Airway & Breathing

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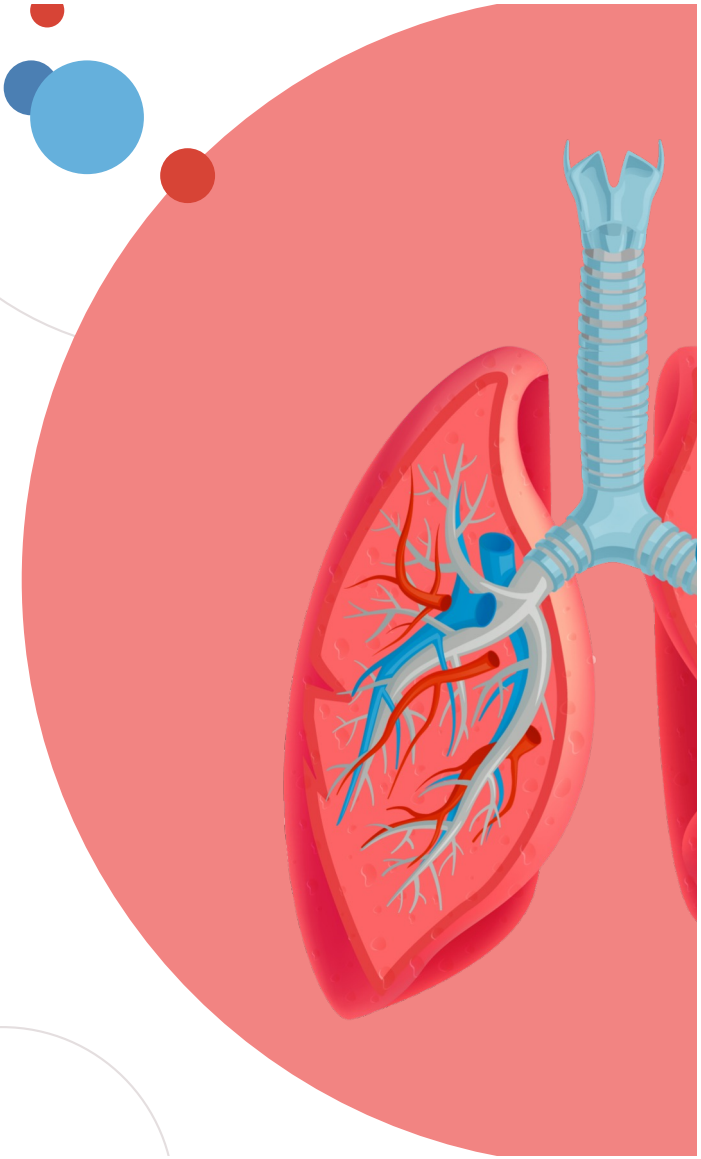
R&R 2026



