BASIC PRINCIPLES OF VENTILATION IN THE INTENSIVE CARE UNIT

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TYPES OF RESPIRATORY FAILURE

- **HYPOXIC**
  - **ABNORMALITIES OF OXYGENATION**
- **HYPERCAPNIC**
  - **ALVEOLAR HYPOVENTILATION**
  - **INCREASED DEAD SPACE(V_D)**
  - **EXCESSIVE CO_2 PRODUCTION**
- **COMBINED**

TREATMENT OF OF RESPIRATORY FAILURE

- **TREAT CAUSE**
- **HYPOXIC RESPIRATORY FAILURE**
  - **OXYGEN**
  - **PEEP / CPAP**
- **HYPERCAPNIC RESPIRATORY FAILURE**
  - **VENTILATE**
- **ADJUNCT THERAPY**
  - **OPTIMAL FLUID BALANCE**
  - **NUTRITION**
  - **BRONCHODILATOR THERAPY**
  - **PHYSIOTHERAPY**
  - **PRONE POSITION**
  - **Nitric Oxide**
  - **etc.**

INDICATIONS FOR MECHANI VENTILATION

- **Acute Respiratory Failure (66%)**
  - **ARDS**
  - **Heart failure**
  - **Pneumonia**
  - **Sepsis**
  - **Complications of surgery**
  - **Trauma**
- **Coma (15%)**
- **Acute COPD exacerbation (13%)**
- **Neuromuscular disorders (5%)**

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COMPLICATIO
VENTILATI

- **ENDOTRACHEAL TUBE COMPLICATIONS**
  - Tube not in place
    - Oropharynx or esophagus
    - One lung intubation
  - Tube blocked
  - Cuff air leak
- **VENTILATOR FAILURE**
  - Machine failure
  - Alarm failure
    - Alarms off
    - Inadequately set alarms

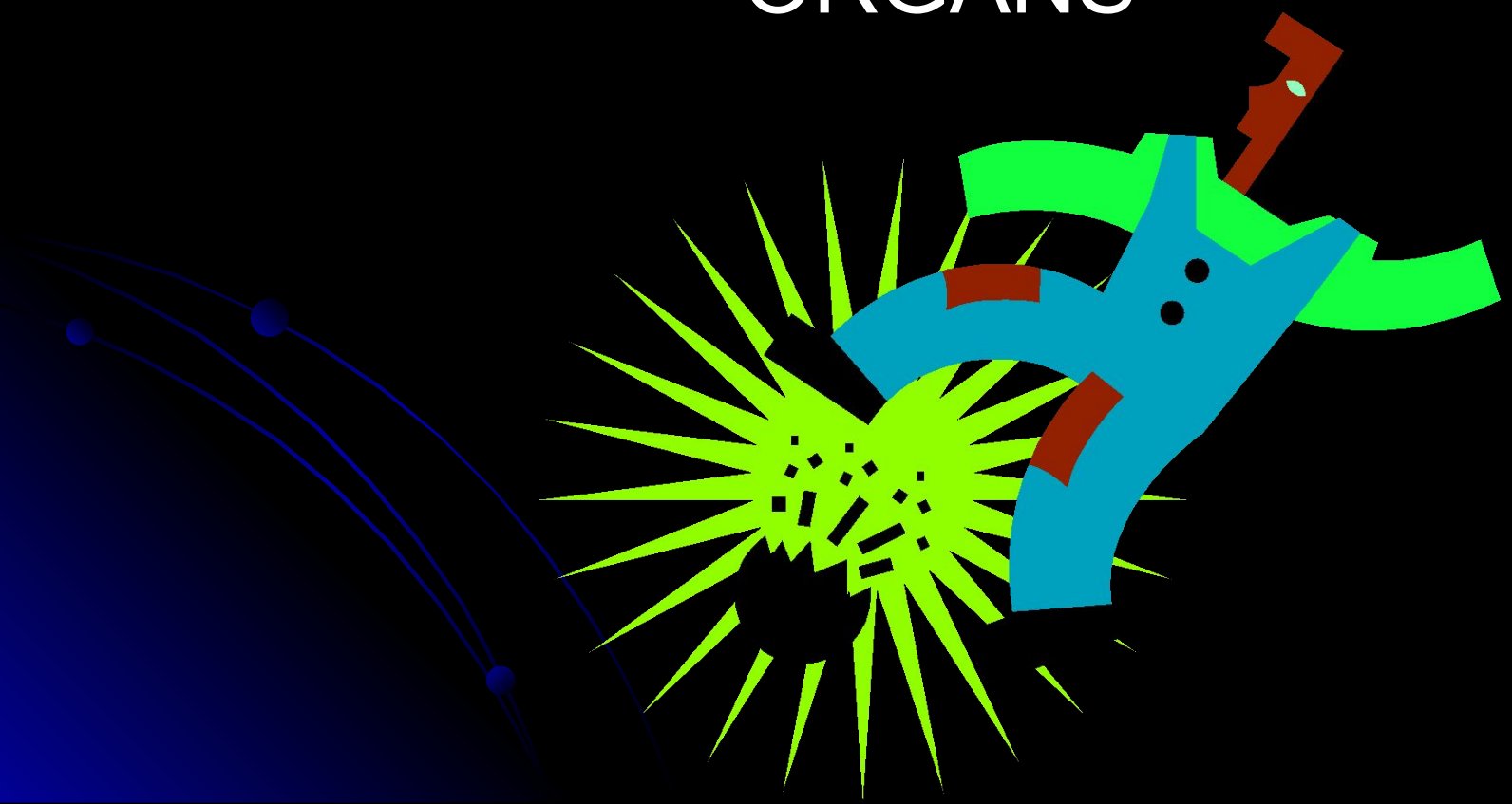
COMPLICATIONS OF VENTILATION

MEDICAL COMPLICATIONS

- Oxygen toxicity
- Barotrauma
  - Pneumothorax
  - Pneumomediastinum
  - Parenchymal interstitial emphysemia
- Volutrauma
- Biotrauma
- Atelectasis

- Infection
- Hypoventilation
- Hyperventilation
- Hypotension
- GI hypomotility
- Stress gastropathy
- Arrhythmias
- Salt + water retention
- Gastric dilatation

