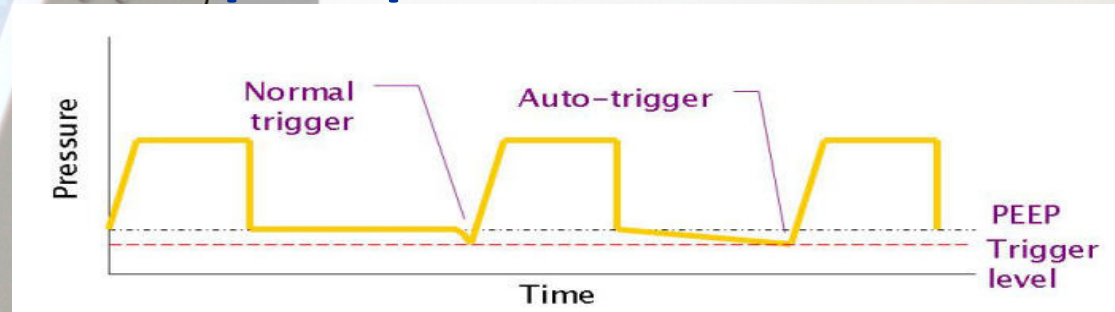
- Ventilator repeatedly triggers itself to start inspiratory (no related to pt's spontaneous breathing effort).

➤ Cause:

- Trigger sensitivity setting is too sensitive
- Water condensed
- Circuit/ET cuff leaks
- Chest tube

➤ Prevention:

