Intro to Critical Care Series Part 2 of 3

Life Support Equipment

By Kreek't Rebaño (PT)

What is Life Support Equipment?

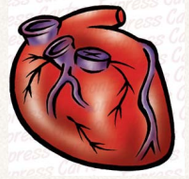
Equipment (and Medications) used to keep people alive in medical situations.

These people usually have one or more failed or failing organs, or organ systems, and would not be able to survive without assistance.

Reasons for life support

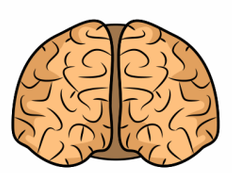
Lungs

Drowning/Choking
Pneumonia/Edema
Overdose
Blood Clots (PE)
Severe Lung Injury
Severe Lung Disease
(Cystic Fibrosis, COPD)
Muscle or Nerve Diseases
(DMD, ALS)



Heart

Cardiac Arrest (sudden)
Heart Attacks/MI
Shock
Severe Trauma



Brain

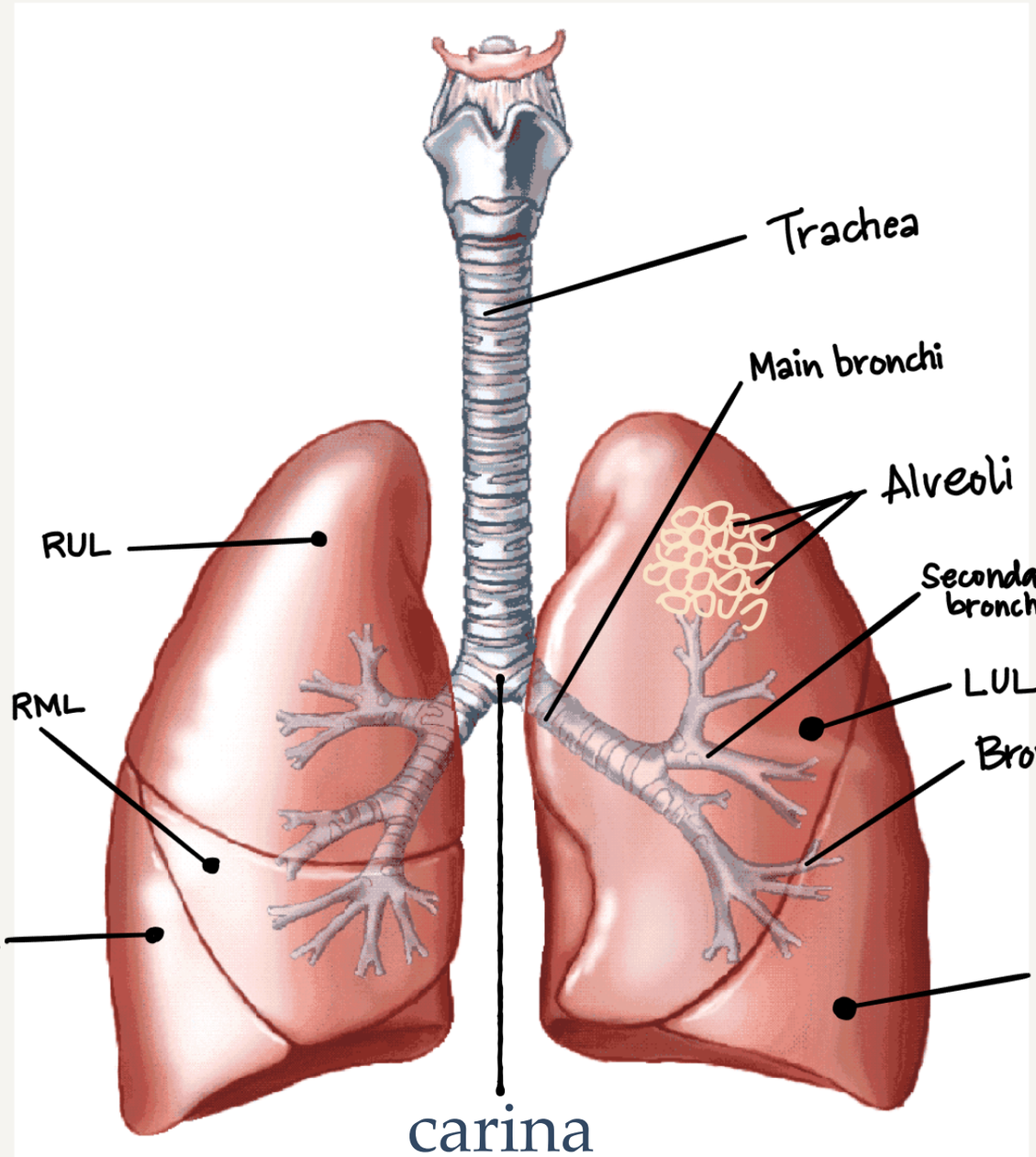
TBI
Stroke

Noninvasive vs Invasive

- Basic Life Support (BLS)
- **Oxygen Delivery Devices (Nasal Cannulas, Masks)**
- **CPAP/BPAP (Positive Pressure Ventilation)**
- External pacemakers (Transcutaneous)
- Manual Resuscitators (Bags)

- Advanced Life Support (ALS/ACLS)
- **Airway Adjuncts (ET Tube, Trach) & Mechanical Ventilation**
- Chest Tubes
- Pacemakers & AICDs
- **IABP** (Intraaortic Balloon Pump)
- **VAD** (Ventricular Assistive Device)
- **ECMO** (Extracorporeal Membranous Oxygenation)
- Hemodialysis

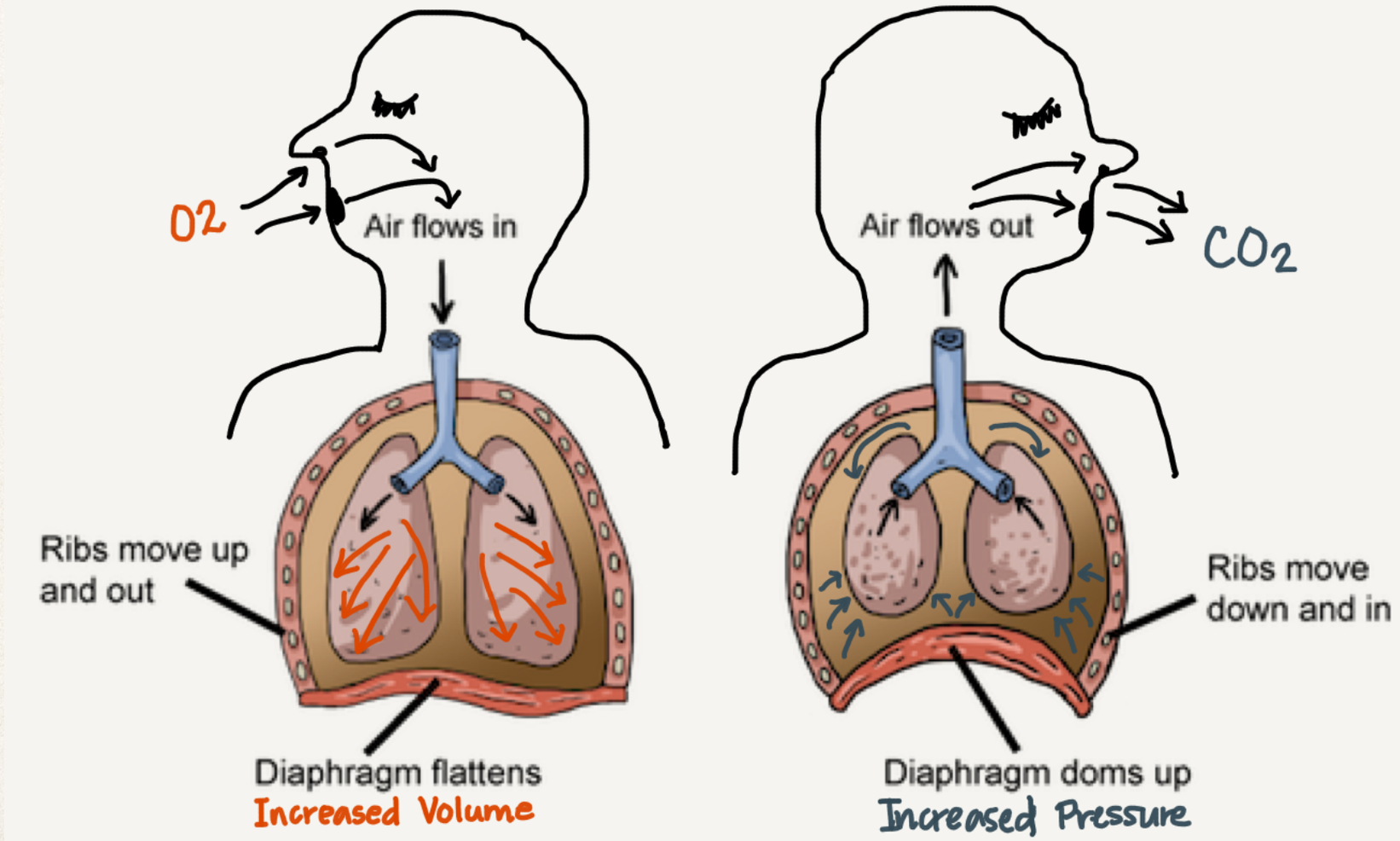
Lung Lingo (Anatomy-Physiology)



Lung Lingo (Anatomy-Physiology)

Ventilation

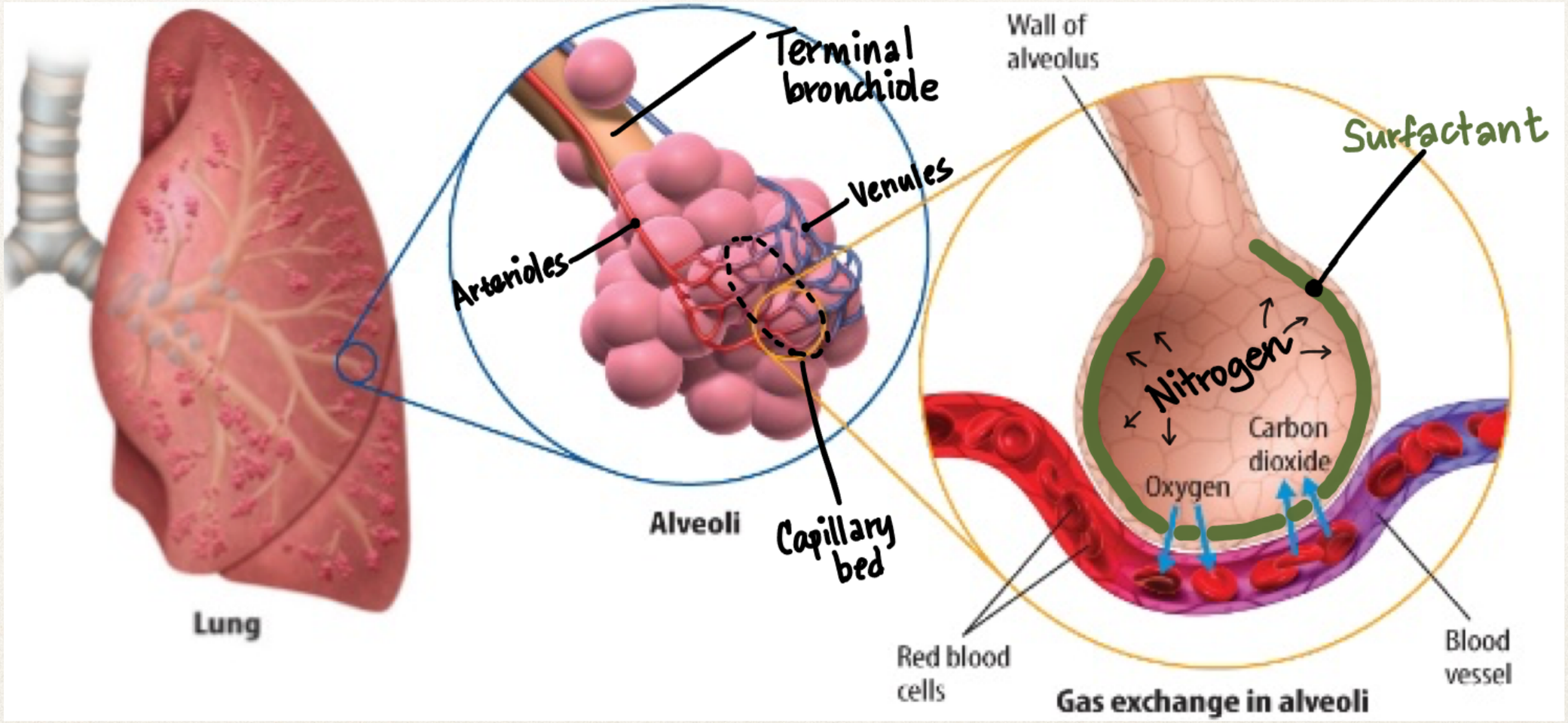
Inhalation-Exhalation to move air between environment and lungs



Lung Lingo (Anatomy-Physiology)

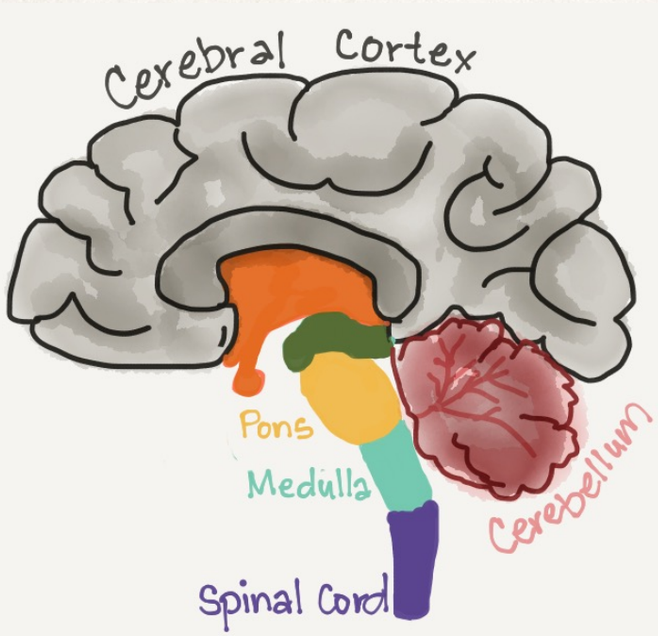
Respiration

Gas exchange (O2-in, CO2-out)
from environment to cells



Lung Lingo (Regulatory Mechanisms)