VENTILATION CAN THEREFORE CAUSE GREAT DAMAGE BOTH TO THE LUNGS AND TO OTHER ORGANS

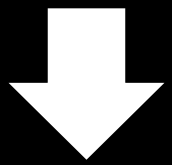


PITFALLS HOW TO AVOID THESE

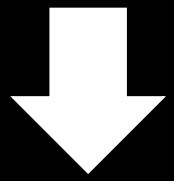
Personnel should

- have basic understanding of ventilators and ventilatory principles.
- Understand the safe limits of ventilation
  - Lowest FIO_2 and PEEP to maintain oxygen saturation > 90%
  - Maintain plateau pressure < 35cmH_2O
  - Maintain sterile techniques

VENTIL



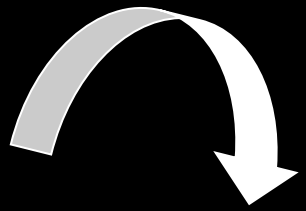
POSITIVE PRESSURE VENTILATION



NEGATIVE PRESSURE VENTILATION

NON INVASIVE VENTILATION

INVASIVE VENTILATION



CONVENTIONAL VENTILATION

NON CONVENTIONAL VENTILATION

High frequency jet

High frequency oscillations

Liquid ventilation

APRV

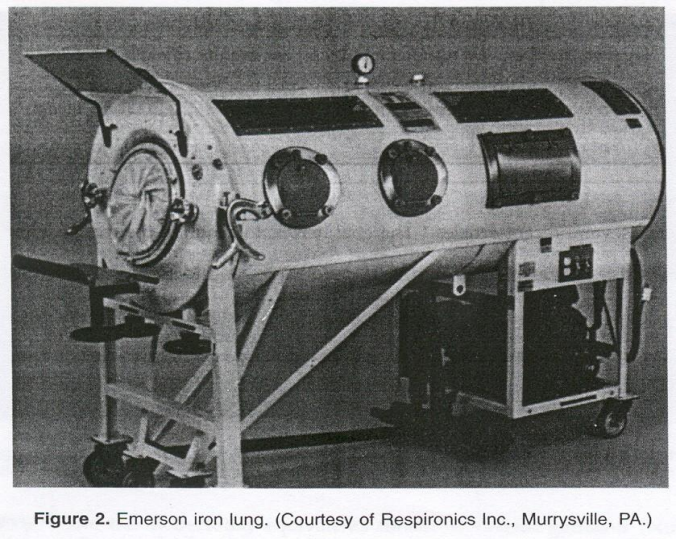


Figure 2. Emerson iron lung. (Courtesy of Respironics Inc., Murrysville, PA.)

Negative pressure ventilation

Negative pr ation

Non invasive ventilation

Invasive ventilation

INVASIVE VENTILATION

Ventilators = Husband

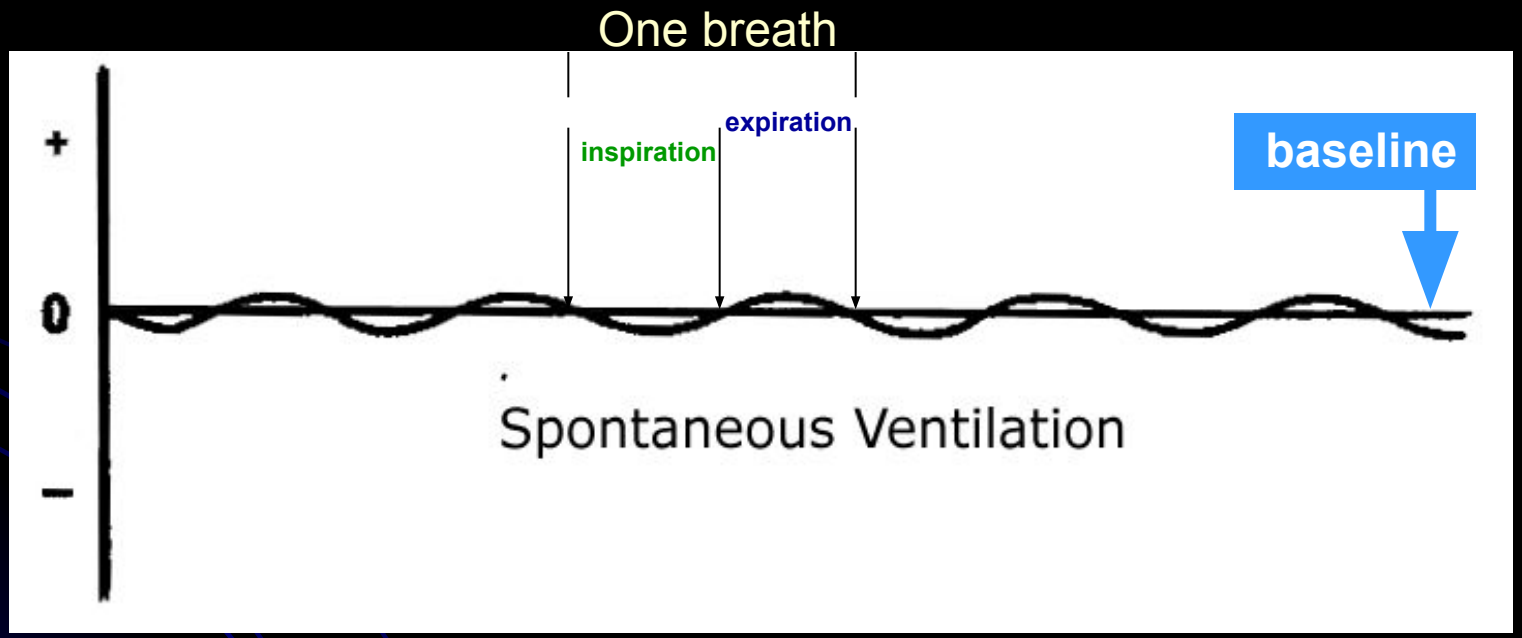
- Have to tell it exactly what to do.
- Sometimes it malfunctions therefore require warnings and backup.