- ✓ Minimize leaks
- ✓ Make trigger threshold less sensitive



Patient

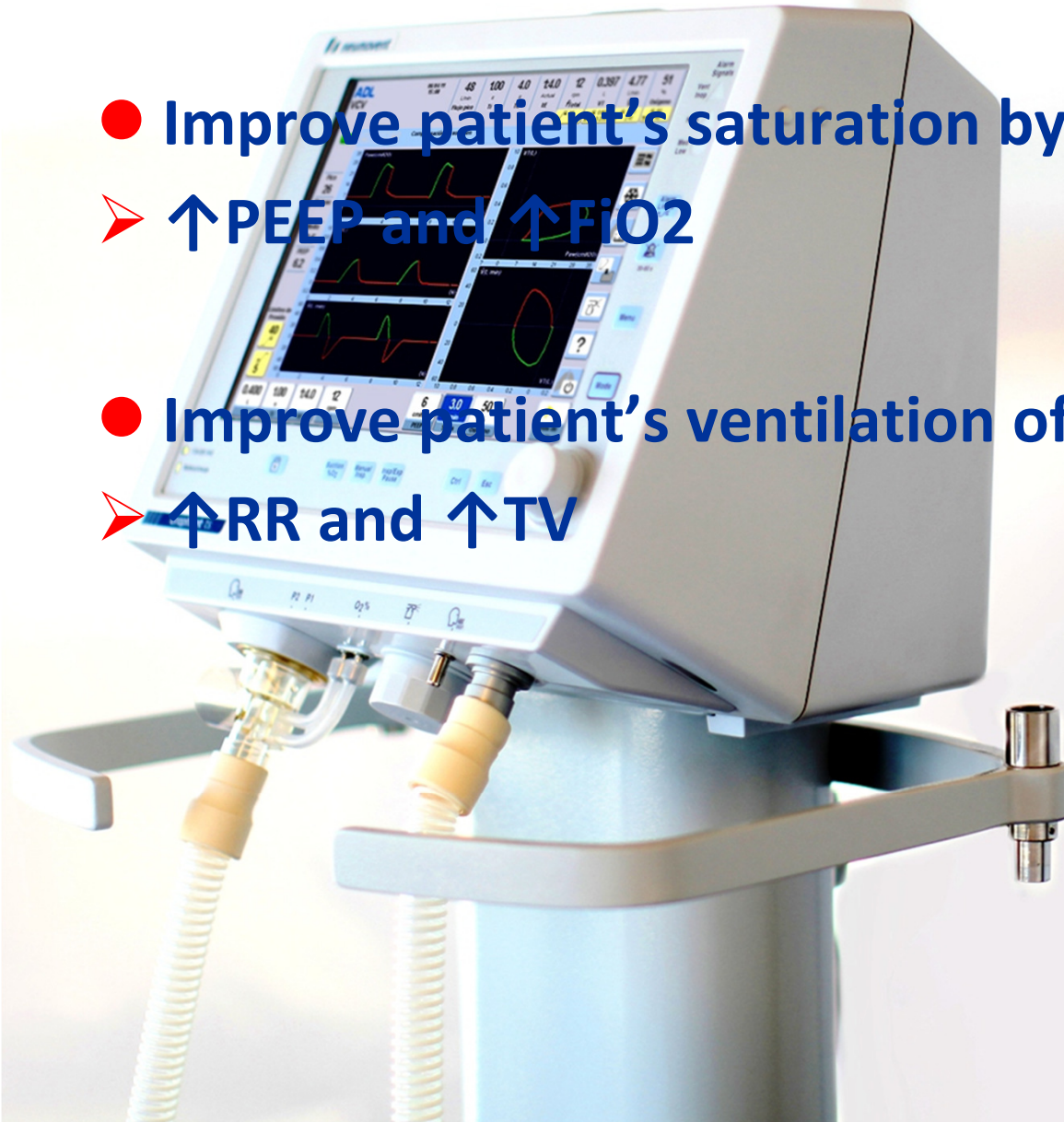
Current Ventilation Status

- **fControl – Mandatory (control) RR (b/min)**
- **fSpont – Spontaneous RR (b/min)**
- **fTotal – Total RR (fControl + fSpont)**
- **TV/ETV – (Expiratory) Tidal Volume**
- **MinVol – Minute Volume (ETV x RR)**
- **Peak Inspiratory pressure (PIP) - Maximum inspiratory pressure measured during inspiratory. (Risk of Barotrauma if \uparrow 40cmH₂O)**



Patient Status

- Improve patient's saturation by
 - \uparrow PEEP and \uparrow FiO₂
- Improve patient's ventilation of CO₂ by
 - \uparrow RR and \uparrow TV



Humidification

Heated Moisture Exchange Filter (HMEF)



Heated Water Humidifier(HWH)

Heated Water Humidifier(HWH)

VS

Heated Moisture Exchange Filter(HMEF)