Neural

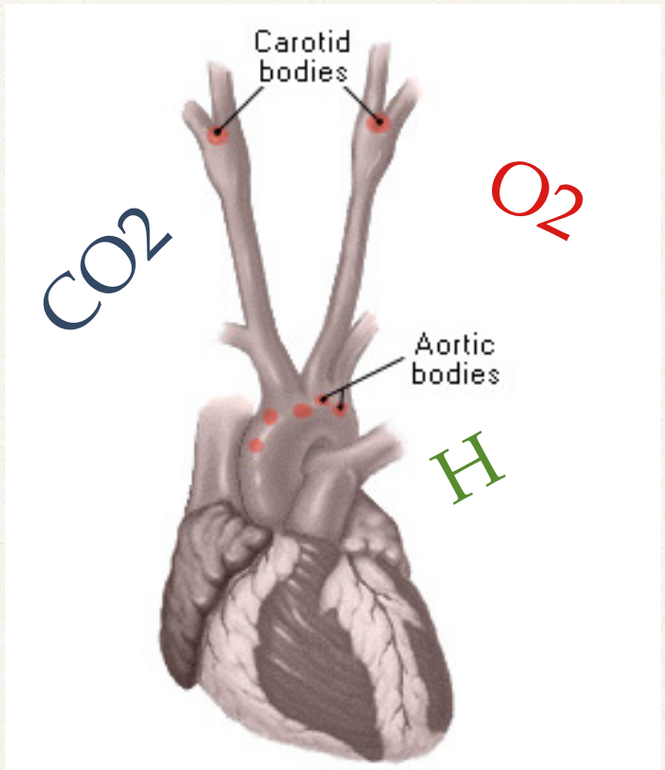


Voluntary Ventilation

Pneumotaxic (RR, Depth)

Rhythmicity, Automaticity

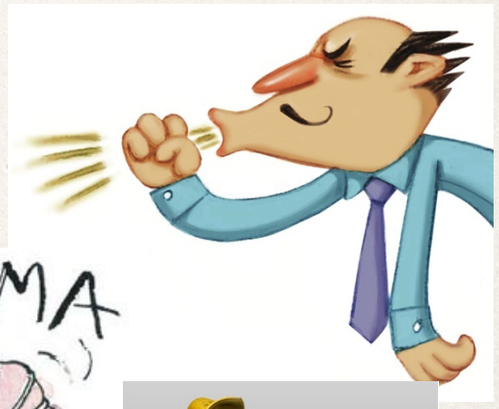
Chemical

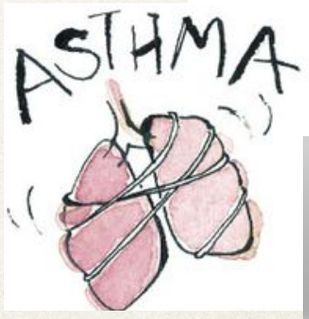


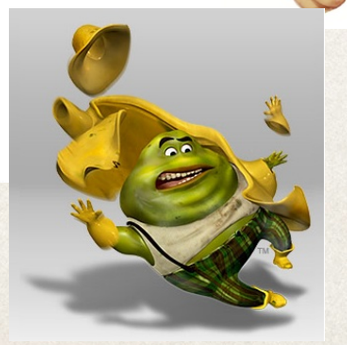
Chemoreceptors stimulation transmit impulses to respiratory centers to vary rate, depth, or both to maintain homeostasis

Non-Chemical (reflex/irritants)

- Coughing, mucus secretion, bronchoconstriction, pain, stressors







Oxygen Delivery Devices

Maintain adequate tissue oxygenation while minimizing cardiopulmonary work.

(hypoxemia, increased working of breathing, hemodynamic insufficiency)

- Administration: low flow vs high flow, with humidity? With reservoir?

- Percentage of O2 delivery: Inconsistent vs Precise.

Note: >60% can be toxic, especially in CO2 retainers, and may washout Nitrogen causing absorption atelectasis

Oxygen Delivery Devices

Low-Flow Delivery

- O2 diluted by ambient air
- Delivers FiO2 at 24-44% (1-8L)

  FiO2 = 20% + (4 x O2 flow)
- FiO2 influenced by RR & Vt
- Humidity added to flows >4 LPM to decrease nasal dryness & bleeding

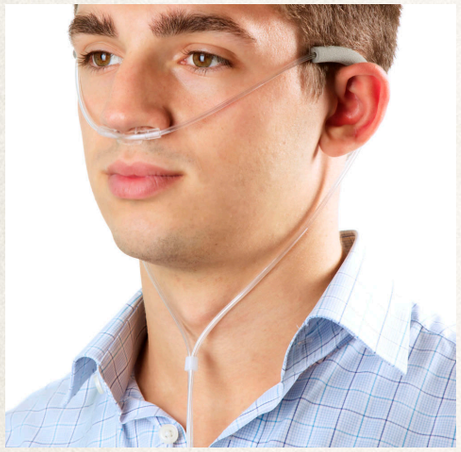
Contraindications

- acute severe hypoxemia
  PaO2 <60 mmHg
  SaO2 <90%
- patients that breathe on a hypoxic drive where too much O2 = respiratory depression

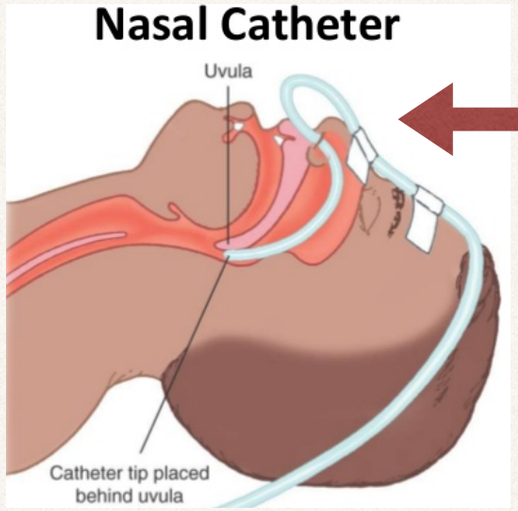
- Supplement during operative or diagnostic procedure
- Chronic home care

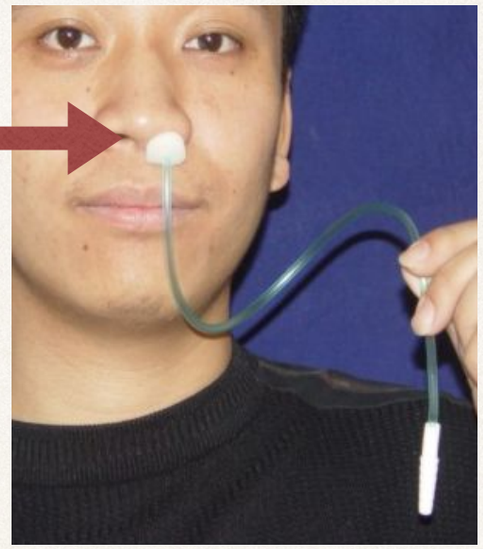
Oxygen Delivery Devices

Low-Flow Delivery (or in terms of FiO2 <35%)

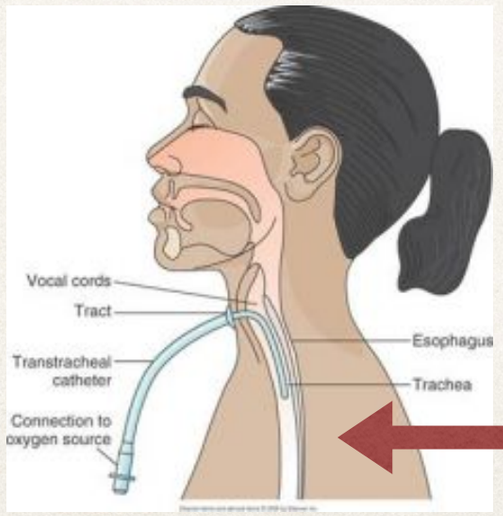


Nasal Cannula





Simple (Face) Mask



Transtracheal Catheter

Trach Collar or Mist Mask

Oxygen Delivery Devices

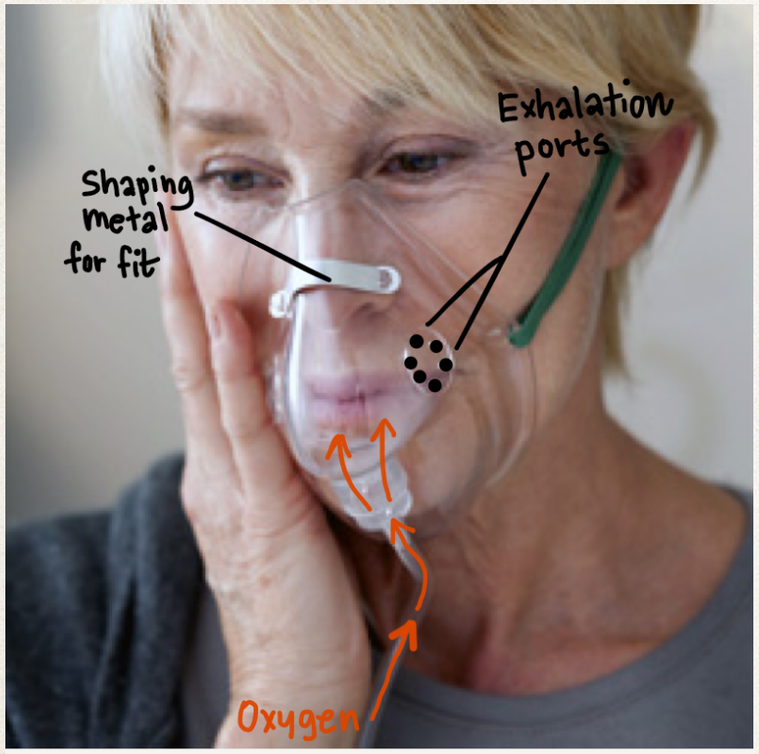
Reservoir Systems (or in terms of FiO2 >35-60+%)

- Gathers & stores oxygen during inhalation & exhalation
- Improves the efficiency of oxygen delivery by conserving O2
- Lower flows are needed