Disclosures – Wilson Lam

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Empire Life

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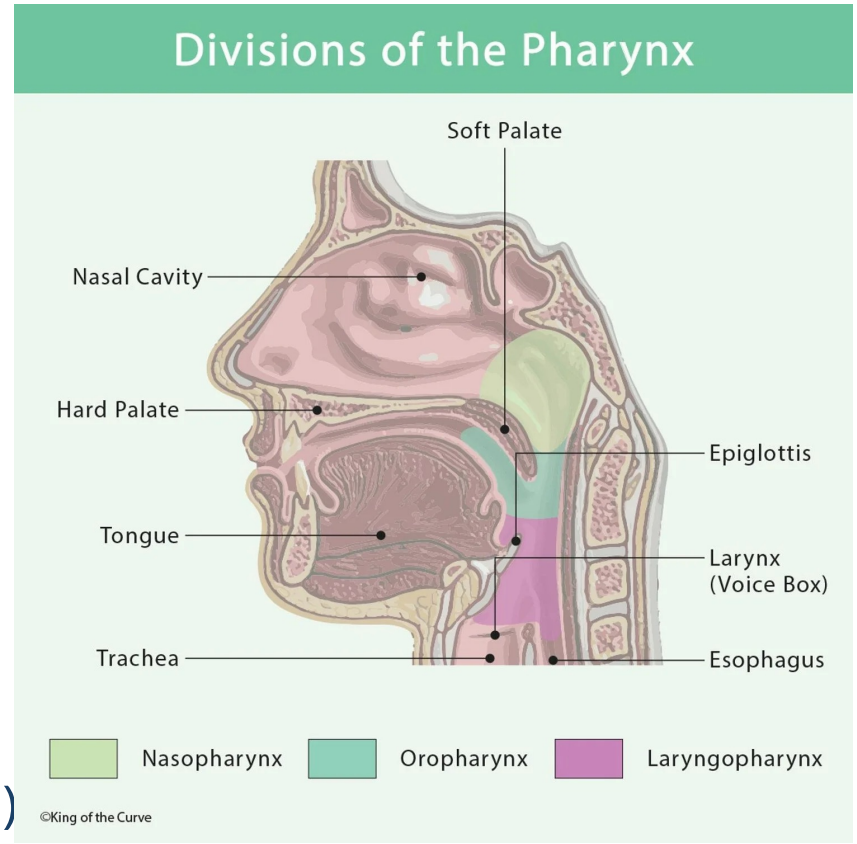
Base Case

50yo M
Found down, altered
IS protecting airway

- GCS 12
- 120/80
- HR 110
- Sat 88%
- Afebrile

01

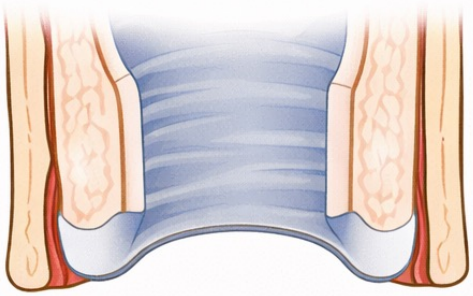
Airway Physiology



- **Nasal Passage** (hard cartilage, mucosa)
- **Oropharynx** (mucosa, tongue muscle, hard palate)
- **Velopharynx** (soft palate)
- **Laryngo Pharynx** (muscles, low compliance tissue)
- **Parapharyngeal fat pads** (dependent on level of obesity)
- **Trachea** (hard cartilage)

Cartilage

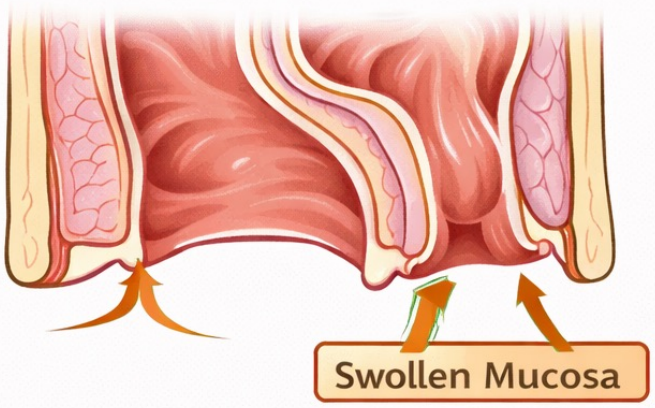
- Non-Distensible



Soft Tissue

- Distensible
- Perfusion Pressure
  20-30cm H_2O "Stiffens"

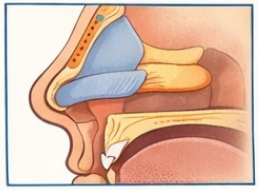
- Mucosa like Erectile Tissue
  Can Swell & Swell