HWH

HMEF

Mechanism

- Direct boiling of water to create warm vapour for humidity

- Passive retain patient exhalation warm vapour in HME for humidity

Advantage

- More efficient and patient comfort

- Disposable and convenience for patient transportation

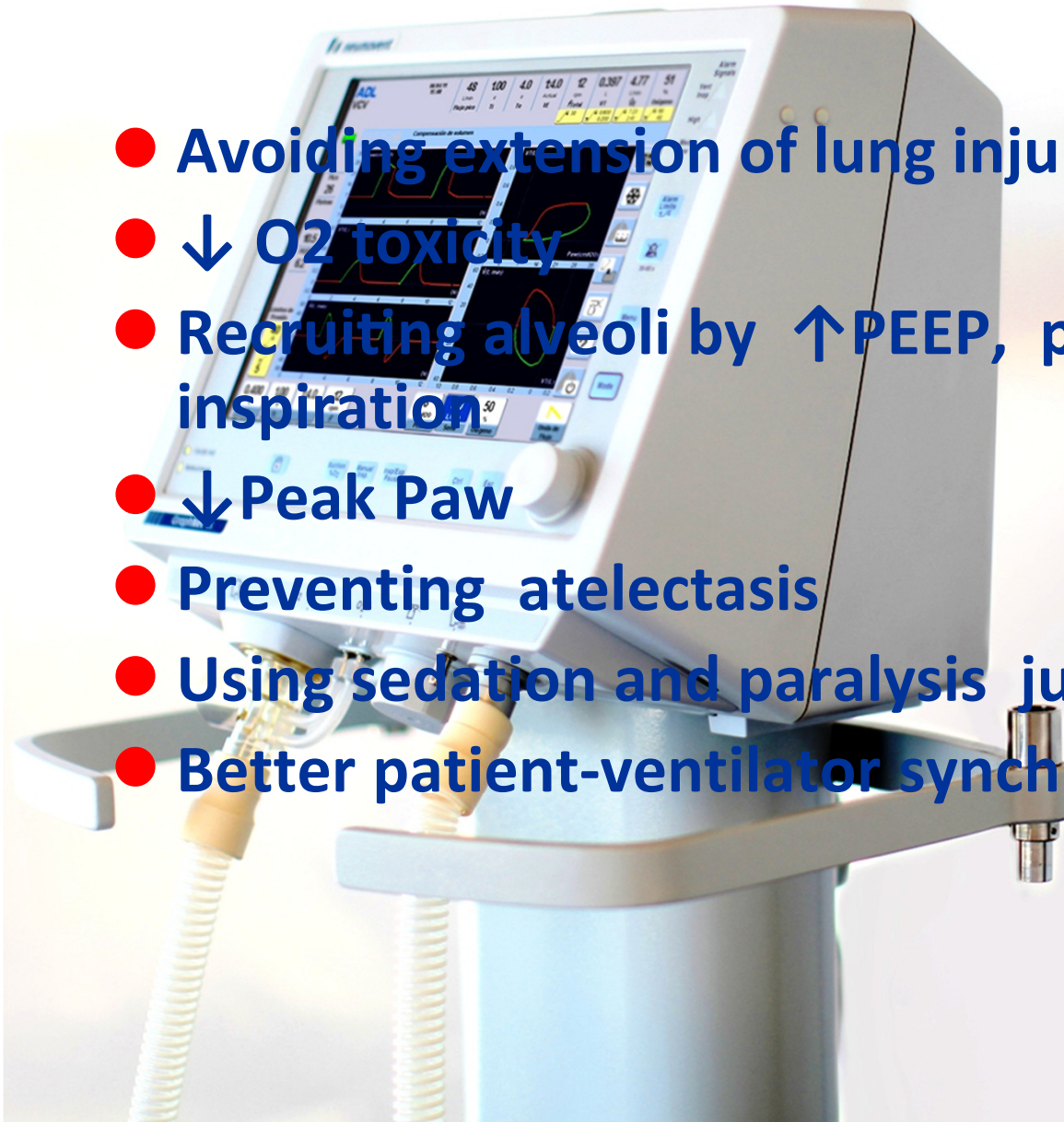
Disadvantage

- No advised to use in severe pneumonia and heavily infected patient.
- Over humidification

- Not suitable for case of hypothermia, dehydrated, burn, thick sputum, short term ventilation.