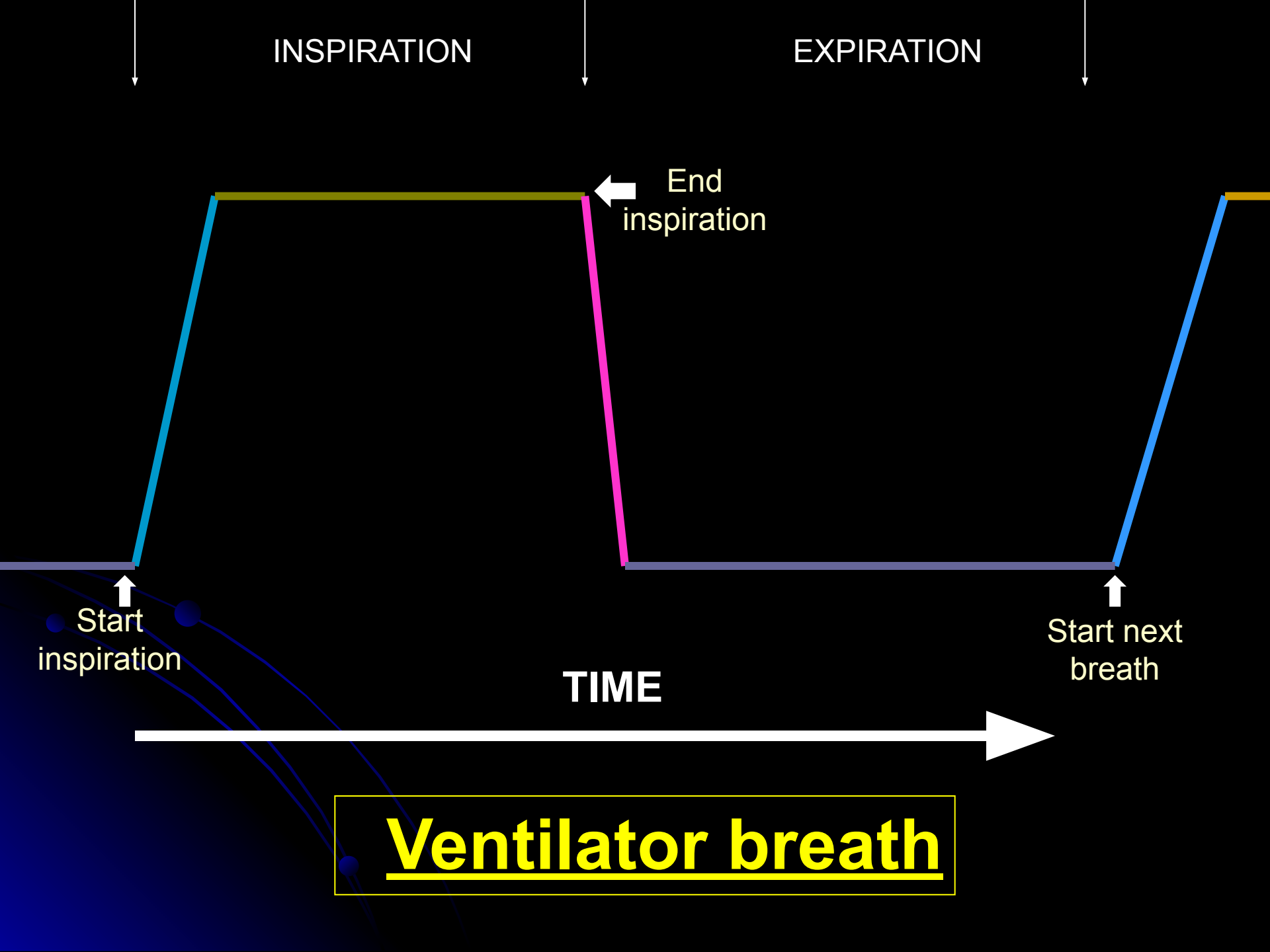
- Ventilators can measure 4 parameters
  - TIME
  - PRESSURE
  - FLOW
  - VOLUME
- We can use these parameters to tell the ventilator when to start pushing air/oxygen into patient and when to stop.

Ventilators need to know 5 basic things:

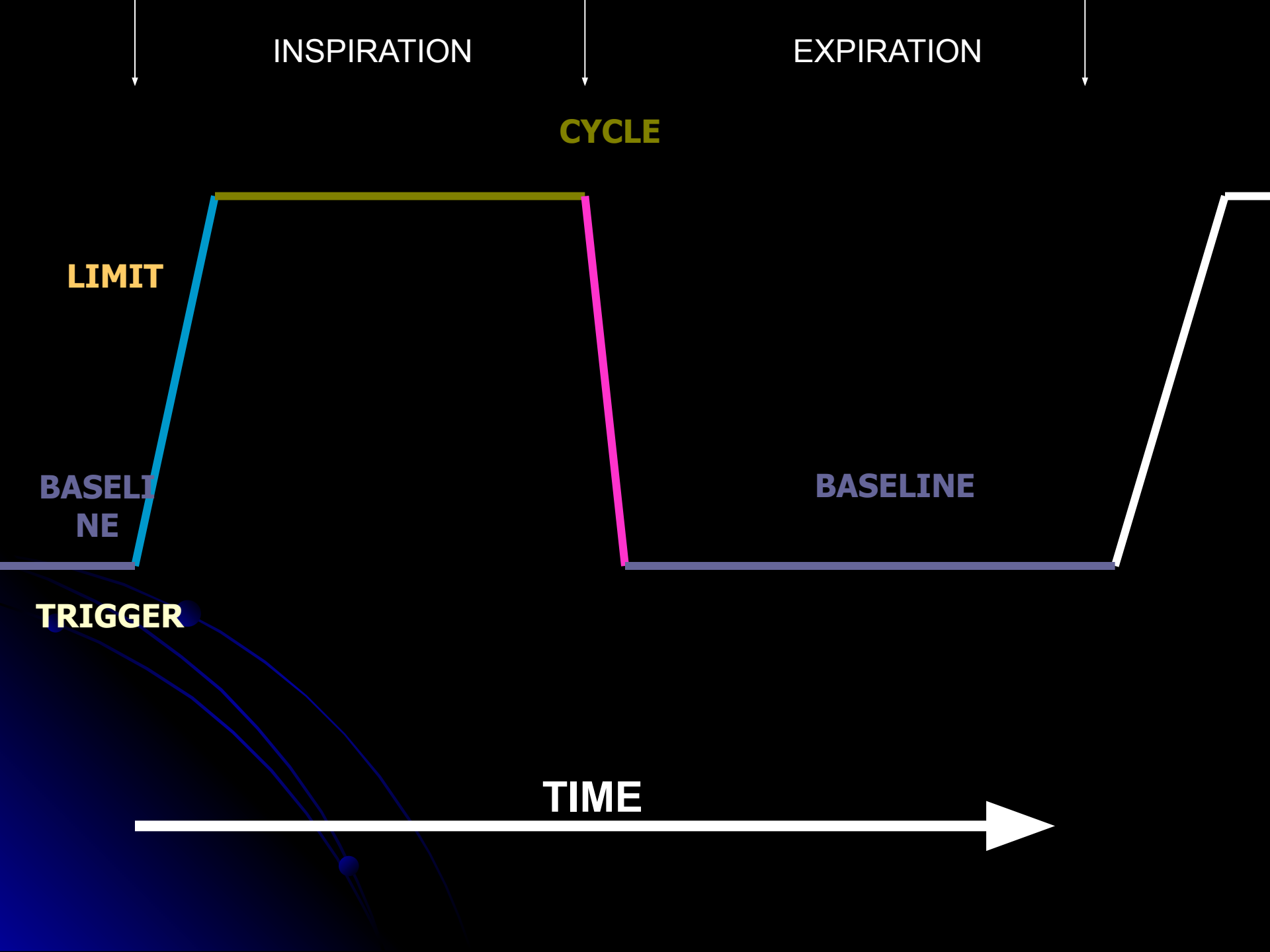
- The amount of oxygen to provide – FIO_2
- What is the baseline pressure
  - PEEP
- When to start pushing air/O_2 into patient
  - TRIGGER
- How quickly to push the air/O_2 in
  - LIMIT
- When to stop pushing air/O_2 in
  - CYCLE