Mechanisms Maintaining Airway Patency

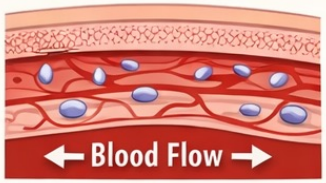
Structural Rigidity

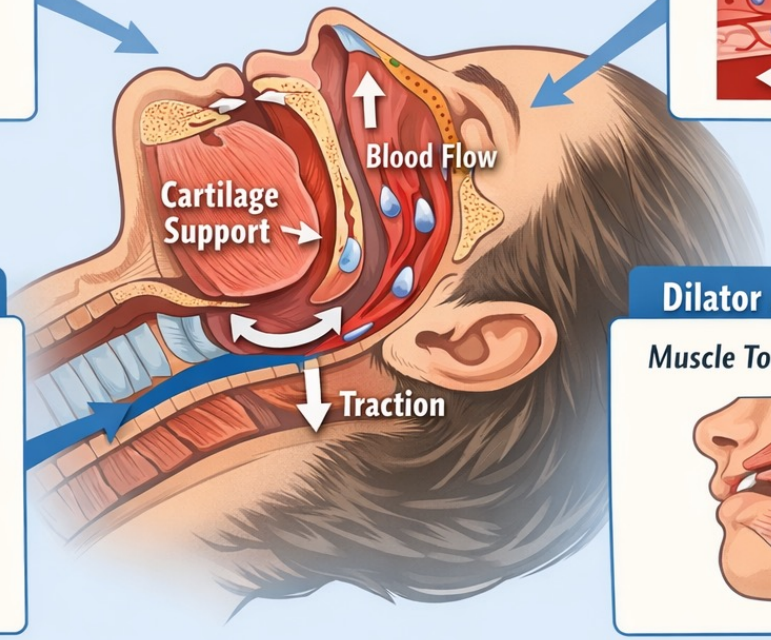
Nose & Larynx
Supported by Cartilage



Mucosal Perfusion

Perfusion Pressure
Stiffens Airway Walls



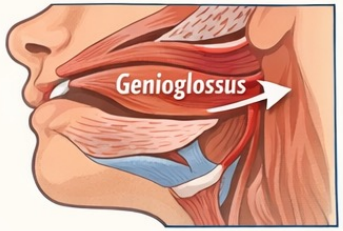


Lung Traction

Lung Inflation
Pulls Airway Open

Dilator Muscle Activation

Muscle Tone Keeps Airway Open



Neck extension:

- Moves the **hyoid bone** anteriorly and superiorly
- Pulls the **tongue** and attached **soft tissues forward** via the **genioglossus** and **suprahyoid** muscles.
- Opens the **oropharyngeal airway.**

Neck flexion:

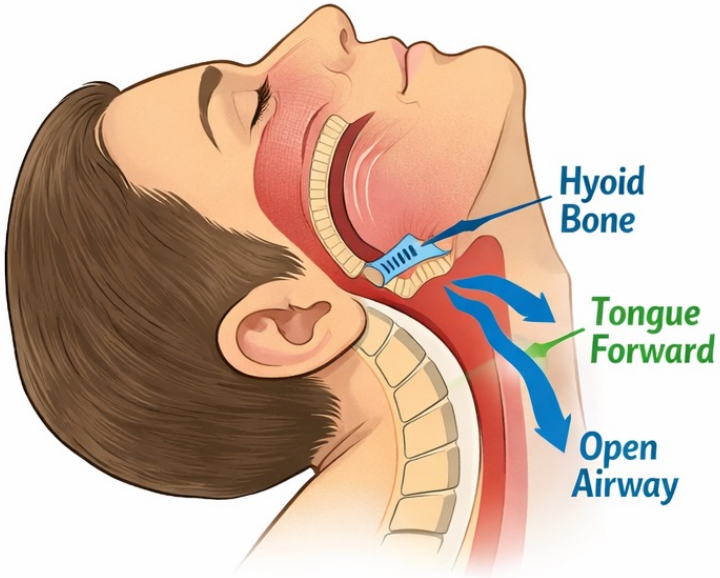
- Causes the **tongue** and **soft tissues** to **move posteriorly** and **inferiorly**
- Moves the hyoid **backward,** decreasing airway diameter
- Narrows or **collapses** the pharyngeal airway

Summary:

- **Extension:** Hyoid & tongue move anteriorly – airway **opens.**
- **Flexion:** Tongue & tissues move **posteriorly** – airway collapses.