6 LPM via nasal cannula = Fi02 44%
6LPM via non-rebreather = Fi02 60%

Oxygen Delivery Devices

Reservoir Systems



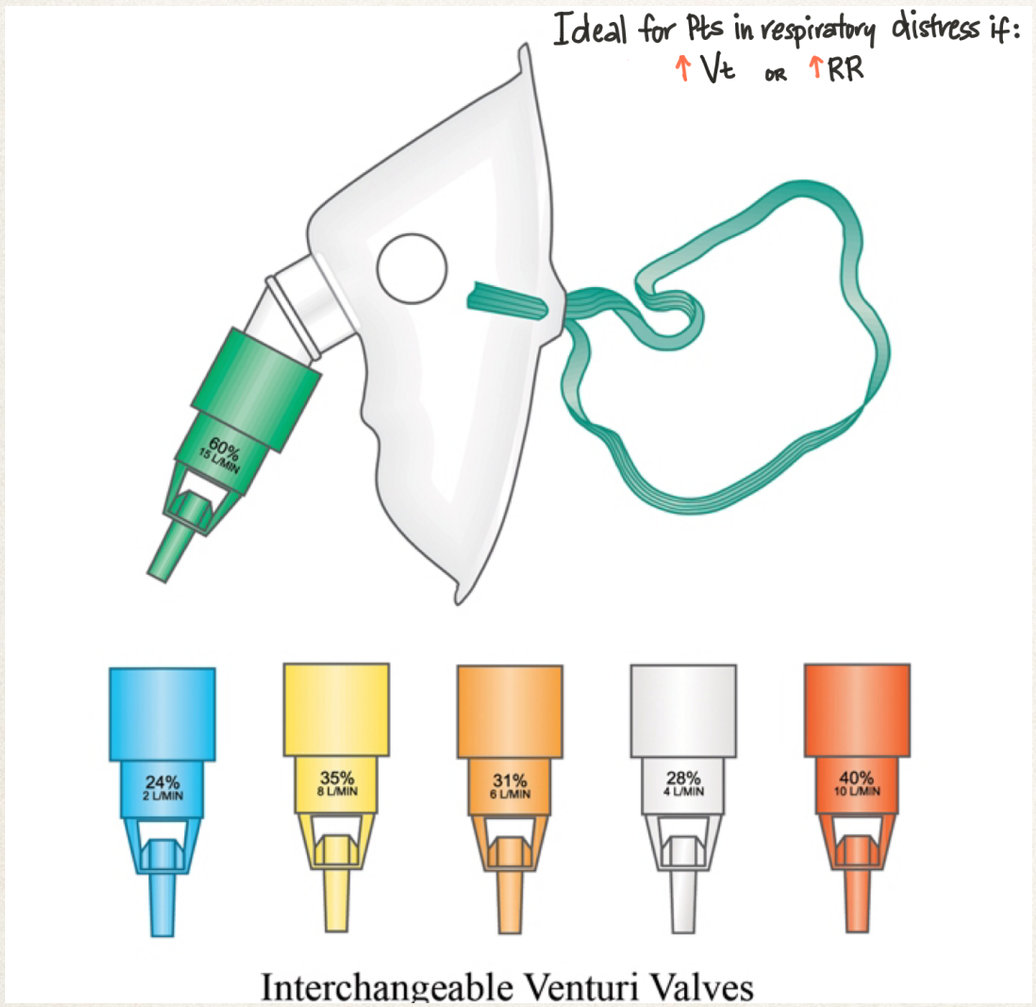
Simple Mask

Aerosol Mask

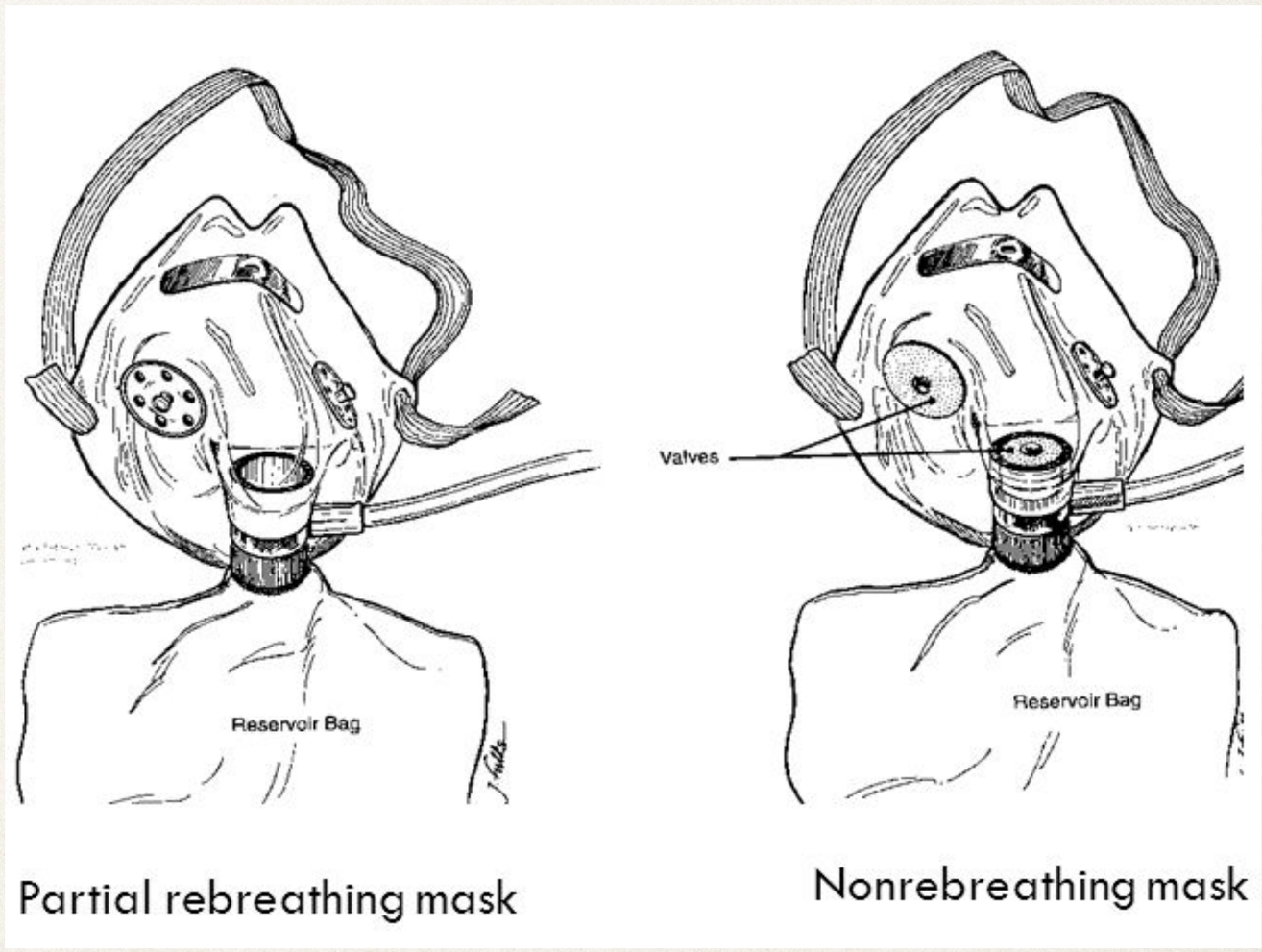
Venturi Mask

Oxygen Delivery Devices

High-Flow Devices (in terms of FiO2, >60%)



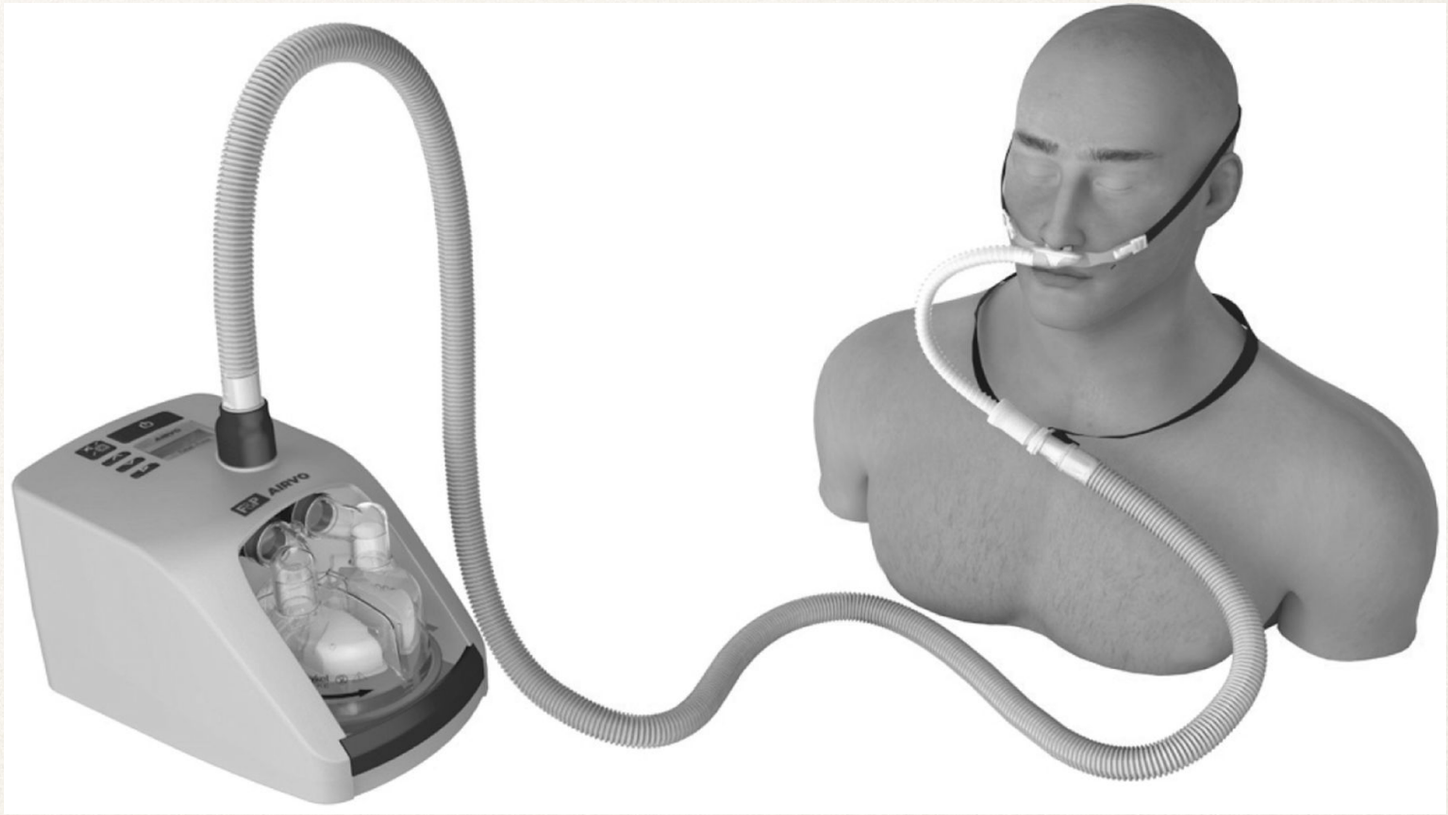
Venturi Mask



Partial or NRB Mask

Oxygen Delivery Devices

High-Flow Devices (in terms of FiO2, >60%)



High Flow Nasal Cannula (HFNC)

Calculation for remaining 02

Serve capacity for an e-cylinder is 1900 psi
This delivers about 660 L of Oxygen (02)

660L / 1900 psi = 0.35 LPM/psi to be delivered.
Multiply this with the remaining 02 in tank.
Divide both by the Flow Rate (LPM) your Pt needs.

You are transporting your patient, who has emphysema, from their unit to XR for spine surgery follow-up. Without oxygen at 6 L/min, your patient's O2 saturation on room air drops to 75%. It will take you 10 minutes to get there and back. The portable O2 tank you grabbed has 500 psi left in it.
Do you have enough oxygen left for the trip?

Yes, we have enough Oxygen!

$$\frac{0.35\,L\,(500\,psi)}{6\,L\cdot psi/min} = \frac{175\,L\cdot psi}{6\,L\cdot psi/min}$$

$$= 29.16$$

or

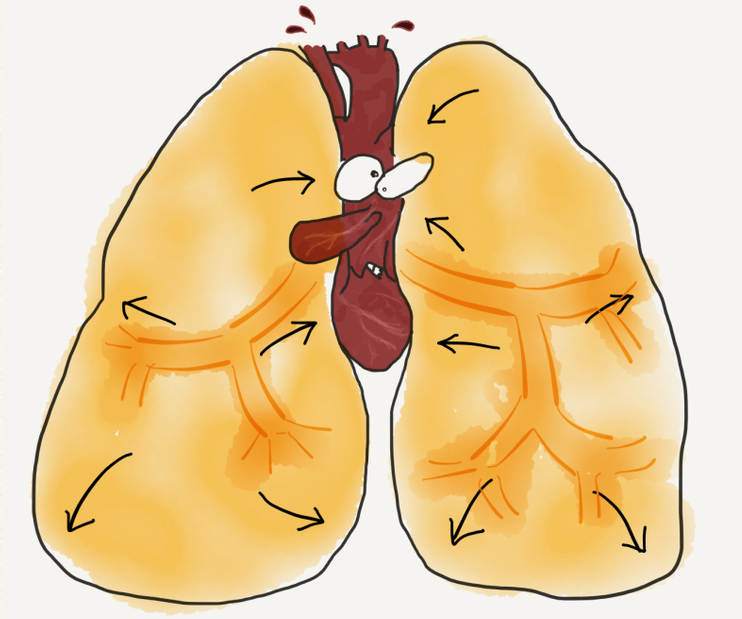
29 mins

http://www.manuelsweb.com/O2remaining.htm

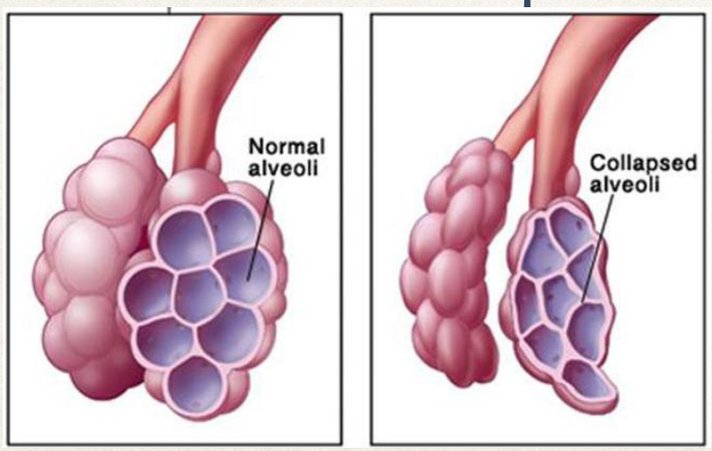
Dangers of Excessive Oxygen

Oxidative Damage to cell membranes

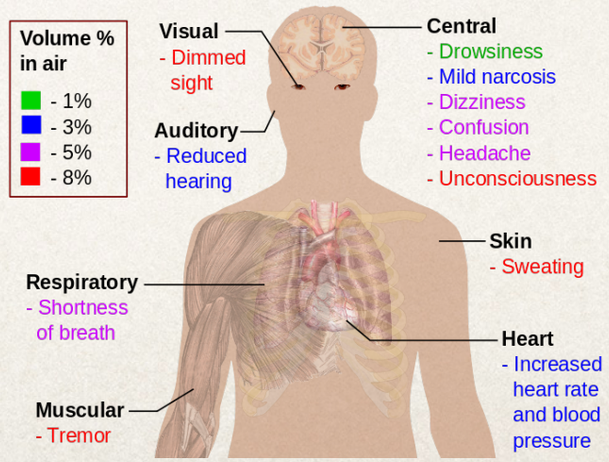
Decreased CO, CV compromise



Alveolar Collapse



Indirect cause of CO2 narcosis



Mechanical Ventilation

Mechanical - working or produced by machines

mēkhanikos

Artificial - not naturally occurring

1. To assist or replace spontaneous breathing
   (depressed respiratory drive, respiratory failure)
2. To protect airways (aspirations, secretions, drug OD, CVA, SCI)
3. To prevent excessive work of breathing
4. To relieve airway obstruction (tumors, edema, asthma)
5. To correct ventilation or oxygenation

Mechanical Ventilation

Iron Lung 1930s-1950s

Polio Epidemic

Negative Pressure Device

+ Mimicked natural/physiologic breathing
− Bulky, impedes movement, impedes examination

Mechanical Ventilation

Positive Pressure Device

Ventilators : "Convenient, Practical, Easy to Use"

Complications associated with device working against natural physiologic principles

