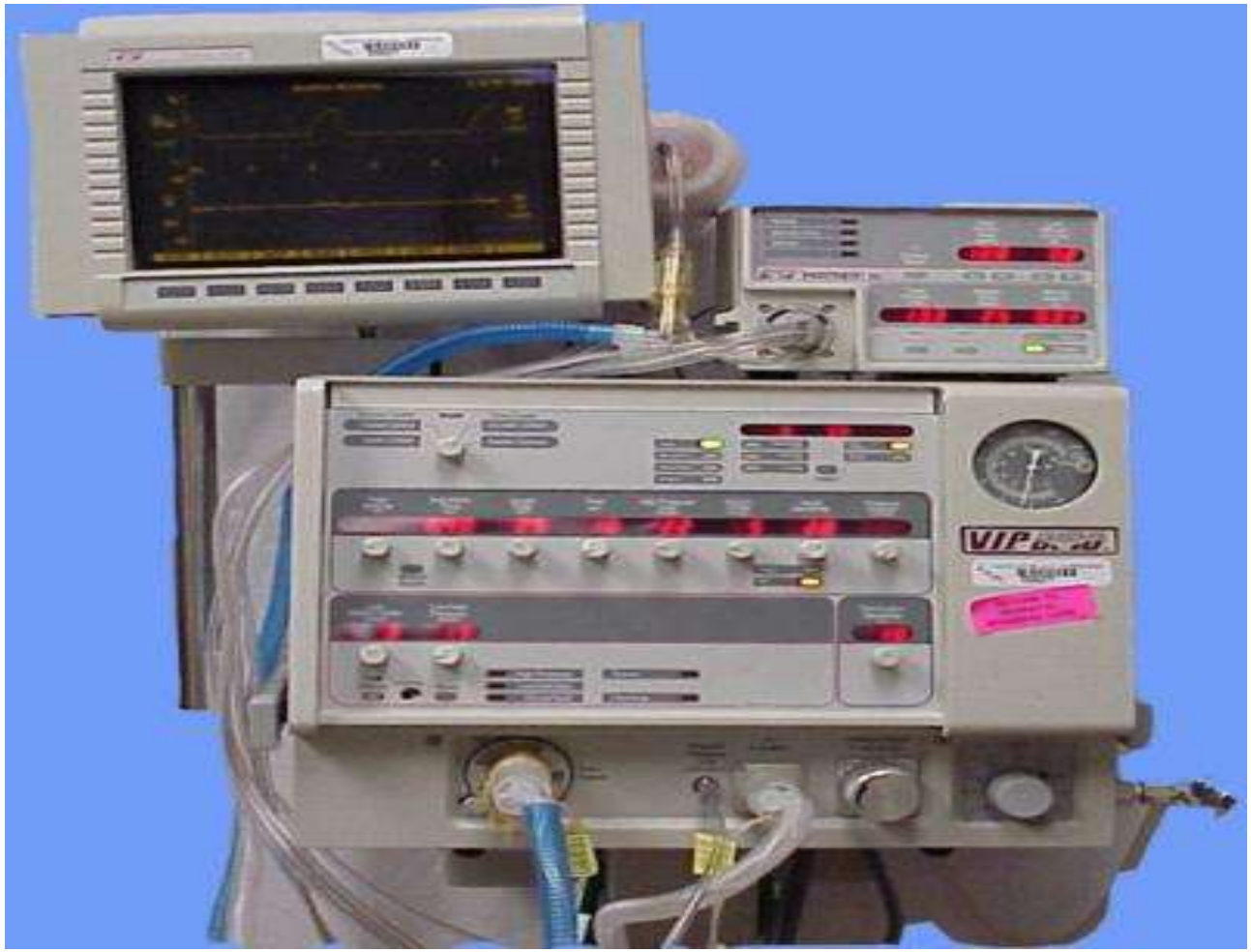
INDIAN SOCIETY OF ANAESTHESIOLOGISTS (ISA)
MECHANICAL VENTILATION MODULE (BASIC)

Orientation Course for Clinical Specialists &
Refresher Course for Anaesthesiologists

BASICS OF MECHANICAL VENTILATION

Simple Positive Pressure Mechanical Ventilator



Basic Anatomy of Airway

- Upper Airway
  - humidifies inhaled gases
  - site of most resistance to airflow
- Lower Airway
  - conducting airways (anatomic dead space)
  - respiratory bronchioles and alveoli (gas exchange)

Basic Physiology

- Negative pressure circuit
  - Gradient between mouth and pleural space is driving pressure
  - need to overcome resistance
  - maintain alveolus open
  - overcome elastic recoil forces

Concept of Mechanical Ventilation

- Ventilators deliver gas to the lungs using positive pressure at a certain *rate*.
- The amount of gas delivered can be *limited* by time, pressure or volume.
- The duration can be *cycled* by time, pressure or flow.

Indications for Mechanical Ventilation

- The work of breathing usually accounts for 5% of oxygen consumption ($V0_2$).

- In the critically ill patient this may rise to 30%.

- Invasive mechanical ventilation eliminates the metabolic cost of breathing.

Indications for Mechanical Ventilation

Inadequate oxygenation (not corrected by suppl. O_2 by mask).

Inadequate ventilation (increased $PaCO_2$).

Retention of pulmonary secretions (bronchial toilet).

Airway protection (obtunded patient, depressed gag reflex).

Cardiac Insufficiency: *eliminate work of breathing*
reduce oxygen consumption

Neurologic dysfunction: *central hypoventilation/ frequent apnea*
patient comatose, GCS $\leq$ 8
inability to protect airway

Principles of Mechanical Ventilation

- Positive pressure ventilation involves delivering a mechanically generated 'breath' to get O_2 in and CO_2 out.