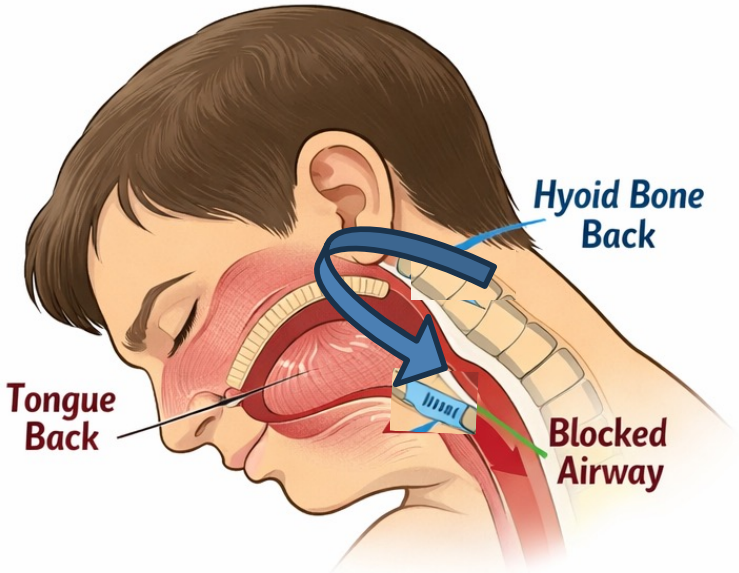
Neck Extension

- Hyoid & Tongue Move Forward
- Airway Open ✓



Neck Flexion

- Tongue & Tissue Move Back
- Airway Collapsed ✗



Extension: Airway Open | Flexion: Airway Collapsed

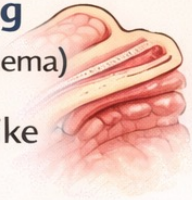
WAYS THE UPPER AIRWAY NARROWS

(↑ Resistance to airflow)

1. Mucosal swelling

(congestion / angioedema)

- Mucosa behaves like erectile tissue
- Airway narrows



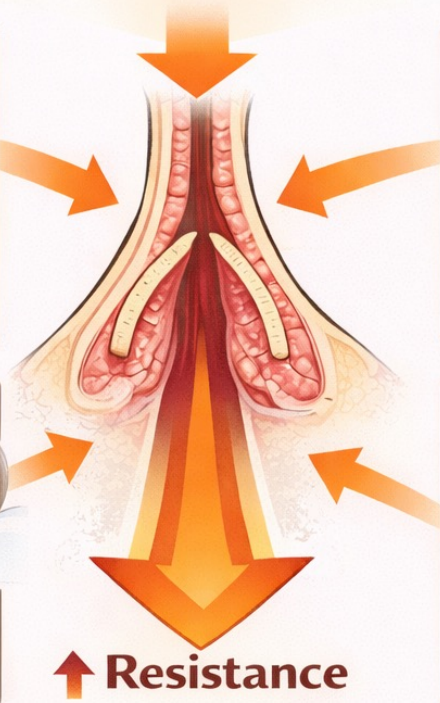
2. Obesity

- Parapharyngeal fat pads
- Velopharyngeal narrowing

3. Supine position

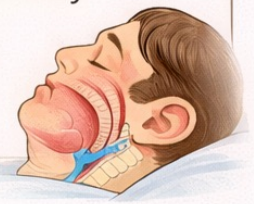
- Venous congestion in neck veins (no venous valves)
- ↓ Nasal airflow