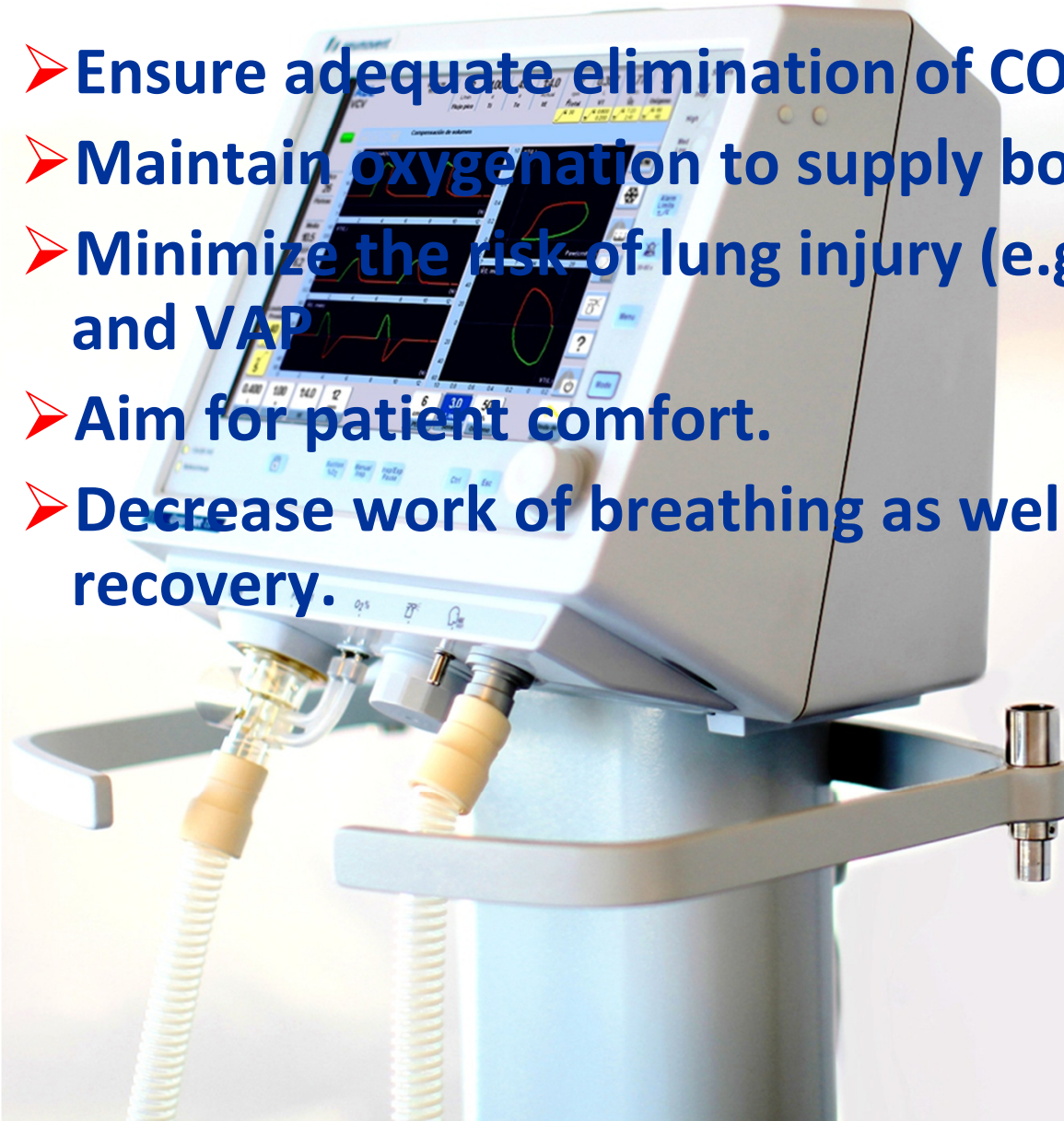
Goals of Mechanical Ventilation

- Avoiding extension of lung injury
- ↓ O₂ toxicity
- Recruiting alveoli by ↑ PEEP, prolonging inspiration
- ↓ Peak Paw
- Preventing atelectasis
- Using sedation and paralysis judiciously
- Better patient-ventilator synchrony




Ideal Mechanical Ventilatory Support


- Ensure adequate elimination of CO₂.
- Maintain oxygenation to supply body tissue.
- Minimize the risk of lung injury (e.g. baro/volutrauma) and VAP.
- Aim for patient comfort.
- Decrease work of breathing as well as muscle rest during recovery.