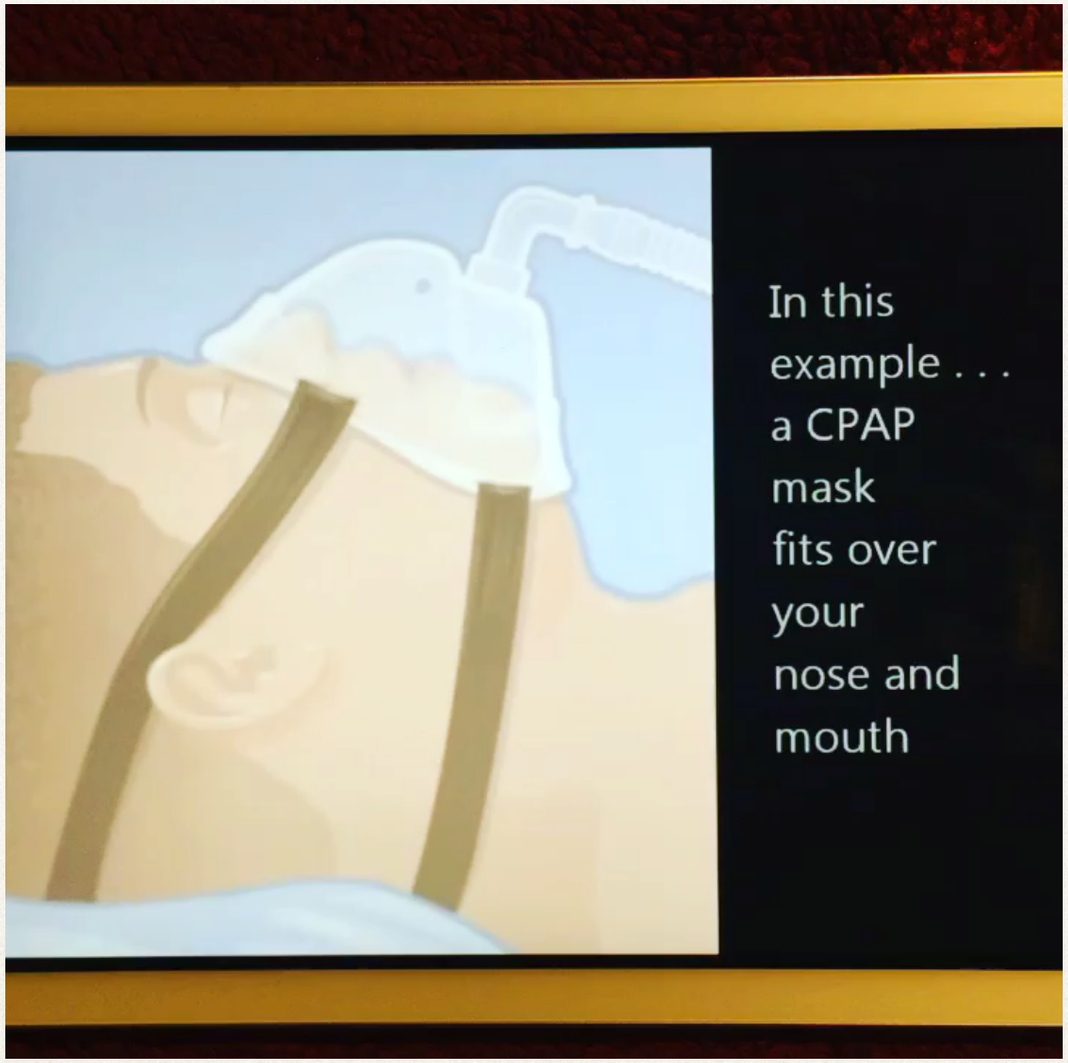
- Barotrauma
- Oxygen toxicity
- Autopeep
- Diaphragm atrophy
- Decreased cardiac output
- Ventilator-Associated Pneumonia (VAP)

Positive Pressure Ventilation

Manual Resuscitators

- In emergencies
- When disconnecting from ventilator is prolonged (suctioning, transfers, etc.)
- To stimulate or mimic cough, augment Vt

Positive Pressure Ventilation



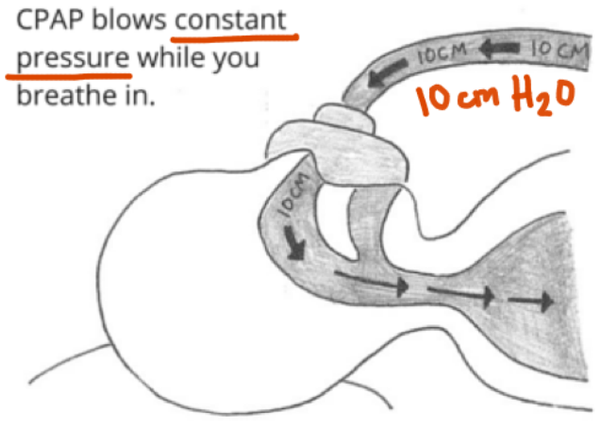
https://youtu.be/AUXYjPbNwqg

Positive Pressure Ventilation

CPAP

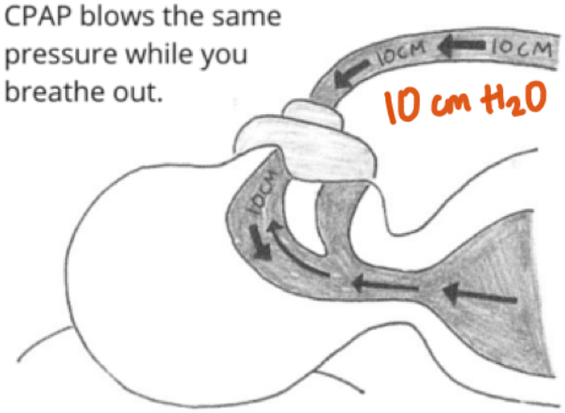
Inhalation (breathing in)

CPAP blows constant pressure while you breathe in.



Exhalation (breathing out)

CPAP blows the same pressure while you breathe out.

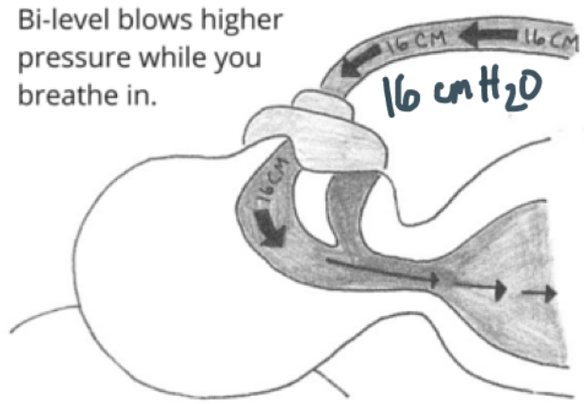


4-20 cmH20

Bi-Level PAP (BiPAP)

Inhalation (breathing in)

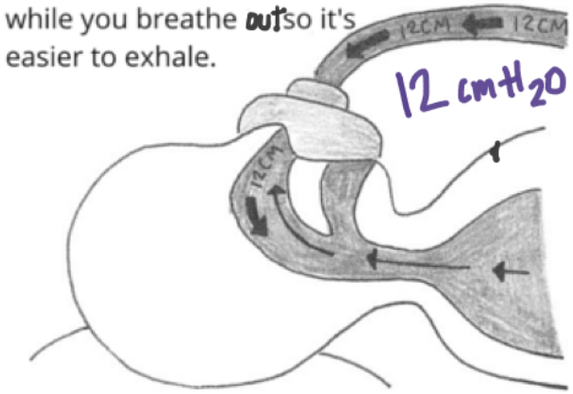
Bi-level blows higher pressure while you breathe in.



16/12

Exhalation (breathing out)

Bi-Level blows lower pressure while you breathe out so it's easier to exhale.



4-20 cmH20

IPAP*
(Increase Ventilation)
Typically initially set at 8-12

EPAP**
(Increase Oxygenation)
Typically initially set at 3-5

*PIP on a ventilator
**PEEP on a ventilator

Positive Pressure Ventilation

Continuous or Bilevel (variable) Positive Airway Pressure (CPAP, VPAP/BPAP)

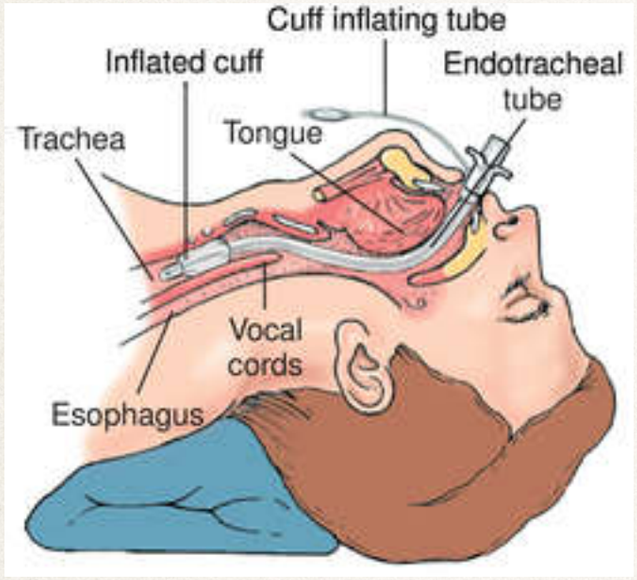
- Short-term support primarily seen in OSA, chronic or acute ventilatory failure
- Delivered with a mask instead of an artificial airway

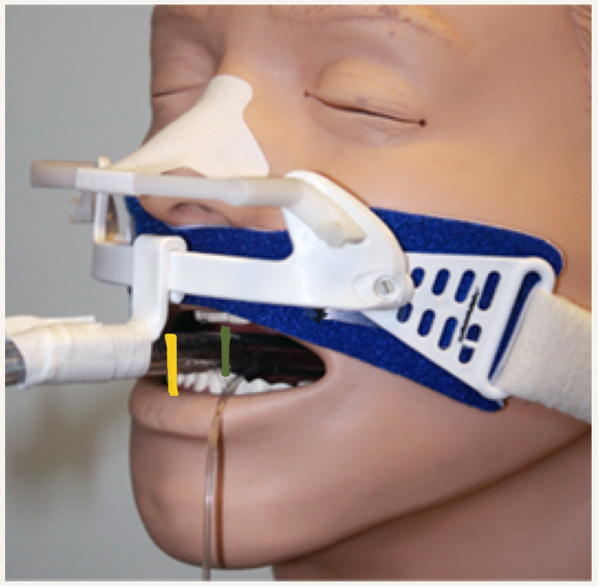
Airway Adjuncts (Artificial Airways)

Why do we need it?

- Upper airway obstruction
- Inability to protect lower airways from aspiration
- Inability to clear or manage secretions
- Hypoxemia despite supplemental 02
- Progressive general fatigue & AMS / deterioration
- Need for Positive Pressure Ventilation

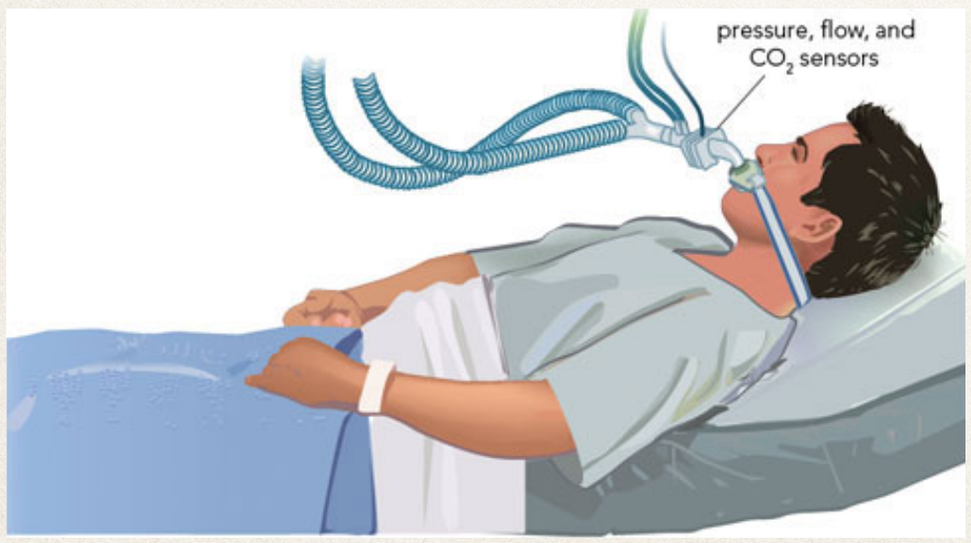
Airway Adjuncts (Endotracheal/ET Tube)





Inspect and document the position of the ETT before, during, and after treatment.