↑↓ Soft tissue collapse

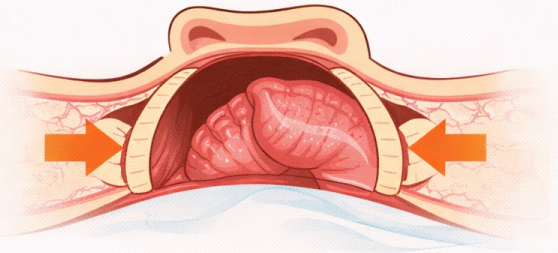


4. Neck flexion

- Tongue moves posteriorly
- Hyoid moves posteriorly
- Pharyngeal airway narrows



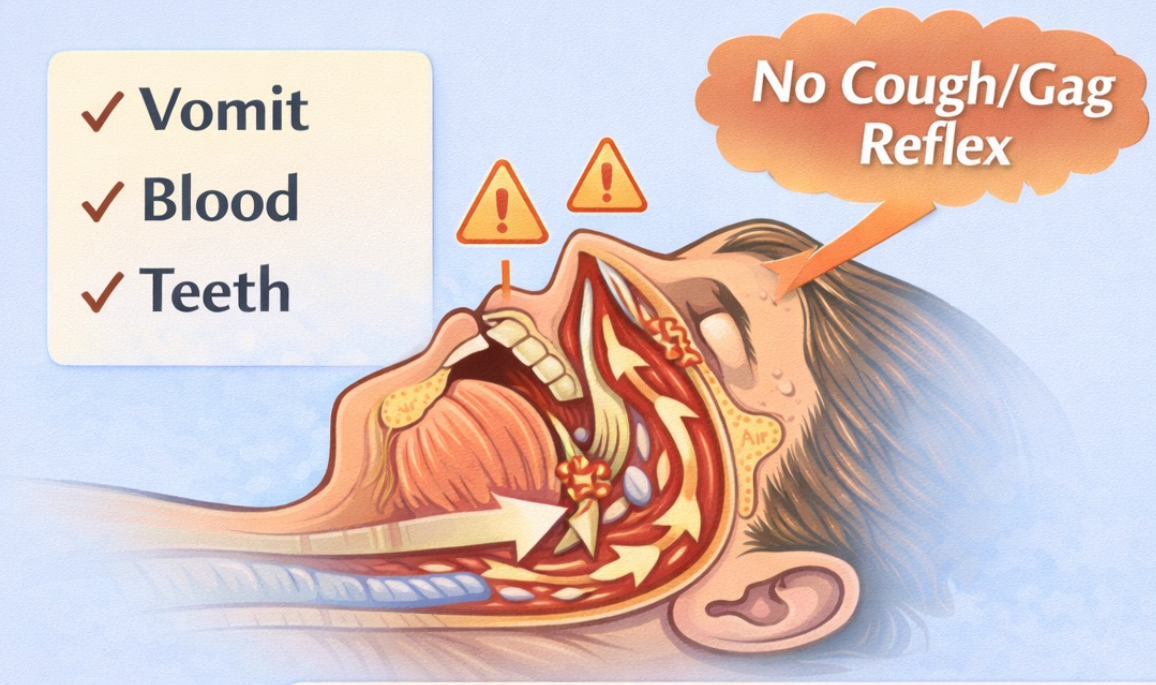
Take away muscle tone thru sedation or paralysis