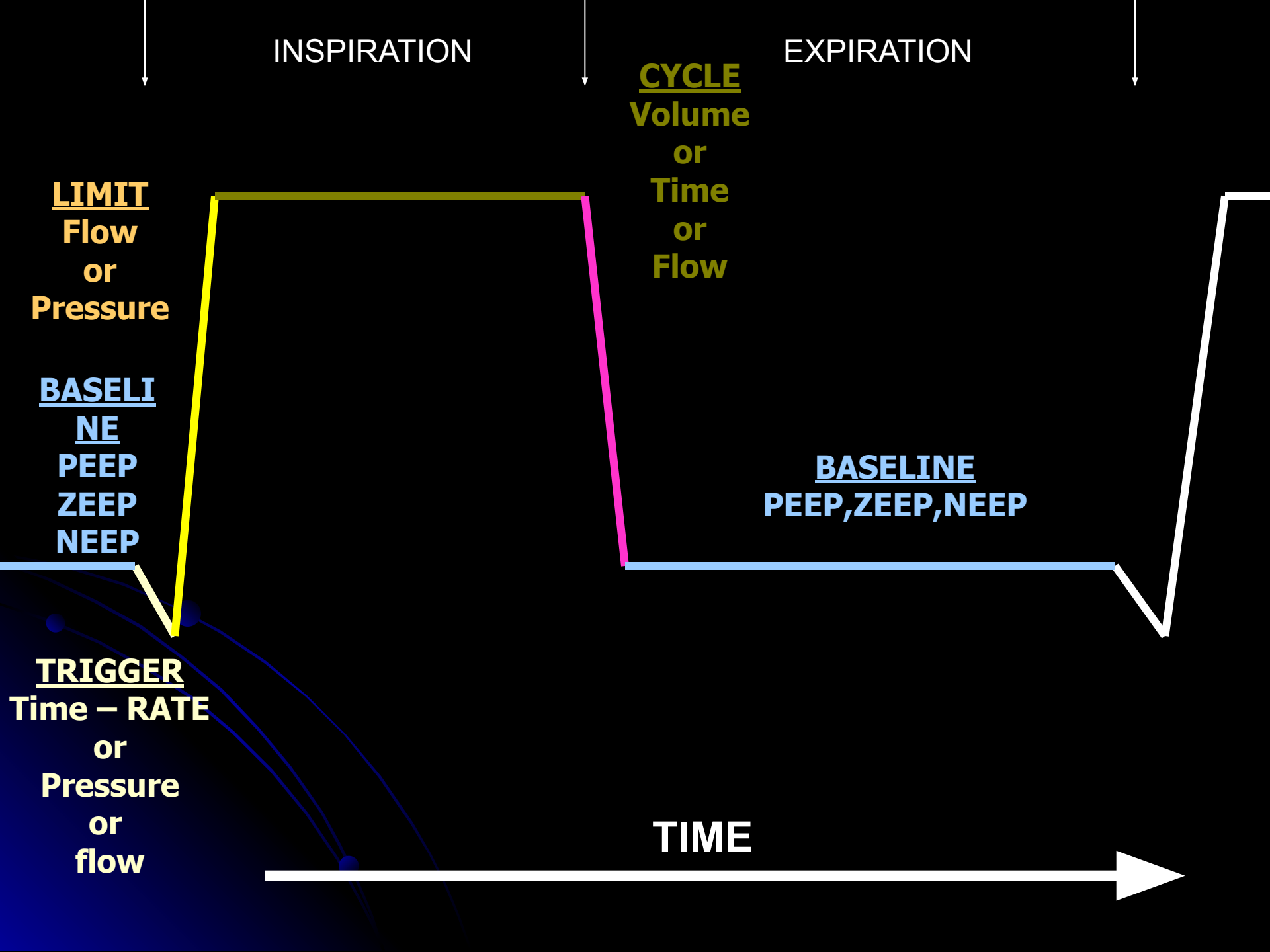
Normal spontaneous breathing





Ventilator breath


INSPIRATION
EXPIRATION
CYCLE
LIMIT
BASELI
NE
BASELINE
TRIGGER
TIME

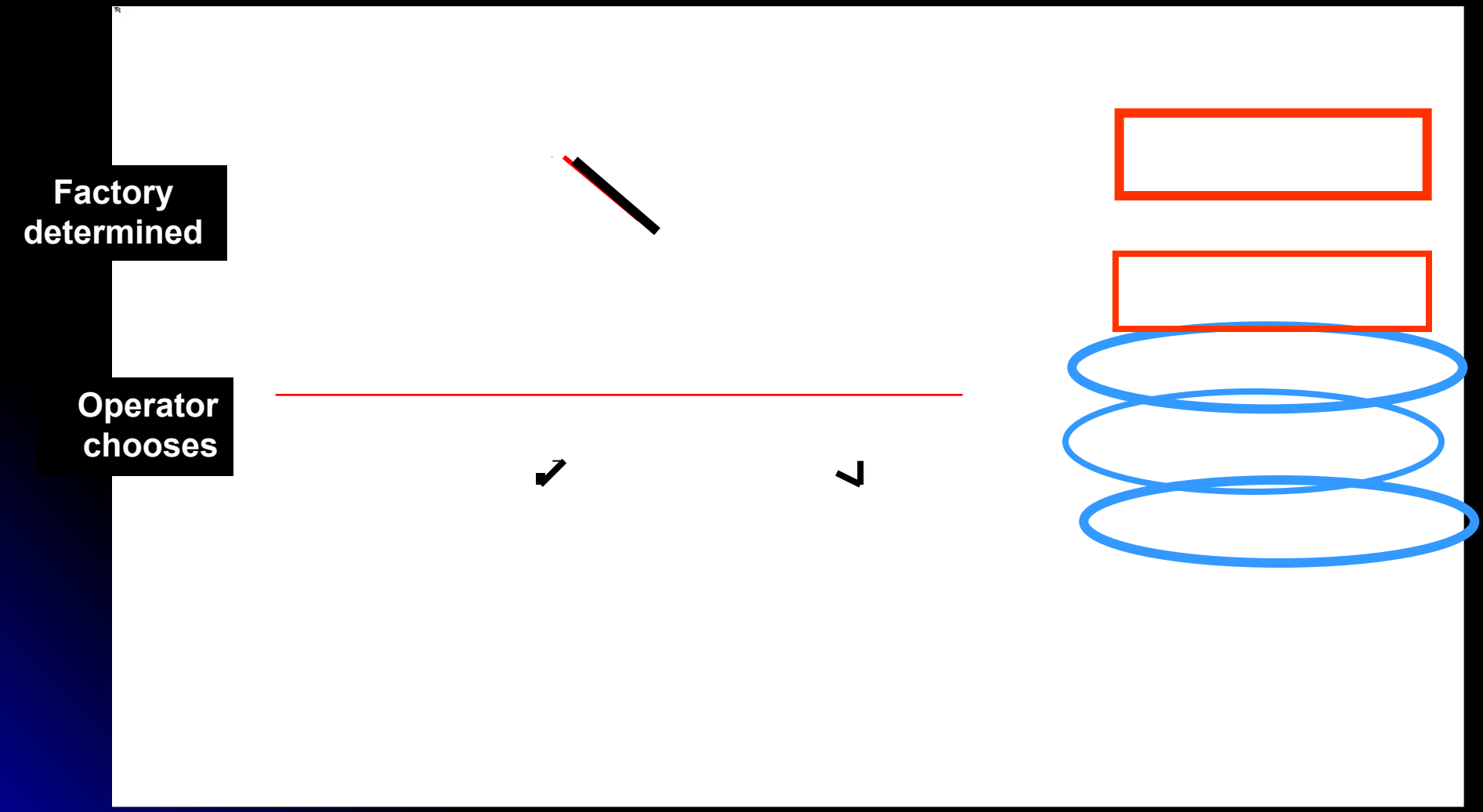

INSPIRATION
EXPIRATION
CYCLE
Volume
or
Time
or
Flow
LIMIT
Flow
or
Pressure
BASELI
NE
PEEP
ZEEP
NEEP
BASELINE
PEEP,ZEEP,NEEP
TRIGGER
Time – RATE
or
Pressure
or
flow
TIME

MODE OF VENTILATION DETERMINED BY LIMIT AND CY

- Pressure Limited Flow Cycled
  - PRESSURE SUPPORT VENTILATION
- Flow Limited Volume Cycled
  - VOLUME CONTROLLED VENTILATION
- Pressure Limited Time Cycled
  - PRESSURE CONTROLLED VENTILATION