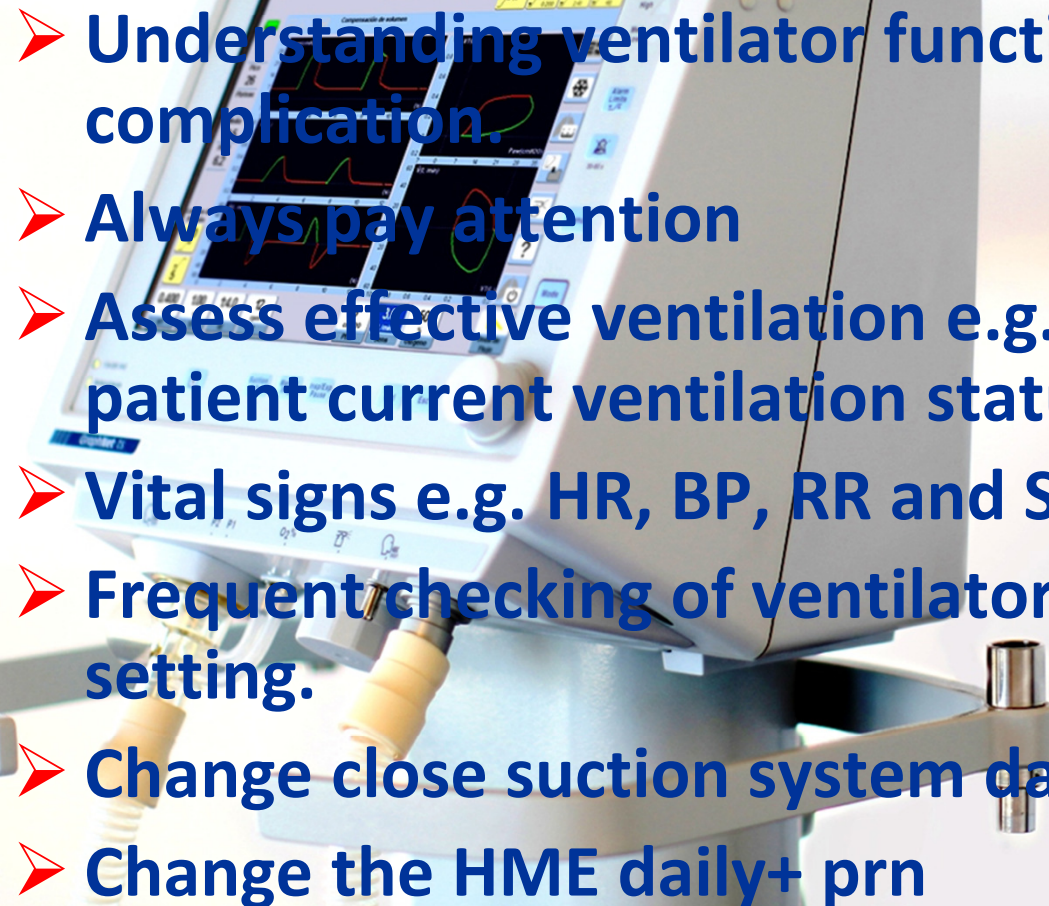
Specific mode

- 
- Spontaneous Mode (SPONT)
 - Duo Positive Airway Pressure (DuoPAP)
 - Controlled Mandatory Ventilation (CMV)
 - Synchronized Intermittent Mandatory Ventilation VC + PS (SIMV VC + PS)
 - Synchronized Intermittent Mandatory Ventilation PC + PS (SIMV PC + PS)
 - Pressure Regulated Volume Control (PRVC)
 - Pressure Control Ventilation (PCV)
 - Airway Pressure Release Ventilation (APRV)
 - Adaptive Support Ventilation (ASV)

Possible complications of mechanical ventilation

- 
- Accidental extubation
 - Blockage (secretions/blood clot/water)
 - Aspiration
 - Tracheal damage (ETT/suction)
 - Infection (VAP)
 - Pneumothorax
 - Barotrauma
 - Hypo/hyperventilation
 - Ventilator dependancy/inability to wean
 - Stress ulceration of GI tract
 - Hypotension
 - Decrease in renal function (↓perfusion)
 - Mechanical equipment failure

Nursing care of Invasive Ventilated Patient (1)

- 
- Understanding ventilator function, awareness of complication.
 - Always pay attention
 - Assess effective ventilation e.g. skin colour, SpO₂, patient current ventilation status, ABG, CXR
 - Vital signs e.g. HR, BP, RR and SpO₂.
 - Frequent checking of ventilator setting & alarms setting.
 - Change close suction system daily + prn.
 - Change the HME daily+ prn

Nursing care of Invasive Ventilated Patient (2)

- 
- Record ET tube marking and secure properly
 - Inflate cuff pressure properly and monitor regularly
 - Restrict infection control measure
 - Report any abnormal parameter and symptom
 - Nutritional support
 - Provide oral hygiene care
 - Prop up and turn position frequently
 - Emotional support
 - Low dose sedative and sedation vacation for spontaneous breathing trial

Troubles shooting

High pressure alarm

Causes

Patient bite on ET tube or tube kinked

Sputum retention

Bronchospasm, pneumothorax, barotrauma.