Airway collapses

No Cough/Gag Reflex

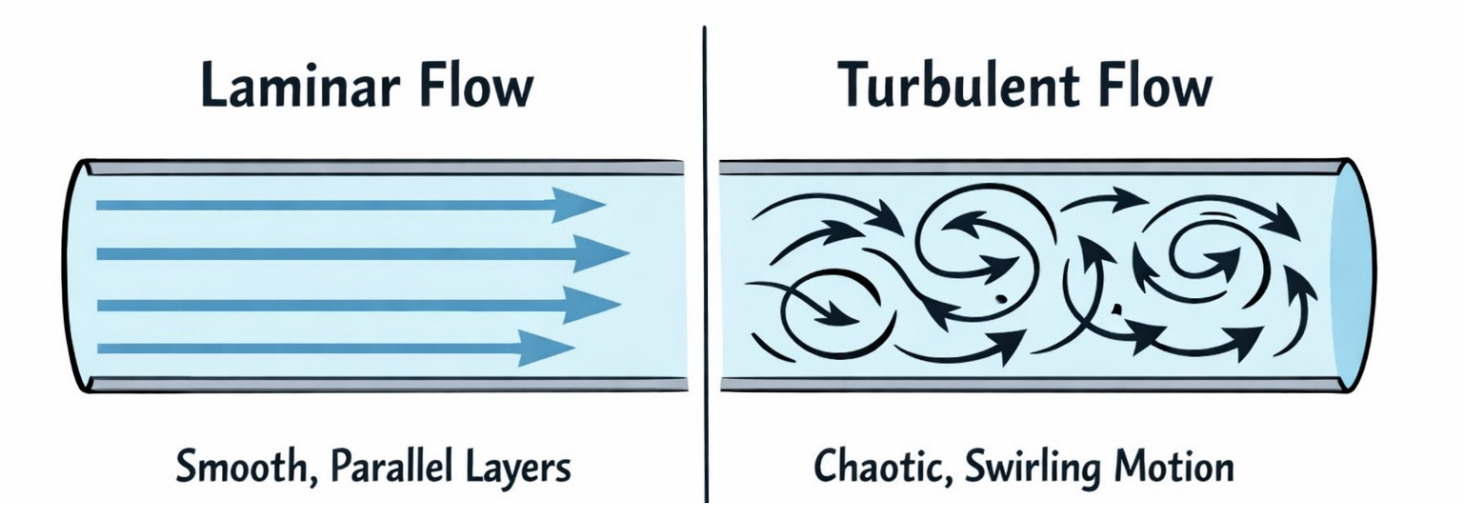
- ✓ Vomit
- ✓ Blood
- ✓ Teeth



~70%
Unresponsive to Pain have No Active Airway Reflexes

Fluid/Objects Can Block Airway

- When things are going well, we are moving <30L/min which airways can accommodate leading to smooth laminar flow



- When airways narrow or we start breathing harder, we transition to noisy turbulent flow