Note marking at the level of the **TEETH** or **LIPS**



Mobilizing Tips

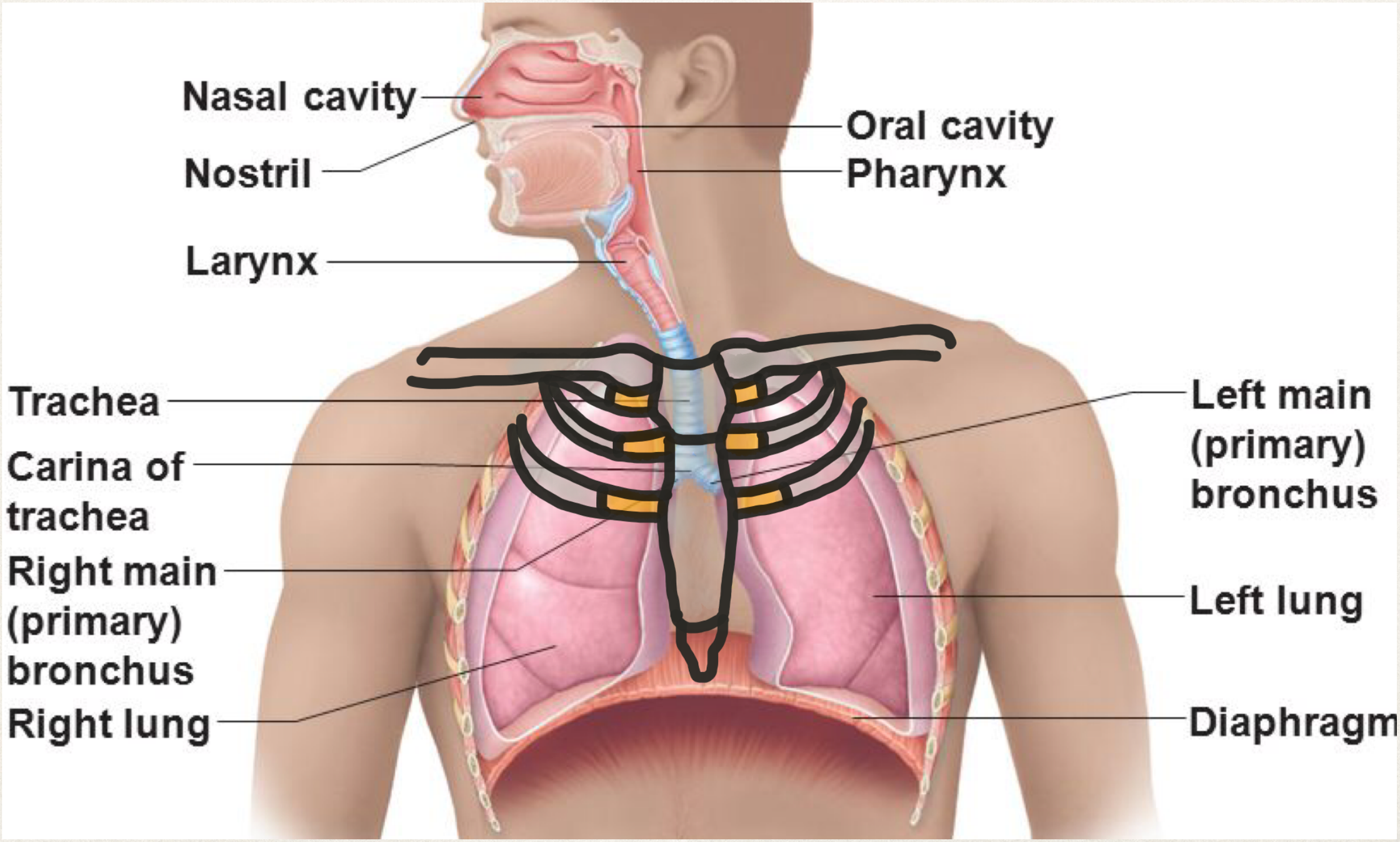
- Head/Neck mobility won't kink ETT
- Avoid axial rotations of ETT, side shifting permitted - for oral protection
- Suspect cuff leak if Pt phonates

Airway Adjuncts (Tracheostomy Tube)

Why do we need it?

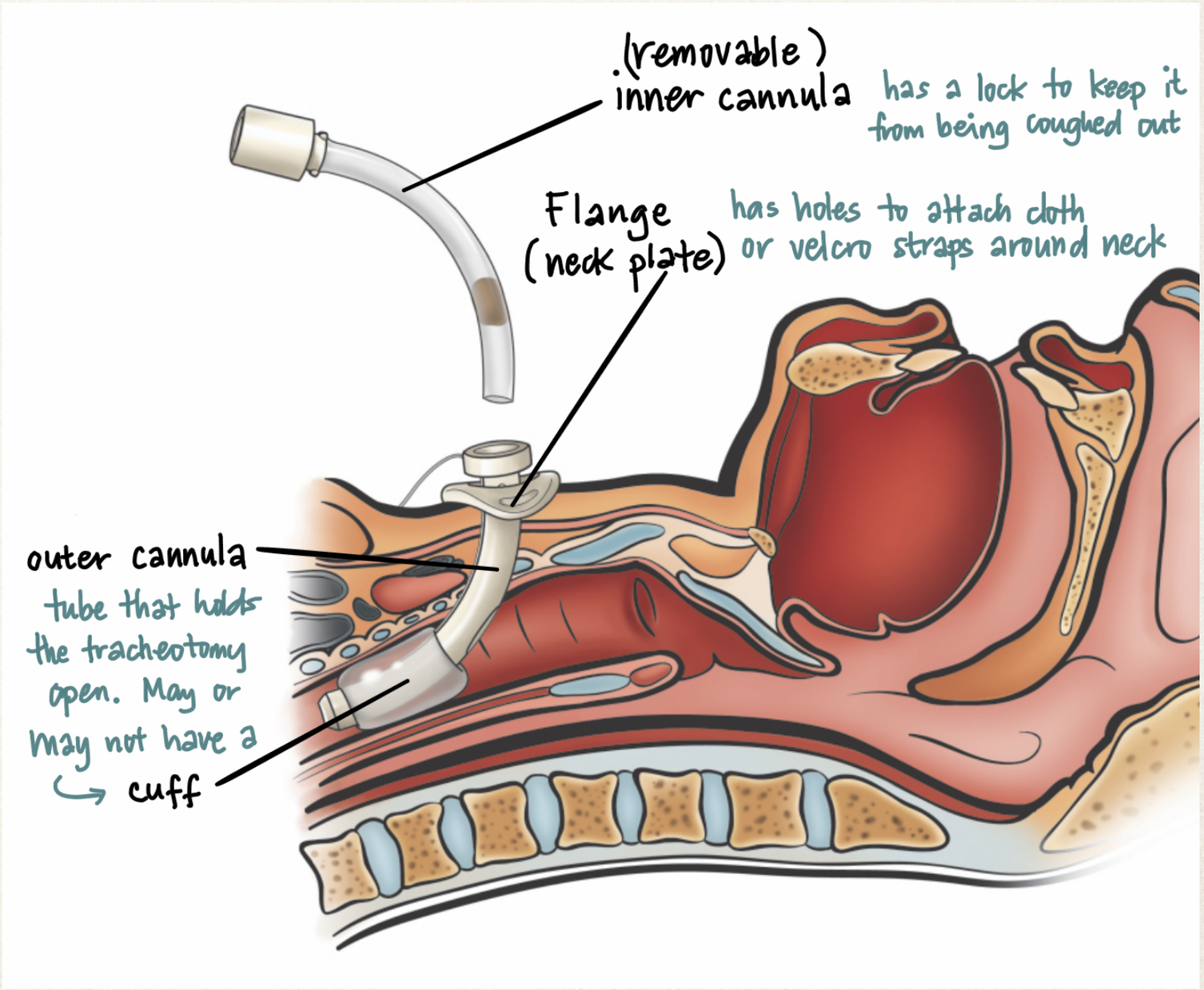
- Reduced laryngeal injury
- Improved oral comfort
- Decreased airflow resistance
- Increased effectiveness of airway care
- Feasibility of oral feeding and vocalization (PMV)

Airway Adjuncts (Tracheostomy Tube)



Airway Adjuncts (Tracheostomy Tube)

- Surgically placed under anaesthesia
- Wait 24 hrs for cannulation
- Takes 5-7 days for track between trach & skin



Airway Adjuncts (Tracheostomy Tube)

Inspect and document the position of the trach tube before, during, and after treatment.

Decannulation Causes

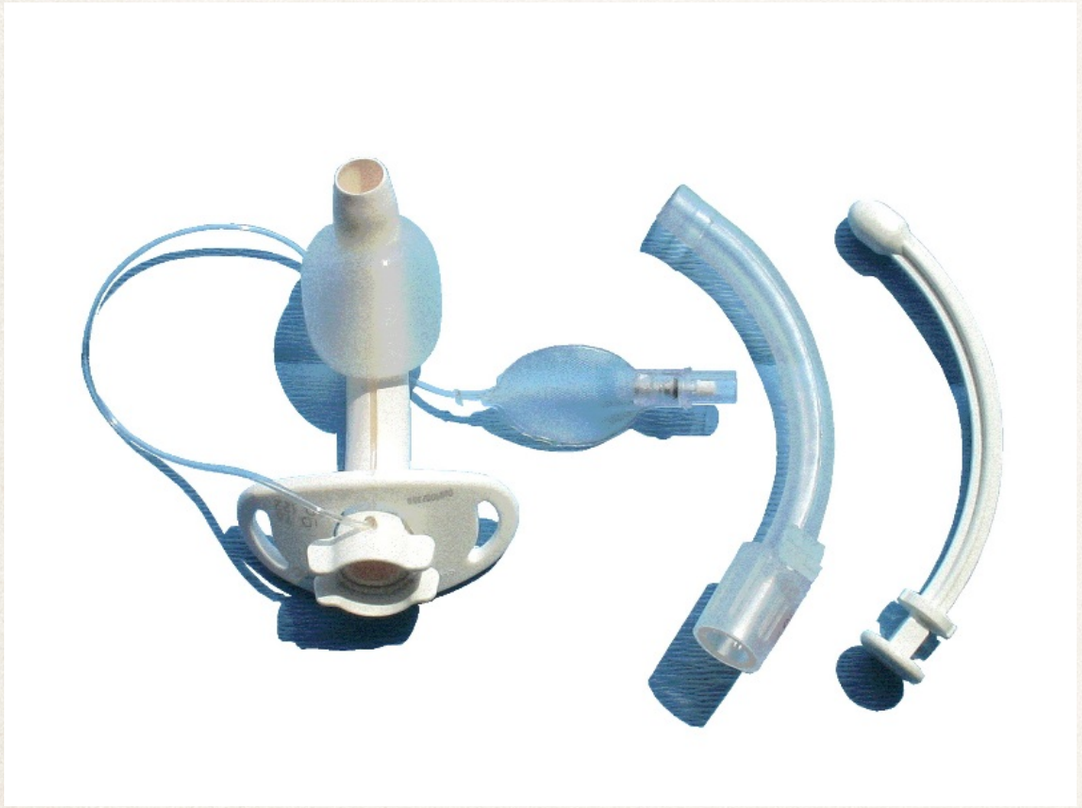
1. **Morbid obesity, Short/thick neck, Goiter**
2. **Prior radiation or surgery of the neck**
3. **Device connected to ventilator tubing**
4. **Patient movement, turning, coughing**
5. **Immediate postoperative period**
6. **Inadequately secured tubes**

Mobilizing Tips

- Head/neck mobility won't kink TT
- Keep trach at center, avoid axial rotations, adjust tubing frequently
- Suspect cuff leak if Pt phonates

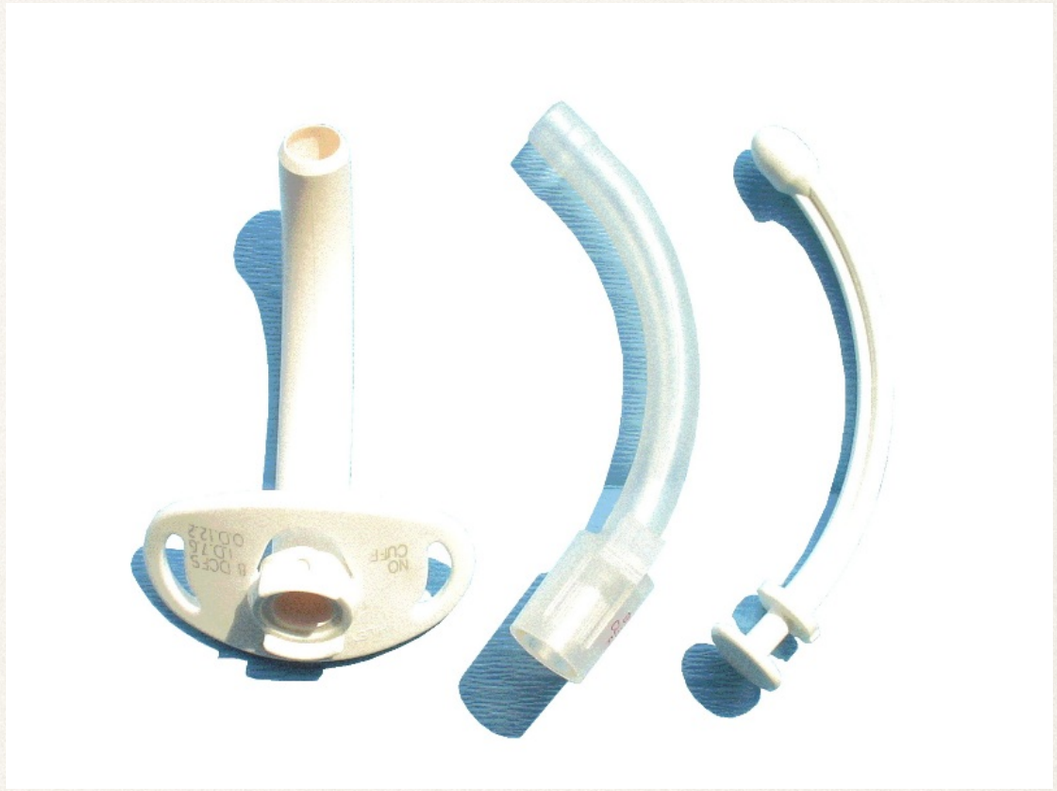
Airway Adjuncts (Tracheostomy Tube)

CuffedTube + Inner Cannula



- closed circuit for ventilation
- (cuff inflated, min. air leak ok)
- cuff <u>deflated for PMV use</u>

Cuffless + Inner Cannula



- for Pts close to decannulation
- Pts can speak/eat without valve
- alt. if Pt has trach problems

Airway Adjuncts (Tracheostomy Tube)