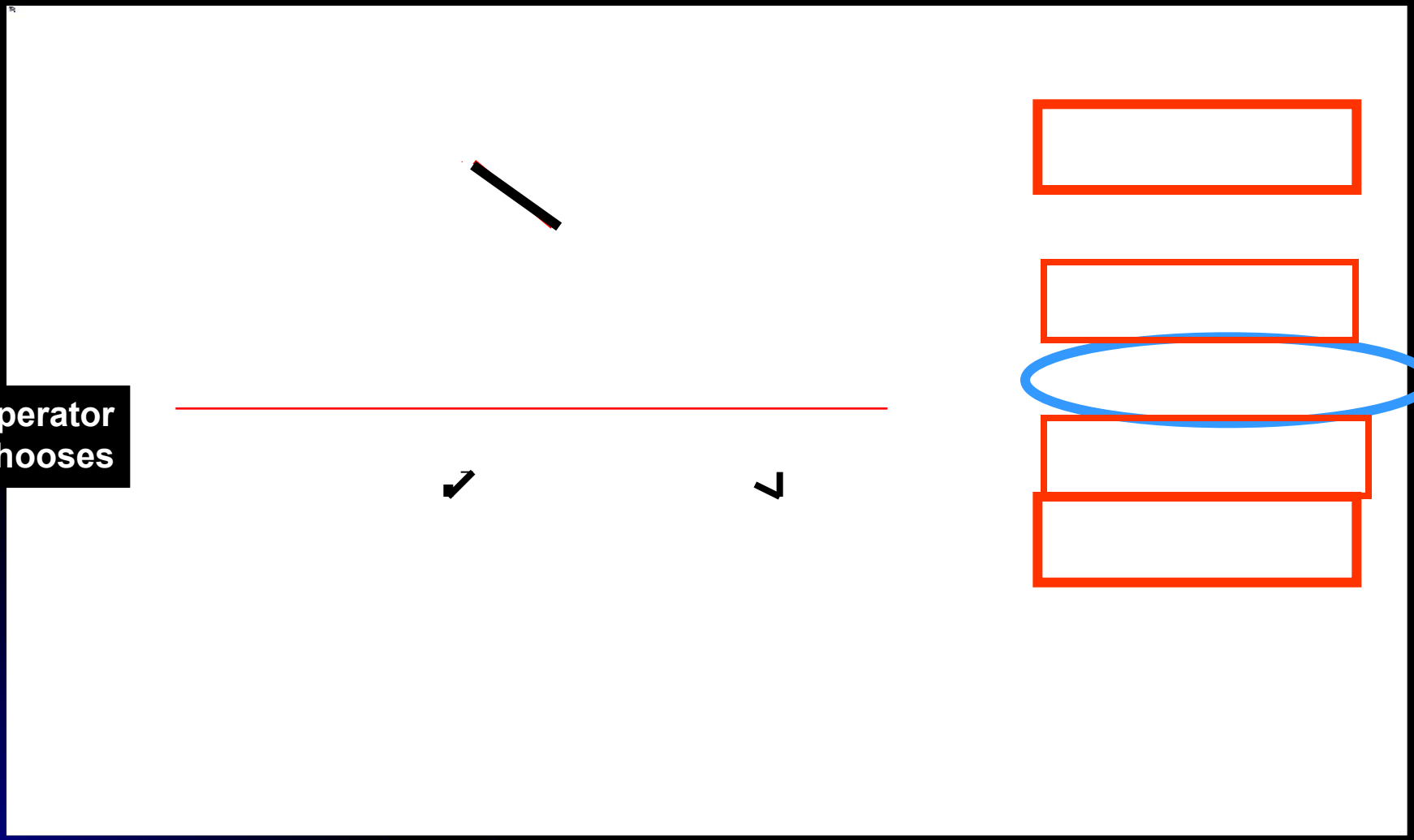
Pressure Limited Flow Cycled Ventilation (PSV)

-operator selects FIO_2, pressure, PEEP



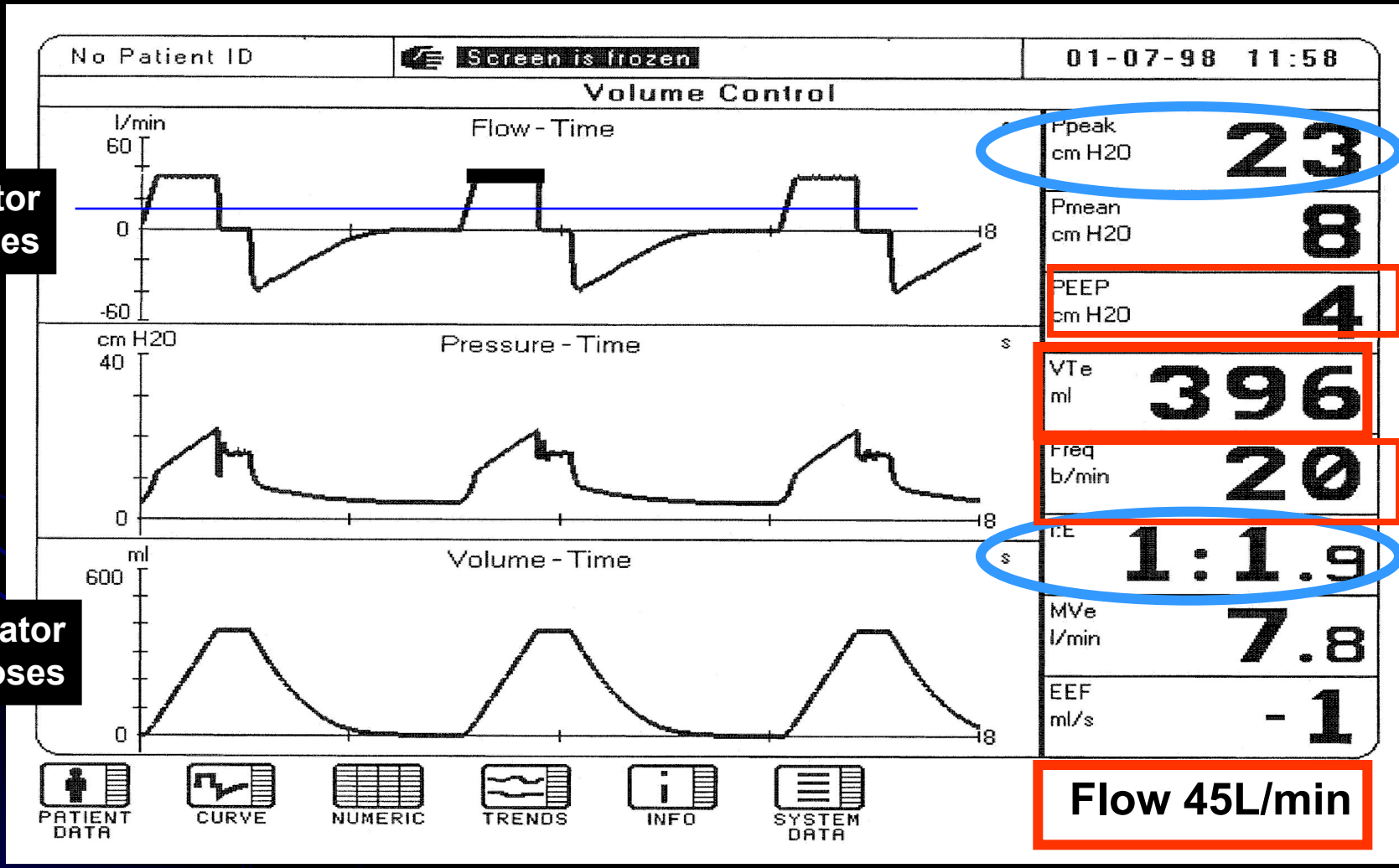
Pressure Limited Time Cycled Ventilation (PCV)

- operator selects FIO_2, pressure, insp time (I:E ratio), rate, PEEP



Flow Limited Volume Cycled Ventilation (VC

- operator selects FIO_2, flow, tidal volume, rate, PEEP



Pressure- limited, flow-cycled ventilation (PSV)