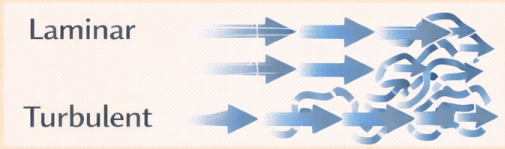
High Minute Ventilation

↓

Higher Airflow Velocity

↓

Transition from Laminar → Turbulent Flow

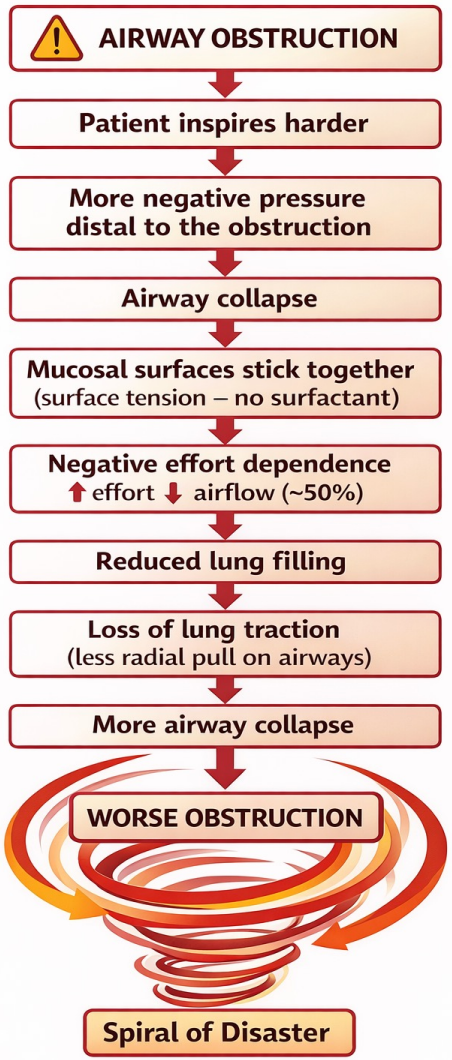


↓

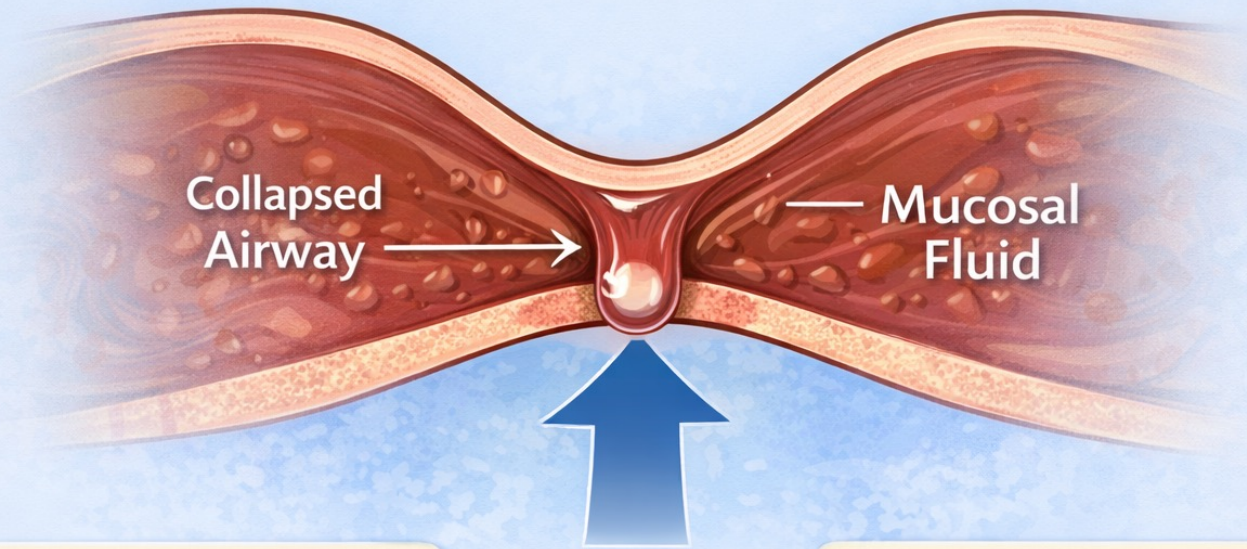
Marked ↑ Airway Resistance

↓

Greater Work of Breathing


AIRWAY OBSTRUCTION
Patient inspires harder
More negative pressure distal to the obstruction
Airway collapse
Mucosal surfaces stick together (surface tension – no surfactant)
Negative effort dependence ↑ effort ↓ airflow (~50%)
Reduced lung filling
Loss of lung traction (less radial pull on airways)
More airway collapse
WORSE OBSTRUCTION
Spiral of Disaster