Patient fight with ventilator

Water or secretions condensed in tubing or HME

Interventions

- Check tubing and positioning
- Mouth pop insertion or sedate if necessary

- Aseptic technique suctioning

- Inform physician, CXR, Bronchodilator, C/D insertion

- Reassurance and sedate if necessary

- Remove condensate or change HME

Low TV and Low MV alarm

Causes

Inadequate cuff seal

Leakage of the circuit system

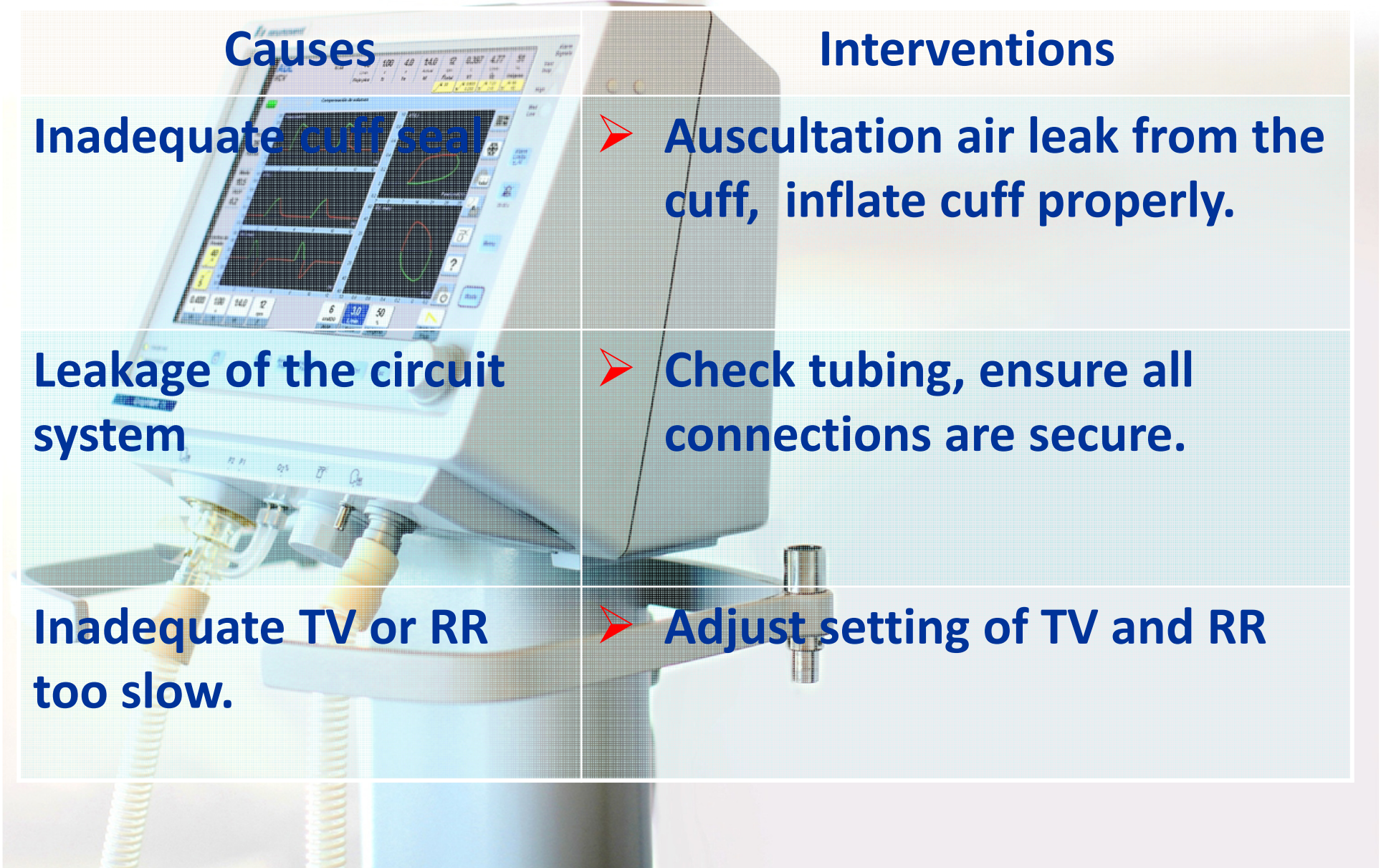
Inadequate TV or RR too slow.

Interventions


➤ Auscultation air leak from the cuff, inflate cuff properly.

➤ Check tubing, ensure all connections are secure.