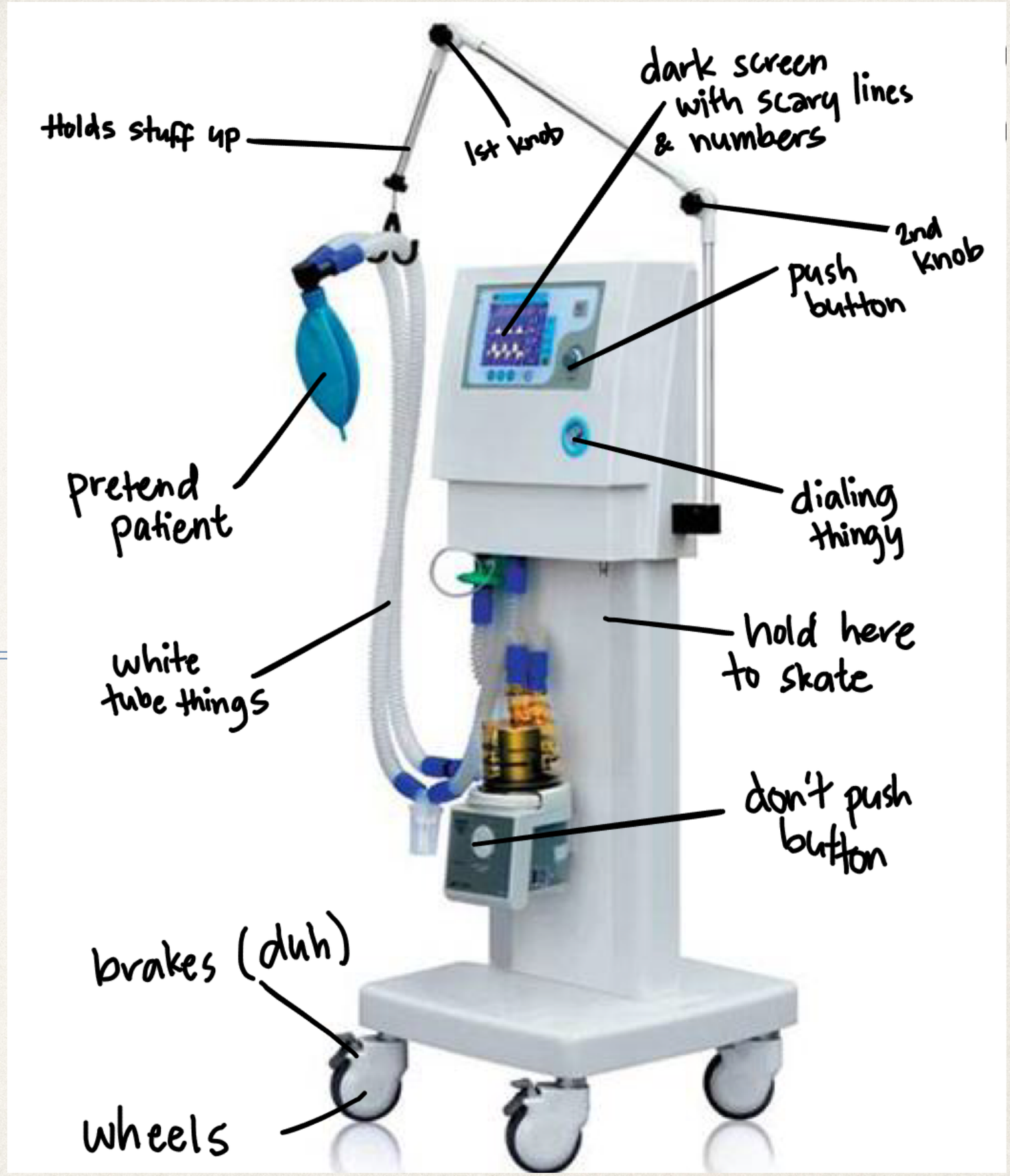
Fenestrated Cuff

Fenestrated Cuffless

- Vented Pts, but unable to tolerate speaking valves
- > aspiration risk, granuloma formation
- risk for poor ventilation

Ventilator Basics

Bells and Whistles by Eric Blake




SPONT
VC
PS
V-TRIG
550
60
8
2.0
40
50
0.0
RAMP
15
PEEP
5.0
To make a selection,
touch a button.
VENT
ALARM
NELLCOR PURITAN BENNETT
840 Ventilator System
Aeroger Pro-I
Fisher & Paykel MR2
Fisher & Paykel
36.9
TriMedx
CLINICAL ENGINEERING LD.#
210021488


NELLCOR
PURITAN
BENNETT
VENT
INOP

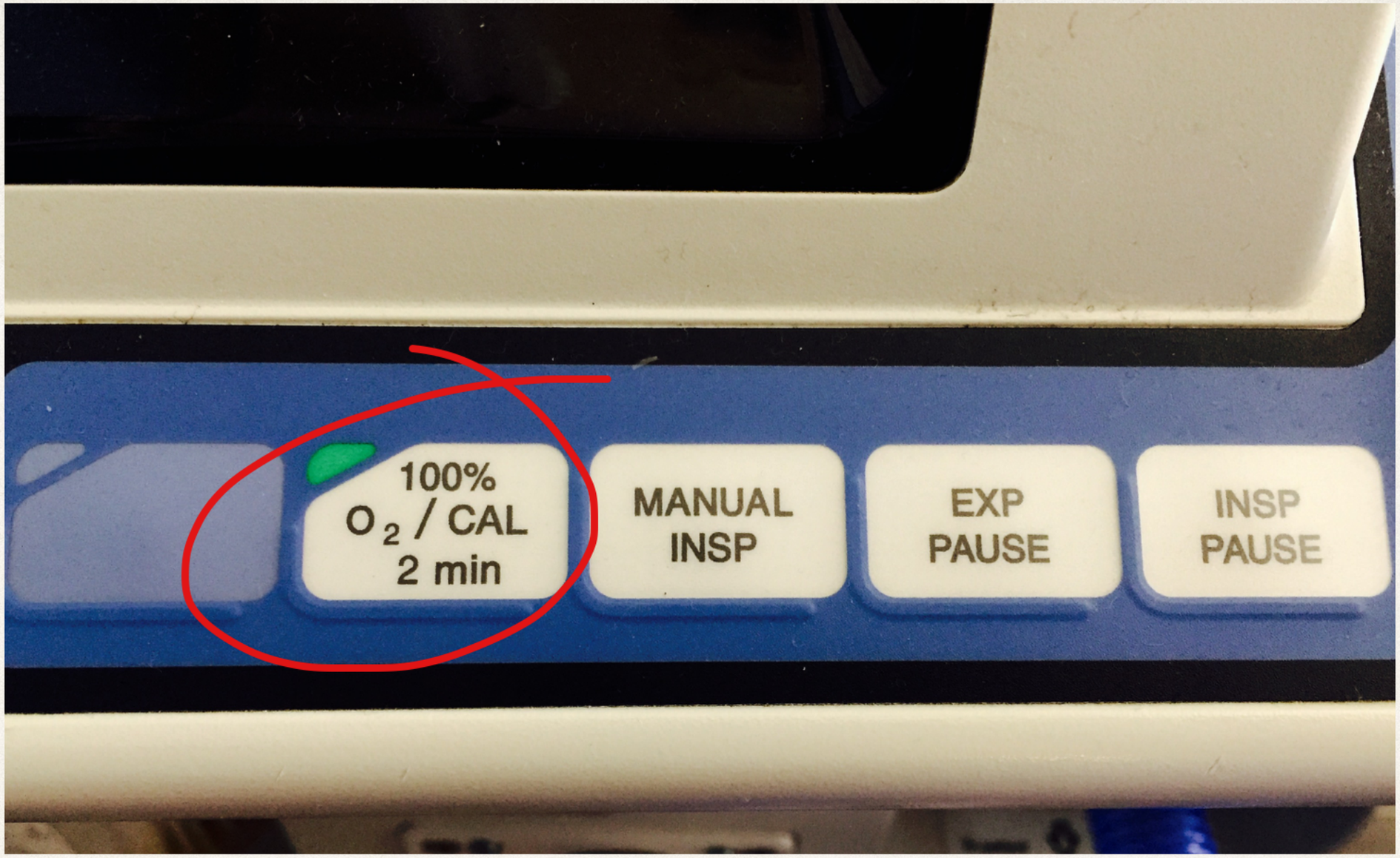
S

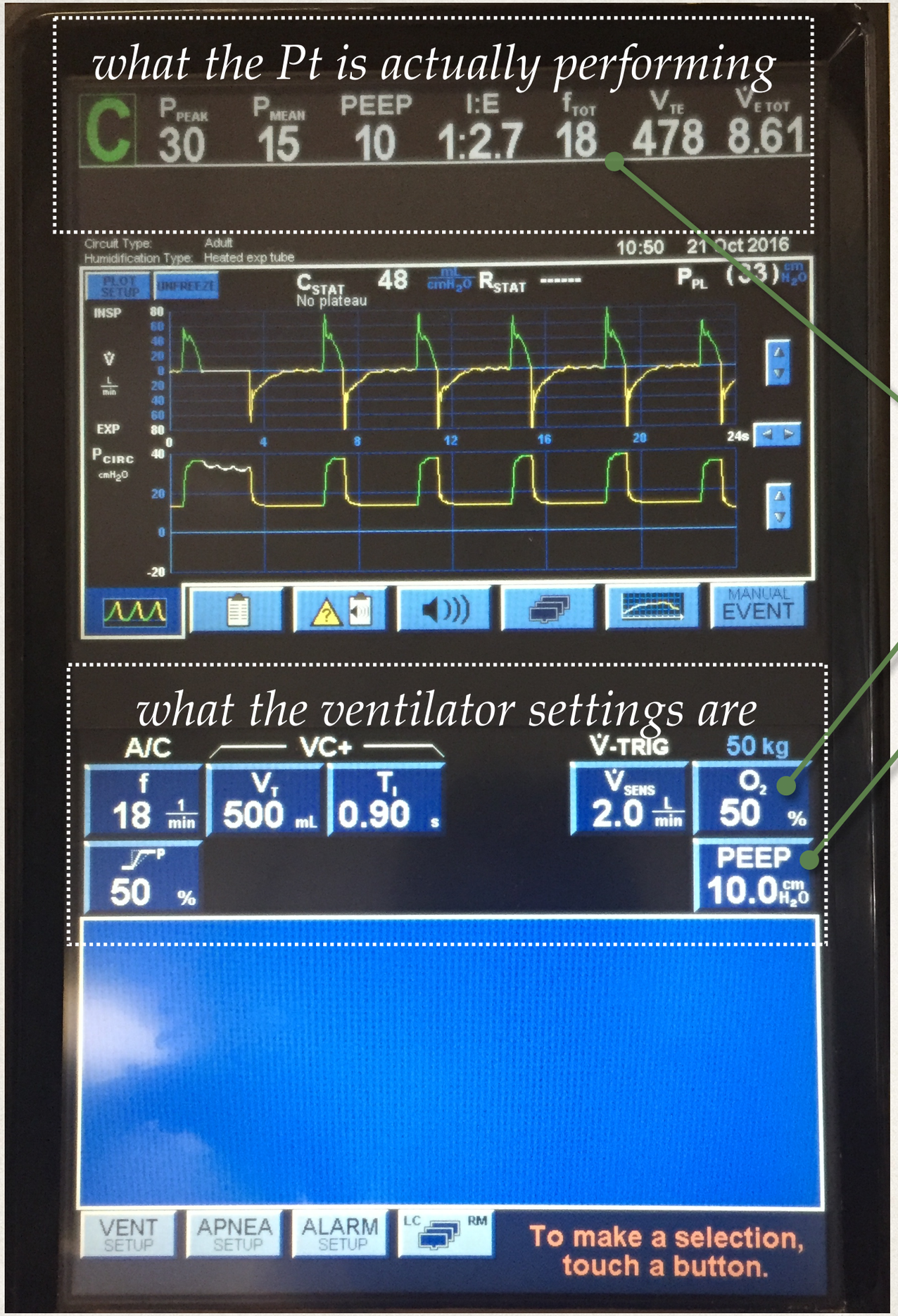
Spontaneous Breathing

- Pressure Support (PS)
- Respiratory Rate (RR)
  - **"overbreathing" will trigger RR alarm**
- Tidal Volume (Vt)
- Minute Volume (Ve)

Pt support with exercise:

- Inc. Pressure support
- Inc. 02 (100% button)
- **Never hit alarm silence**


100%
O 2 / CAL
2 min
MANUAL
INSP
EXP
PAUSE
INSP
PAUSE



C

A

Control

Assist

- RR increases with exercise
- Currently delivered Fi02
- Higher PEEP=need more oxygenation/keep alveoli open

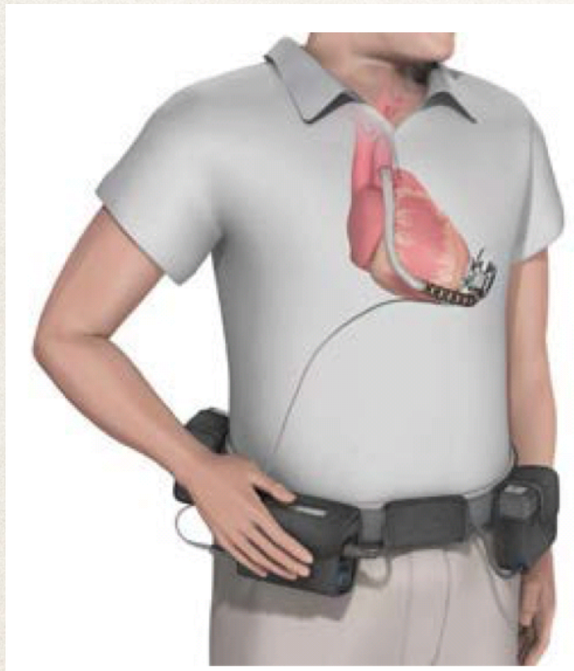
Pt support with exercise:

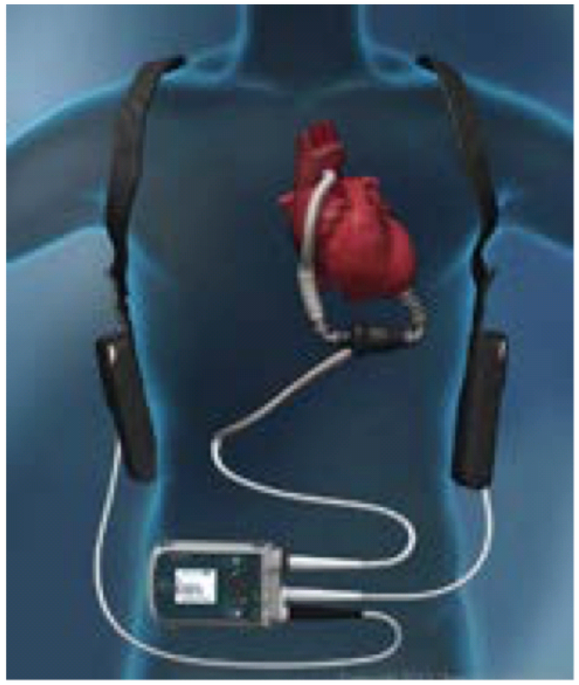
- Inc. 02 (100% button)
- **Remember Ambu bag check before moving Pt**