- Gas is pumped in during inspiration (Ti) and the patient passively expires during expiration (Te).

- The sum of Ti and Te is the respiratory cycle or 'breath'.

Basic Settings on the Ventilator

- Tidal Volume

  Pressure controlled breath (15-20 cm H_20)

  Volume controlled breath (500 mls)

  Rate (frequency) (10-12 breaths/minute)

- Positive end expiratory pressure (PEEP) (5 cm H_20)

- FiO_2 (0.21-1)

- Peak airway pressure (PAP)

Standard Ventilator Settings

MORITE

Mode

O_2

Respiratory Rate

Inspiratory Action

Inspiratory Time

Expiratory Action

Standard Ventilator Settings

MORITE

Mode	CMV, Volume Control
O_2	0.5 (50% 0_2)
Respiratory Rate	12/minute
Inspiratory Action	Set Vt at 500 mls
Inspiratory Time	Set I:E ratio 1:2
Expiratory Action	Set PEEP at 5 cm H_20
Be Aware	PAP ≤35 cm H_2O

Trigger

- How does the vent know when to give a breath?

  “Trigger”

  - patient effort
  - elapsed time

- The patient’s effort can be “sensed” as a change in pressure or a change in flow (in the circuit)

Initial Settings

⦿Pressure Limited

- FiO_2
- Rate
- I-time or I:E ratio
- PEEP
- PIP or PAP

⦿Volume Limited

- FiO_2
- Rate
- I-time or I:E ratio
- PEEP
- Tidal Volume

Initial Settings

- Settings
  - Rate: start with a rate that is somewhat normal; i.e., 12 for an adult,15 for adolescent/child, 20-30 for infant/small child
  - FiO_2: 100% and wean down
  - PEEP: 3-5
  - Control every breath (A/C) or some (SIMV)
  - Mode ?

Nomenclature

- Airway Pressures
  - Peak Inspiratory Pressure (PIP)
  - Positive End Expiratory Pressure (PEEP)
  - Mean airway pressure (MAP)
  - Continuous Positive Airway Pressure (CPAP)
- Inspiratory Time or I:E ratio
- Tidal Volume: amount of gas delivered with each breath

Principles of Mechanical Ventilation

- Mechanically ventilated patients usually receive positive end-expiratory pressure (PEEP), to overcome the loss of physiological PEEP provided by the larynx and vocal cords.

- PEEP is delivered throughout the respiratory cycle synonymous to CPAP, but in the intubated patient.

- Standard PEEP setting is 5 cm H_20 in adults

- Sedation- often required to prevent ventilator-patient asynchrony.

Principles of Mechanical Ventilation

- Why is the peak airway pressure (PAP) important?

- Ventilator Induced Lung Injury (VILI).

  Mechanical ventilation is injurious to the lung.

- Aim PAP < 35 cm H_20

Troubleshooting

- Is it working ?
  - ***Look at the patient !!***
  - ***Listen to the patient !!***
  - Pulse Ox, ABG, $EtCO_2$
  - Chest X ray
  - Look at the vent (PIP; expired TV; alarms)

Troubleshooting

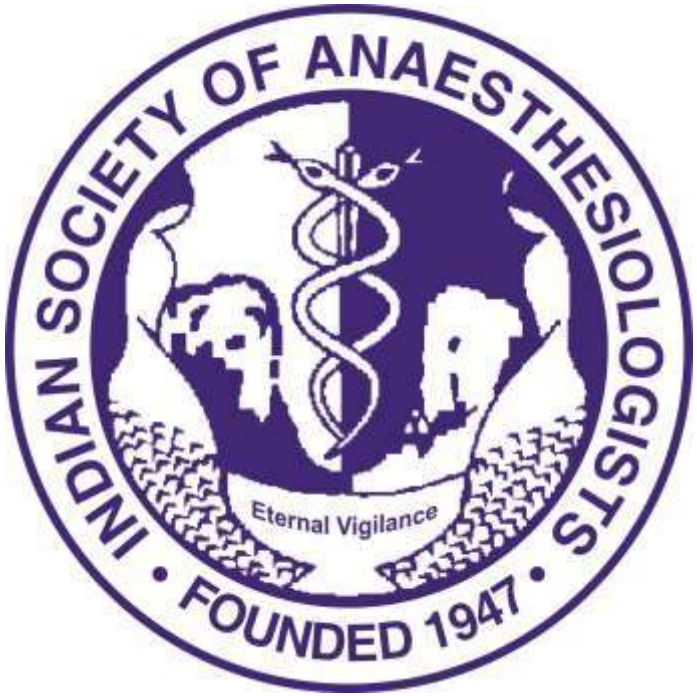
- When in doubt, DISCONNECT THE PATIENT FROM THE VENTILATOR, and begin bag ventilation.
- Ensure you are bagging with 100% O2.
- This eliminates the ventilator circuit as the source of the problem.
- Bagging by hand can also help you gauge patient's lung compliance

Troubleshooting

- Airway first: is the tube still in? (may need DL/$EtCO_2$ to confirm) Is it patent? Is it in the right position?
- Breathing next: is the chest rising? Breath sounds present and equal? Changes in exam? Atelectasis, bronchospasm, pneumothorax, pneumonia? (Consider needle thoracentesis)
- Circulation: shock? Sepsis?

Troubleshooting

- Well, it isn't working…..
  - Right settings ? Right Mode ?
  - Does the ventilator need to do more work ?
    - Patient unable to do so
    - Underlying process worsening (or new problem?)
  - Air leaks?
  - Does the patient need to be more sedated ?
  - Does the patient need to be extubated ?
  - Ventilator is only human…..(is it working ?)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