ADVANTAGES

- improved patient comfort
- patient controls initiation of ventilator supported breath
- patient partially controls cessation of ventilator supported breath

DISADVANTAGES

- no back up

PRESSURE LIMITED TIME CYCLED(PCV)

ADVANTAGES

- **? less barotrauma**
- **improved patient comfort**

DISADVANTAGES

- **minute volume not guaranteed**

FLOW LIMITED VOLUME CYCLED(VCV)

ADVANTAGES

- ensures minute volume
- easy to use

DISADVANTAGES

- may result in high inspiratory pressures
  - barotrauma
- may be uncomfortable to patient
  - flow limit

IF CHOOSE VCV OR PCV must ma
additional choice

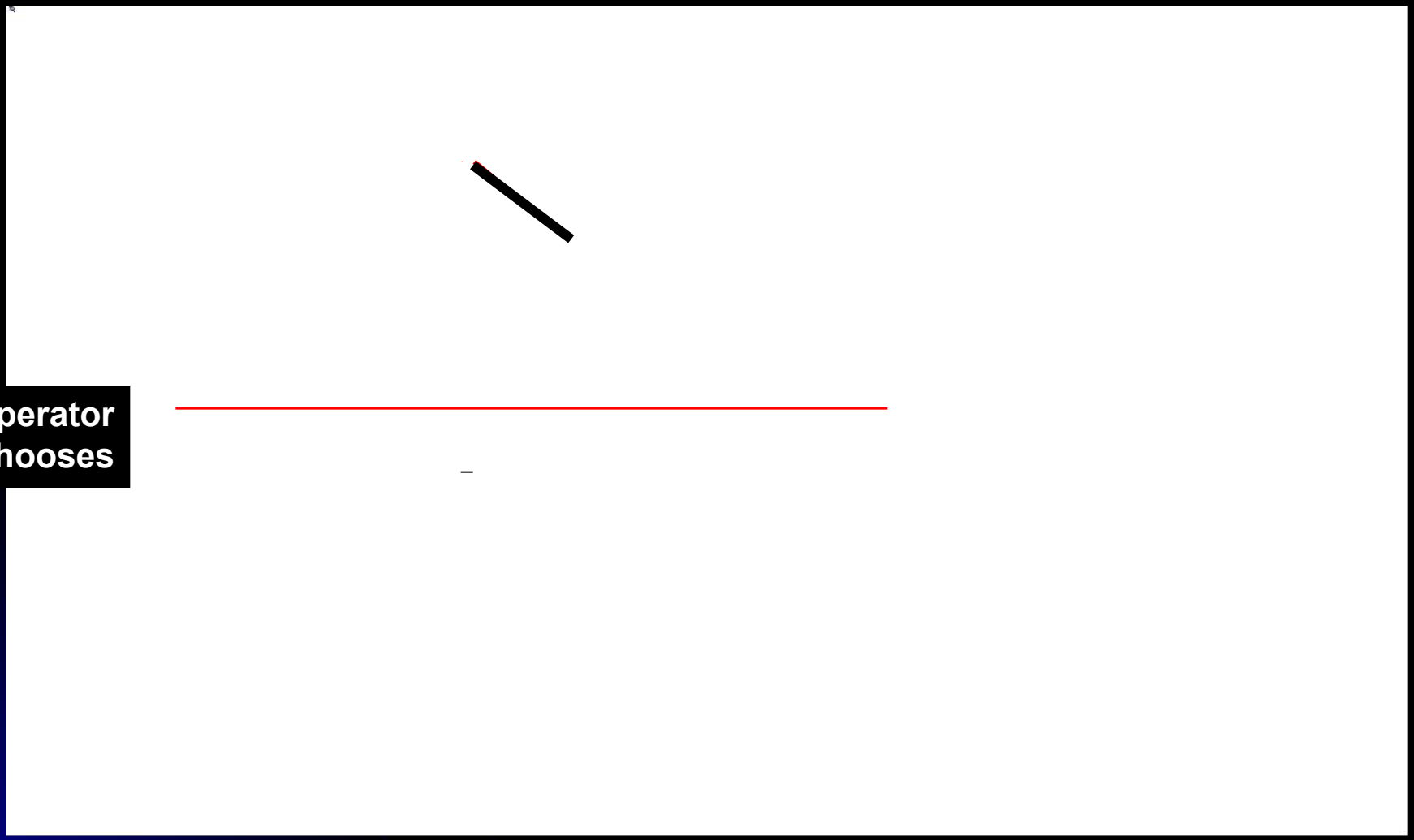
- the character of additional spontaneous br

- Controlled Mechanical Ventilation
  - CMV
- Assist Controlled Ventilation
  - A/C
- Synchronized Intermittent Mandatory Ventilation
  - SIMV

Pressure Limited Time Cycled Ventilation (PCV)

CONTROLLED MECHANICAL VENTILATION(CMV)