Q&A

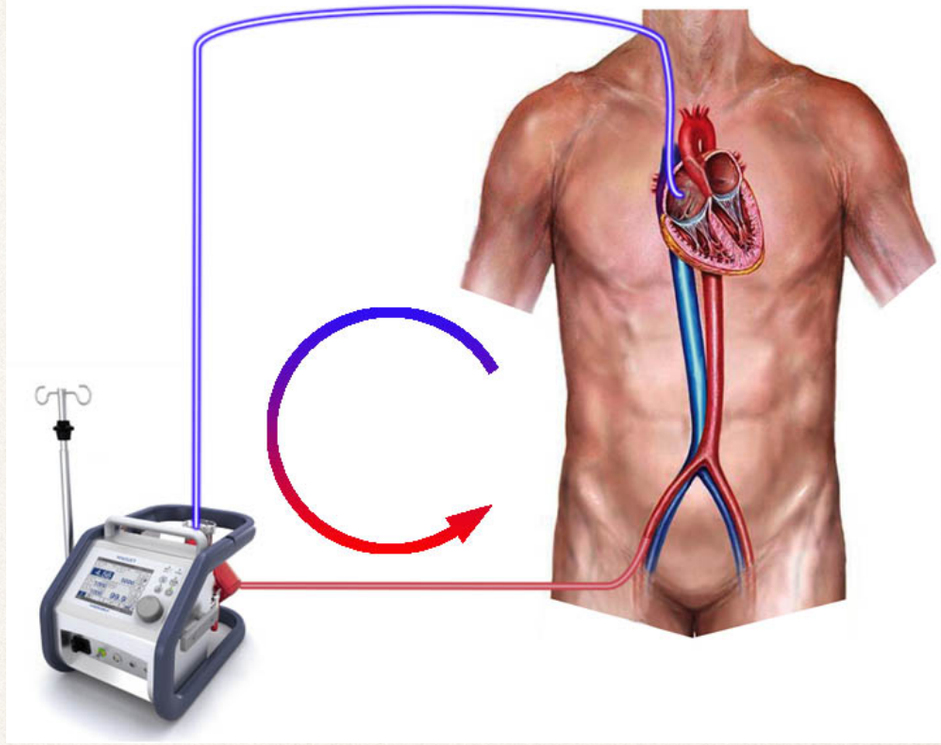
Mechanical Circulatory Support

Perfusion of Organs with Mechanical Devices
(includes Advanced therapies for failing heart and lungs)



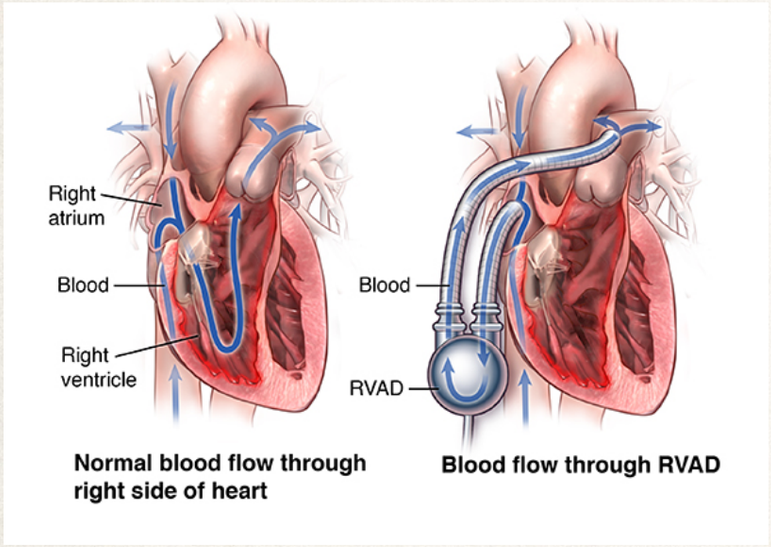


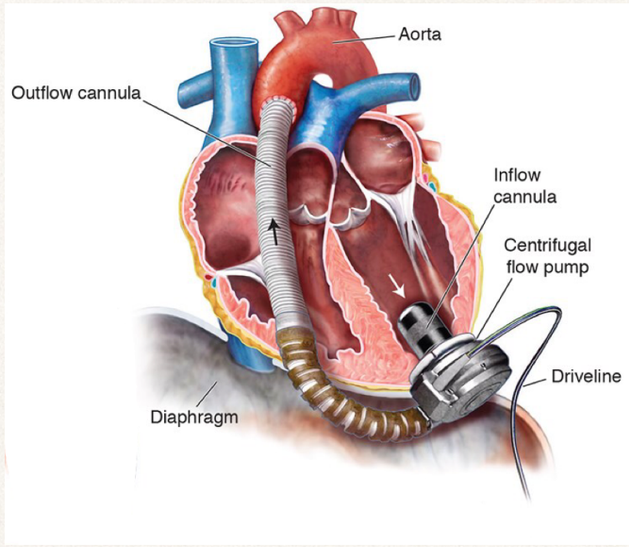
LVAD (Left Ventricular Assistive Device)

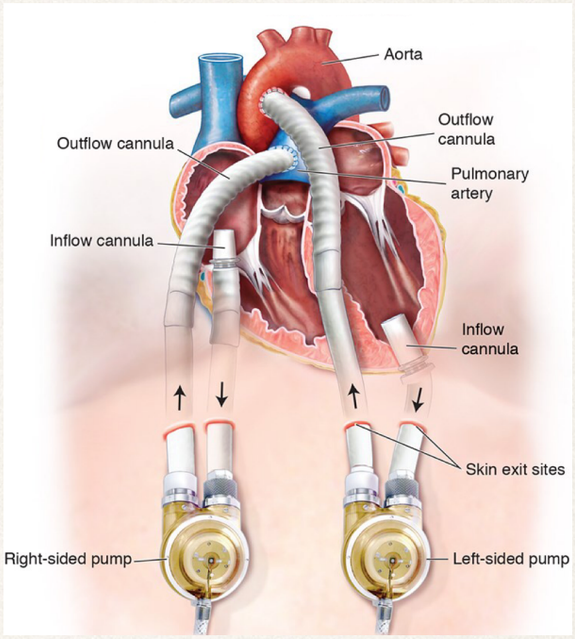


ECMO
Extracorporeal Membranous Oxygenation

Ventricular Assist Device (VAD)







Continuous flow pumps create non-pulsatile flow.

- Bridge-to-transplant
  awaiting cardiac transplantation
- Destination therapy
  ineligible for cardiac transplantation

Mobilizing Tips

- Monitor for symptoms, device alarms
- NO chest compressions
- Defibrillations, Cardioversion ok
- Back up bag of equip, batteries
- NO MRI, Cannot submerge in water

ECMO (Extracorporeal Membranous Oxygenation)

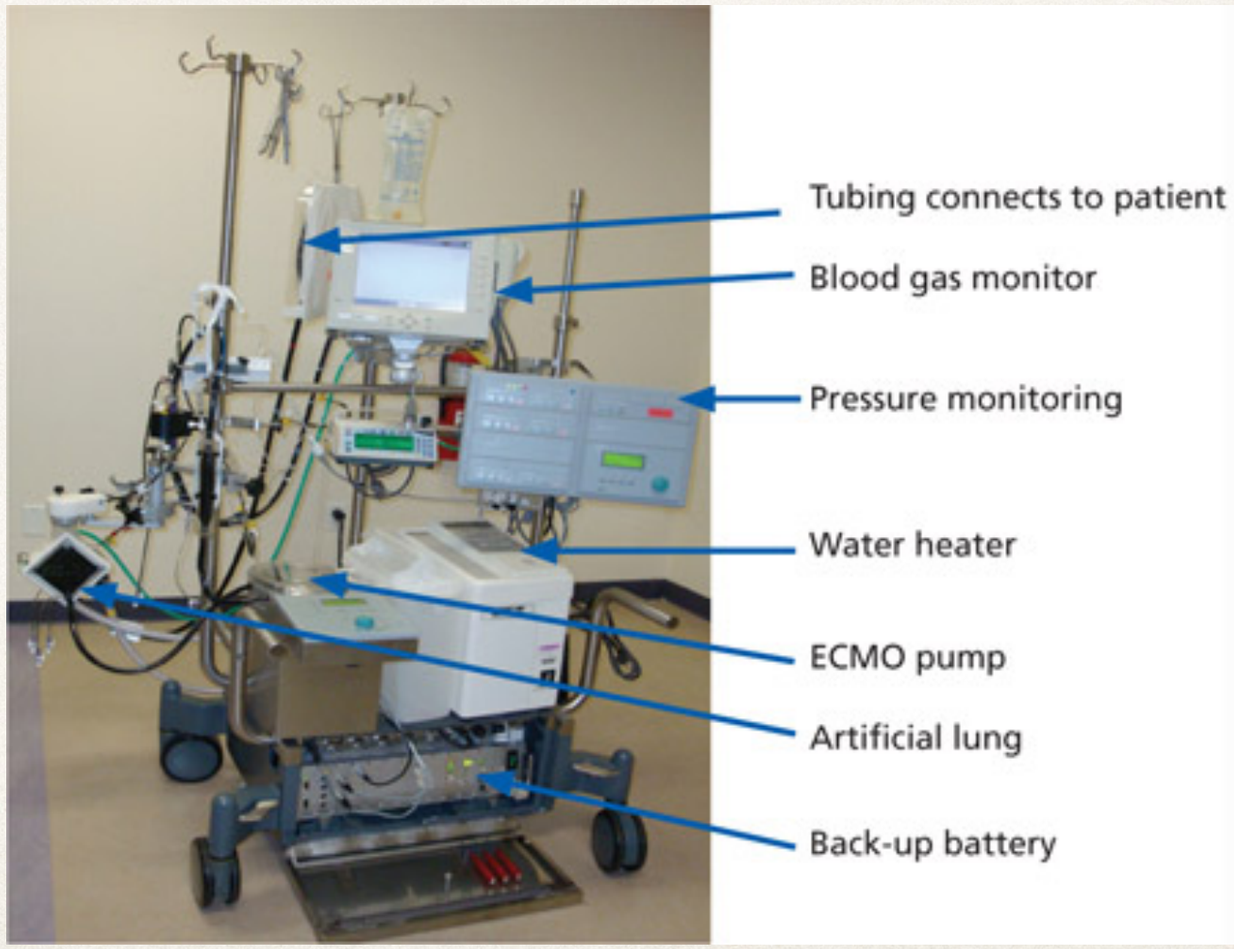
Also: ECLS (Extracorporeal LifeSupport) or **bypass**

- machine to take over the work of the lungs and sometimes the heart

Extracorporeal -
"extra" (outside) ,
"corporeal" (body)
blood circulates outside of the body with the help of a machine

Membrane Oxygenation -
the “artificial lungs" also called "membrane lungs" a special part of the machine that:

1) puts oxygen into the blood
2) takes out carbon dioxide

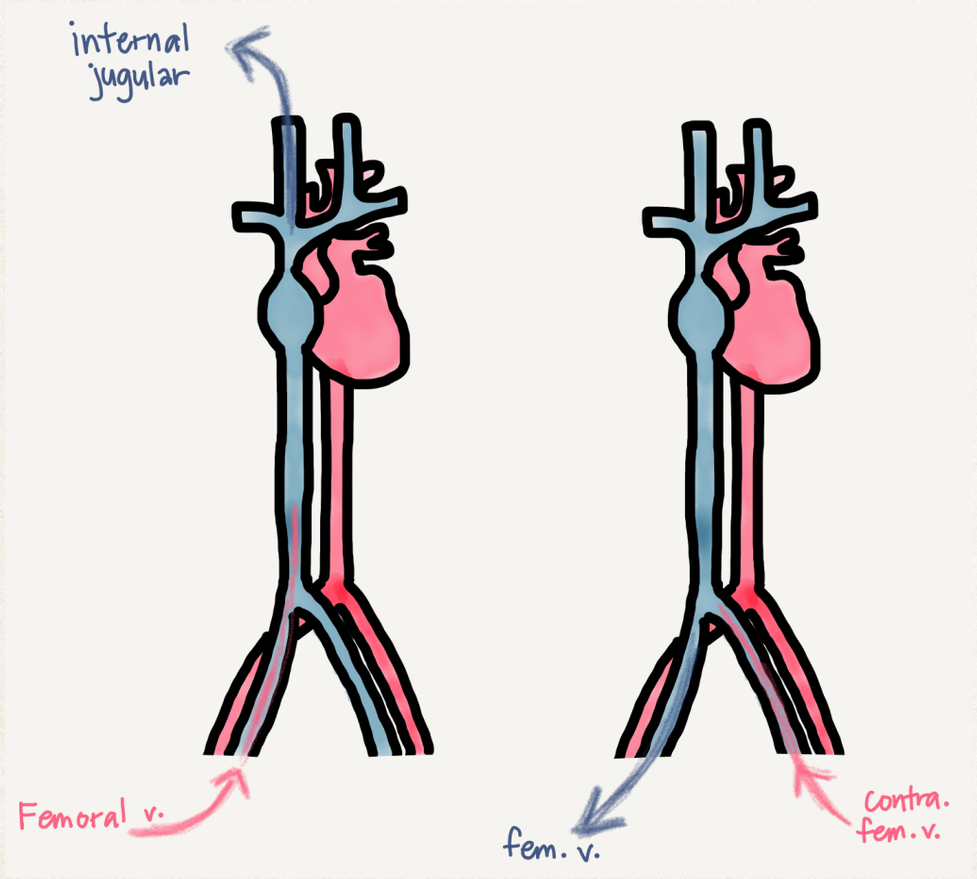


* dellchildrens.net

ECMO (Extracorporeal Membranous Oxygenation)