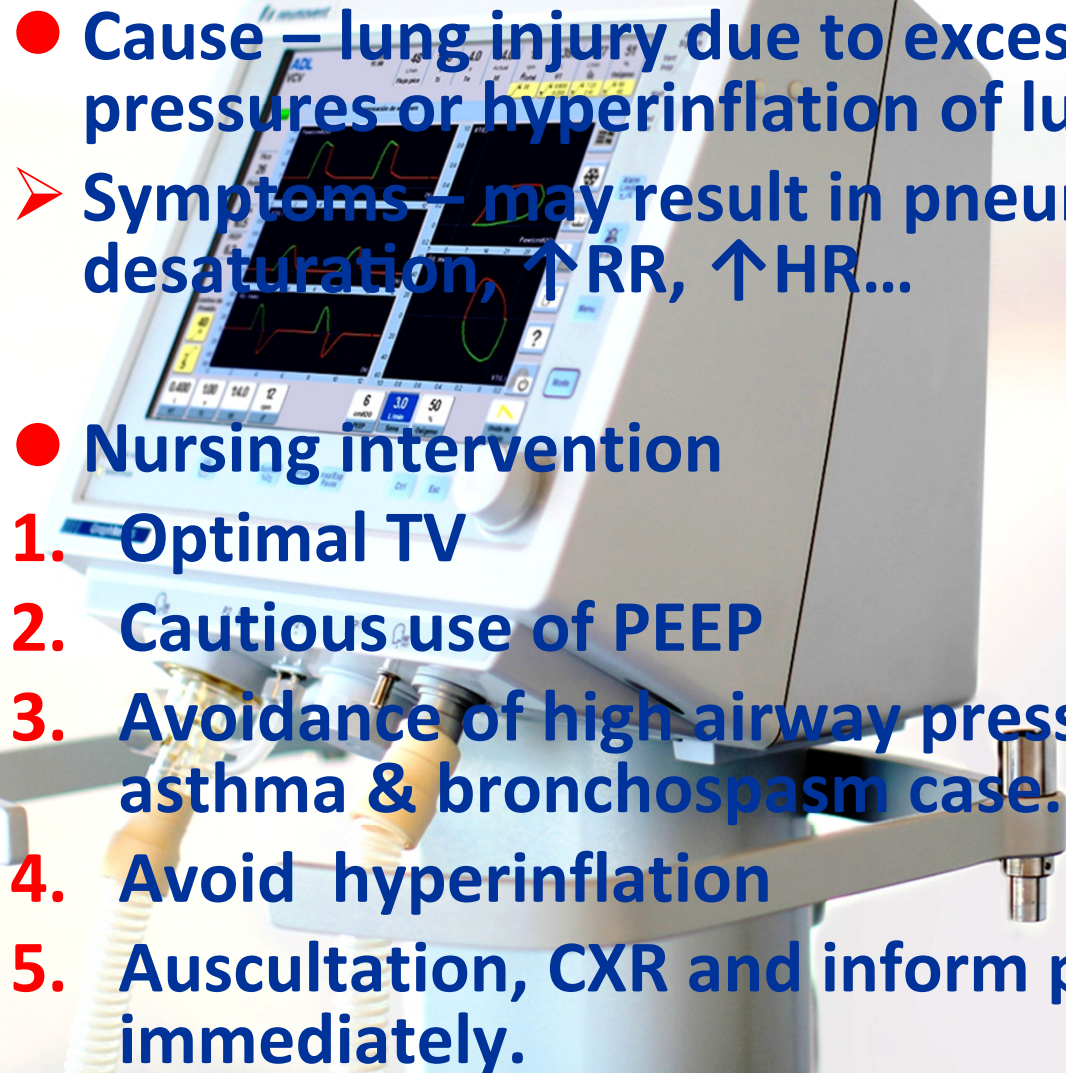
➤ Adjust setting of TV and RR



Decreased Cardiac Output

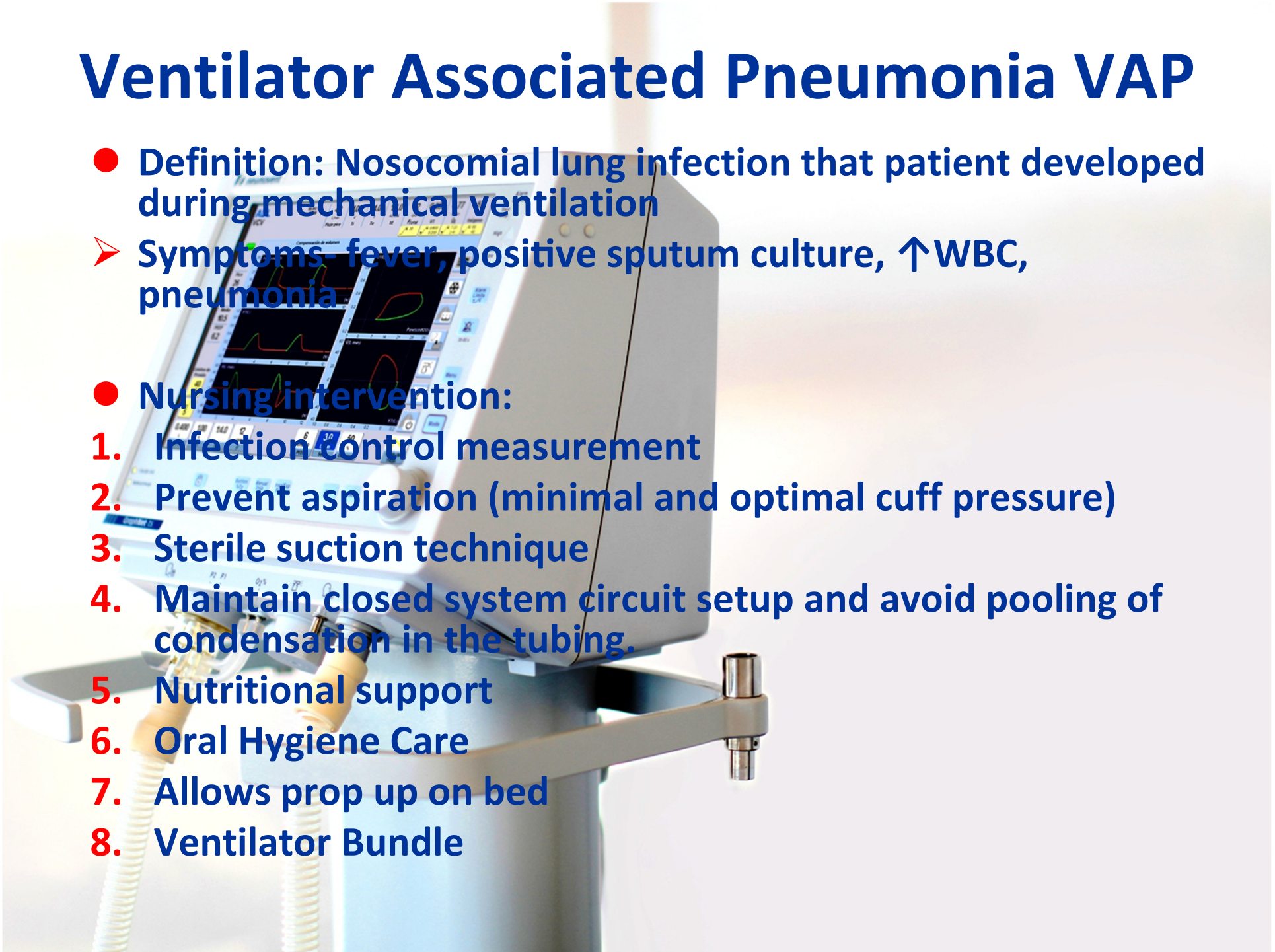
- 
- Cause - \uparrow intrathoracic pressure, \downarrow venous return, \downarrow preload.
 - Symptoms - \downarrow BP, \uparrow HR, LOC...
 - Nursing intervention
 1. Increasing preload (e.g. fluid administration if no contraindication)
 2. Inotropic infusion e.g. Dopamine, adrenaline
 3. Decrease PEEP
 4. Vital signs observation e.g. BP, HR, RR, SpO₂ and UO.

Barotrauma

- 
- Cause – lung injury due to excessive airway pressures or hyperinflation of lung
 - Symptoms – may result in pneumothorax, desaturation, ↑RR, ↑HR...
 - Nursing intervention
 1. Optimal TV
 2. Cautious use of PEEP
 3. Avoidance of high airway pressures particularly asthma & bronchospasm case.
 4. Avoid hyperinflation
 5. Auscultation, CXR and inform physician immediately.

Ventilator Associated Pneumonia VAP

- **Definition:** Nosocomial lung infection that patient developed during mechanical ventilation
- **Symptoms** fever, positive sputum culture, ↑WBC, pneumonia
- **Nursing intervention:**
 1. Infection control measurement
 2. Prevent aspiration (minimal and optimal cuff pressure)
 3. Sterile suction technique
 4. Maintain closed system circuit setup and avoid pooling of condensation in the tubing.
 5. Nutritional support
 6. Oral Hygiene Care
 7. Allows prop up on bed
 8. Ventilator Bundle



Laryngeal or tracheal stenosis

- Cause – injury from OETT to tracheal, resulting in scar formation and airway narrowing
- Nursing intervention:
 1. inflate cuff with minimal pressure
 2. monitor cuff pressure frequently.
 3. suction area above cuff frequently.





Thank You