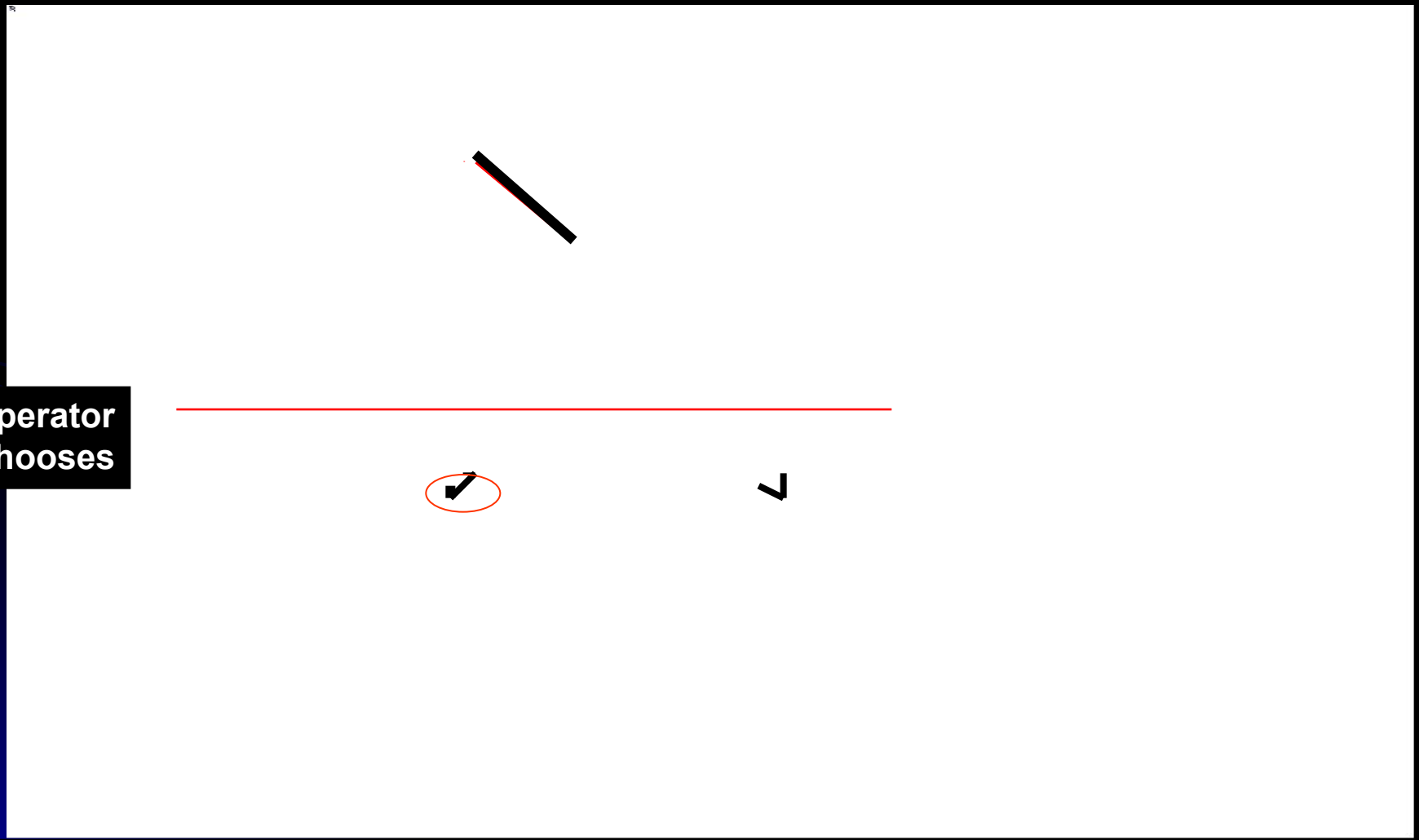
-operator selects FIO_2, pressure, insp time (I:E ratio),rate, PEEP



Pressure Limited Time Cycled Ventilation (PCV)

ASSIST CONTROL VENTILATION (A/C)

- operator selects FIO_2, pressure, insp time (I:E ratio), rate, PEEP



Flow Limited Volume Cycled Ventilati

SYNCHRONIZED INTERMIITENT MANDATORY

(SIMV)

-operator selects FIO_2, flow, tidal volume, ra

?What must I set on the ventilator

PSV or PCV or VCV must set 1) FIO_2

2)PEEP

3)trigger:pressure or flow

Mode	pressure	flow	volume	Ti	rate	other	alarms
PSV	yes					volume- max & min	
PCV	yes		yes	yes		CMV;A/C;SIMV	volume-min & max
VCV		yes	yes		yes	CMV;A/C;SIMV	pressure

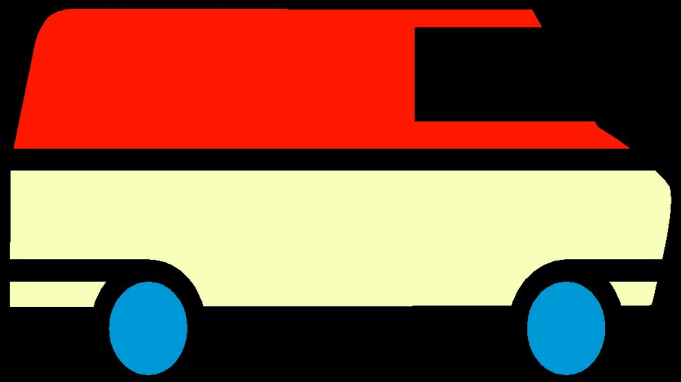
The secret to a happy operator-ventilator relationship is to understand the abilities of .the ventilator

MONITO

- Ventilator-patient synchrony
- Saturation > 90%
- $PaCO_2$
  - Normal only if does not require high pressure
- Peak pressure < 35cmH_2O
- Tidal volume 5 – 7cc/kg
- Rate 8 -30 breaths/min

- **ALARMS**
  - OXYGEN
  - PRESSURE
    - Max 35cmH_2O
    - Min 10cmH_2O
  - Tidal volume
    - Max 7cc/kg
    - Min 3cc/kg
  - Rate
    - Max 30 breaths/min
    - Min 8 breaths/min

- **BACK UP**
  - Apnea time
  - Apnea parameters



SUMM

TYPES OF RESPIRATORY FAILURE

- HYPOXIC
- HYPERCAPNIC
- COMBINED

SUMM

TREATMENT OF RESP. FAILURE

- ALWAYS TREAT CAUSE

SUM

TREATMENT OF HYPOXIC RESP. FAILURE

- OXYGEN
- CPAP / PEEP

SUMM

Rx OF VENTILATORY RESP. FAILURE

- VENTILATION
  - NIPPV
  - INVASIVE VENTILATION
    - PSV
    - PCV or VCV
      - CMV
      - A/C
      - SIMV +PSV

SUMMA

- **All ventilated patients need intensive monitoring for:**
  - **improvement**
  - **synchrony between patient and ventilator**
  - **complications**

SUMM

- **ADJUNCT TREATMENT**
  - **OPTIMAL FLUID BALANCE**
  - **NUTRITION**
  - **BRONCHODILATOR THERAPY**
  - **PHYSIOTHERAPY**
  - **POSITIONAL ADJUSTMENTS**
  - **NITRIC OXIDE**


SPEED LIMIT 40
ONE WAY
ONE WAY
ONE WAY
ONE WAY
ONE WAY
ONE WAY
ONE WAY