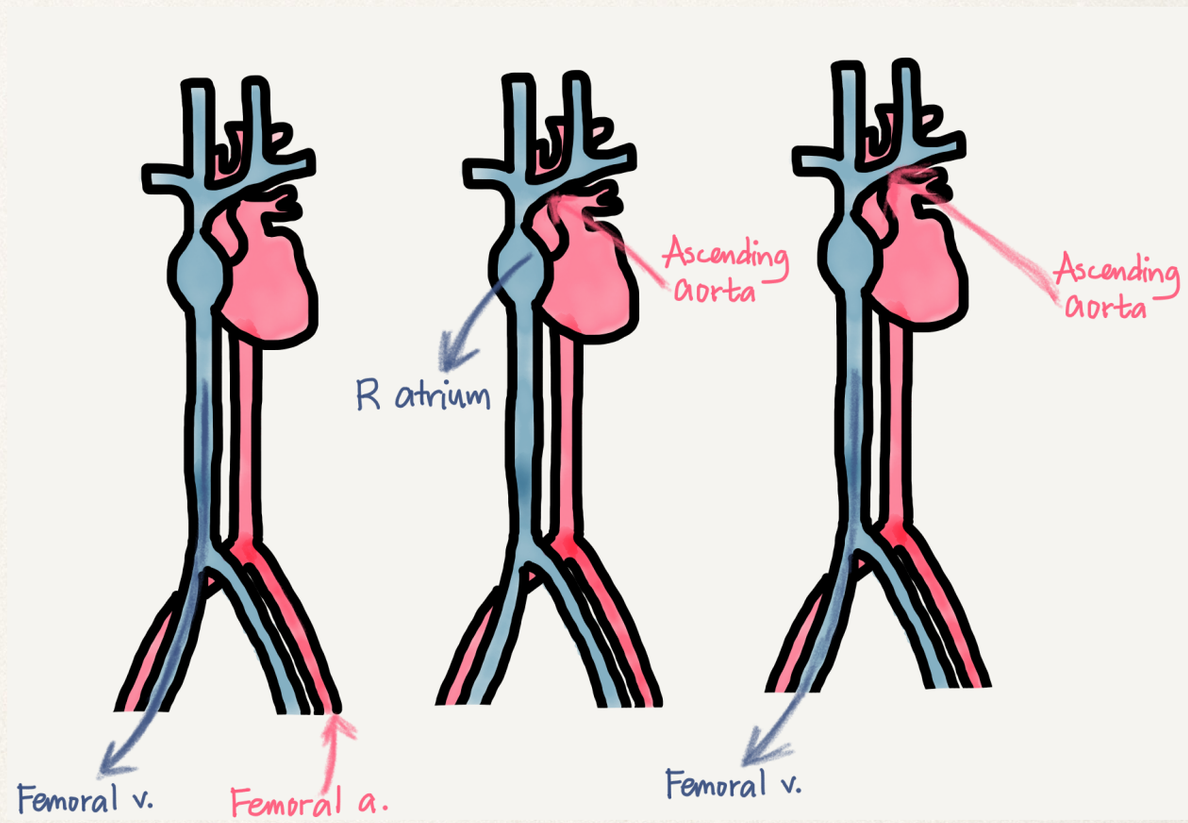
<u>Veno-Venous (VV): Respiratory</u>

provides support for the lungs only



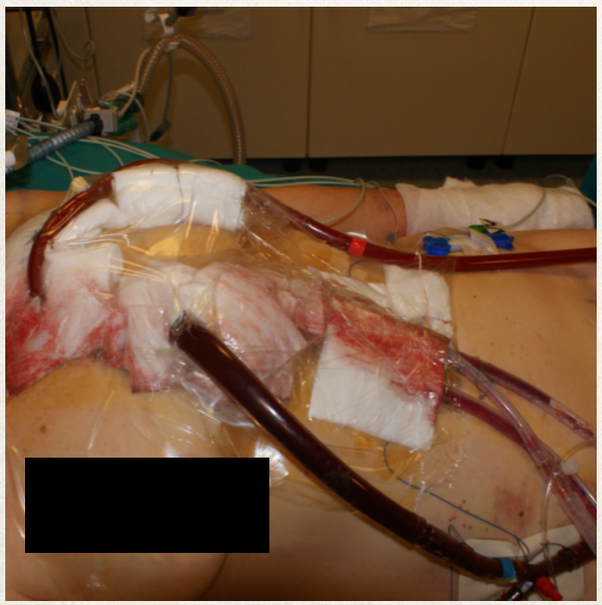
<u>Veno- Arterial (VA): Cardiopulmonary</u>

support for the heart and lungs



Used in: **Neonatal RDS, congenital heart diseases, cardiac arrest, cardiogenic shock, primary respiratory failure, post heart or lung transplant, postcardiotomy**

ECMO patients are generally not mobilized



Due to high risk of dislodgment in patients with severe medical conditions

Some Patients on ECMO can be mobilized!

Things to consider:

VA ECMO

- Typically anti-coagulated (Heparin)
- + IABP for ventricular assist

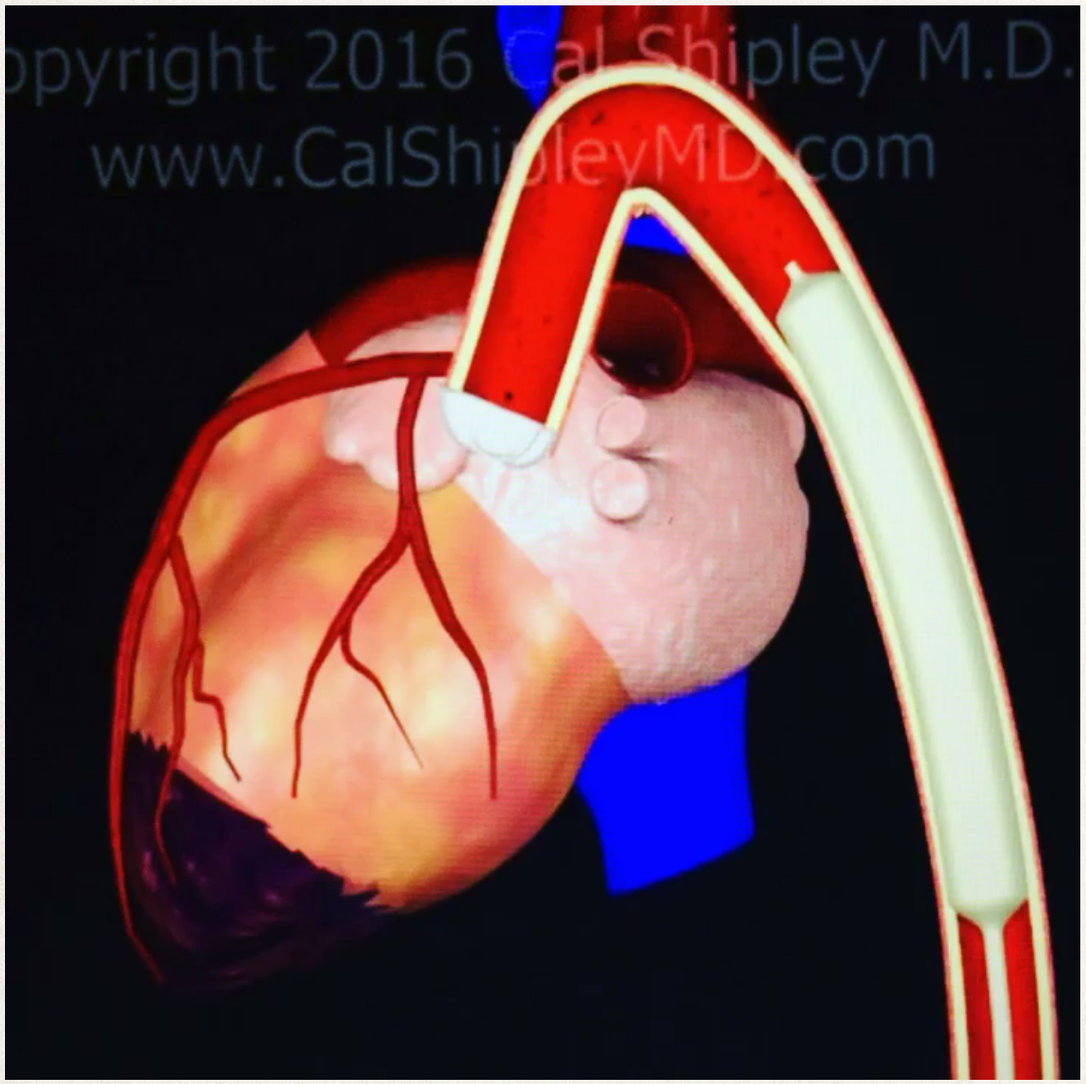
V-V ECMO

- Sedation/medical paralysis

To improve oxygenation
by minimizing demands of an awake person

If you have to absolutely work with a Pt, or if treatment is indicated, reduce Pt's stress level to reduce energy expenditure.

IABP (Intra-Aortic Balloon Pump)



Main function is to lessen the workload of the heart

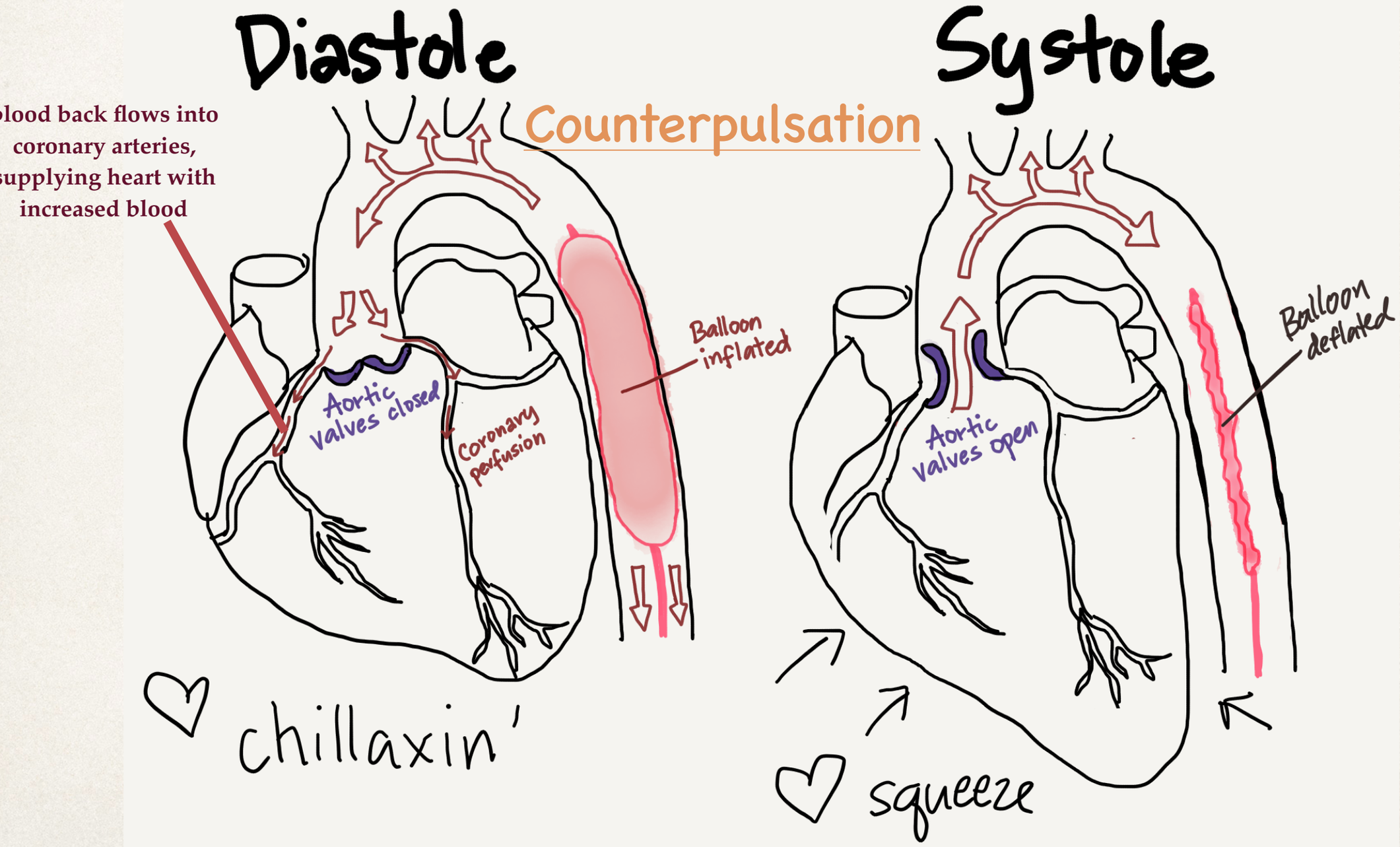
- Decrease afterload in aorta
- Increase myocardial O2 supply

For:

Cardiogenic shock
Acute LV failure, MI, MVR
Weaning from CP bypass
Refractory ventricular dysrhythmias
Pre/intra-op for high risk cardiac Pts

https://youtu.be/mADxD7C8jBw

IABP (Intra-Aortic Balloon Pump)



IABP (Intra-Aortic Balloon Pump)

- Inserted percutaneously into femoral artery
- Threaded anterograde until in proximal descending thoracic aorta

Ratio of heartbeat to counterpulsation indicates the amount of circulatory support needed

1:1

maximum circulatory support

Each heartbeat supported by a counterpulsation

1:4

weaning from IABP

Counterpulsation occurs with each 4th heartbeat

IABP (Intra-Aortic Balloon Pump)

Mobilizing Tips

- The LE with femoral access cannot be flexed at the hip.
- HOB cannot be raised >30 degrees to prevent cath migration.
- If IABP dislodged, allow 1-2 secs bleeding before applying pressure (to allow any clots to be removed) then call MD/RN.
- Bed rest x 8 hrs after removal, avoid exercising the extremity.
- Frequent repositioning, DBE, coughing (prevent pulmo comp.)

Take-Away!

Consider if life support is provided as an emergency procedure, vs "bridging" or weaning off support.

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Thank you.