Airway Collapse & Mucosal Surface Tension

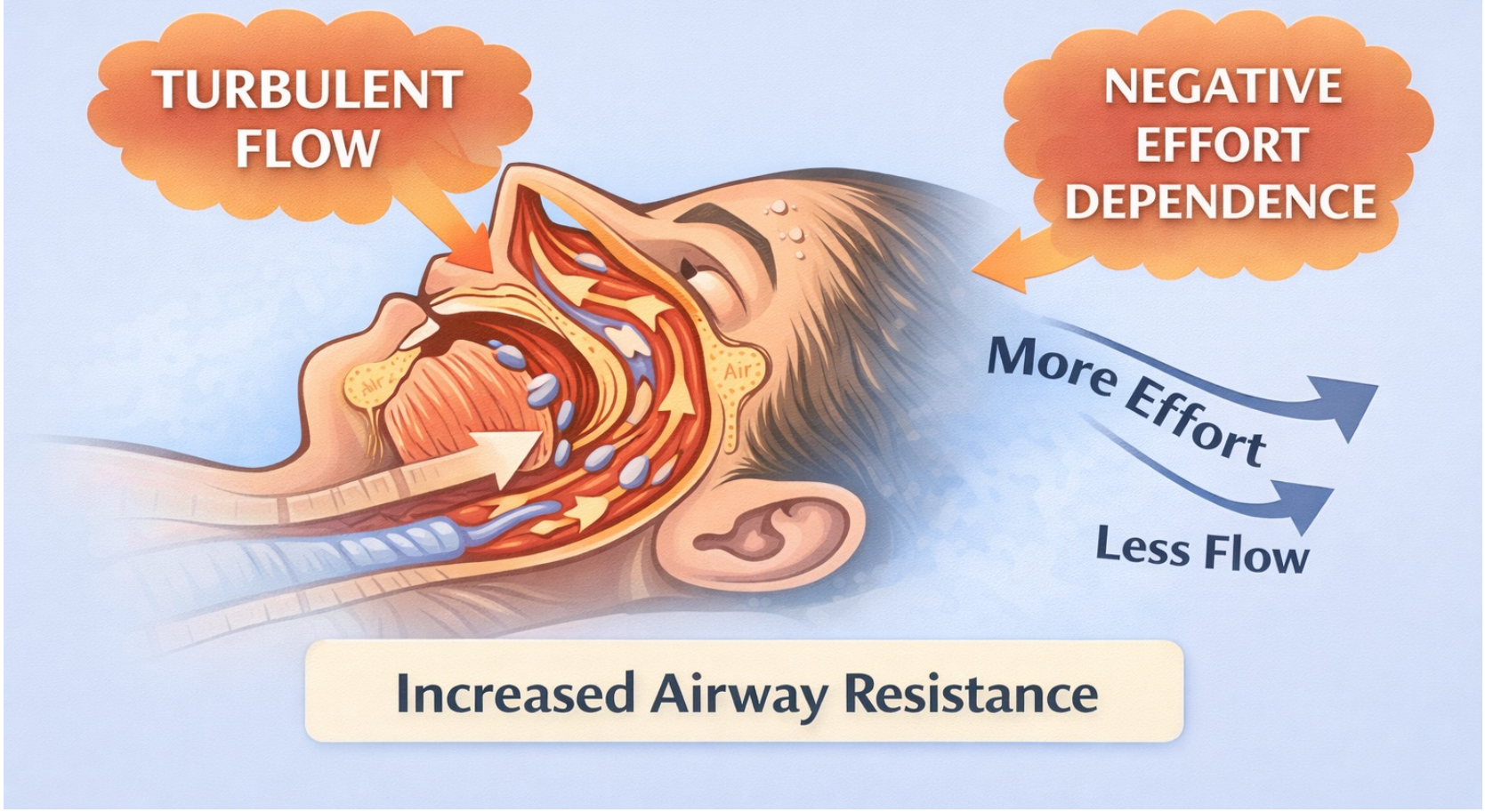


✓ Collapsed Airway; Sealed Mucosa

HIGH PRESSURE

✓ High Pressure Needed to Open

More Effort, Worse Flow

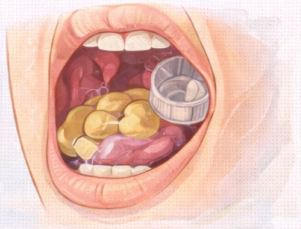


- Closed Airways want to stay closed!!!!
- Working hard makes the situation worse!!!!

Airway Assessment

LOOK

Distorted anatomy or objects in the airway



LISTEN

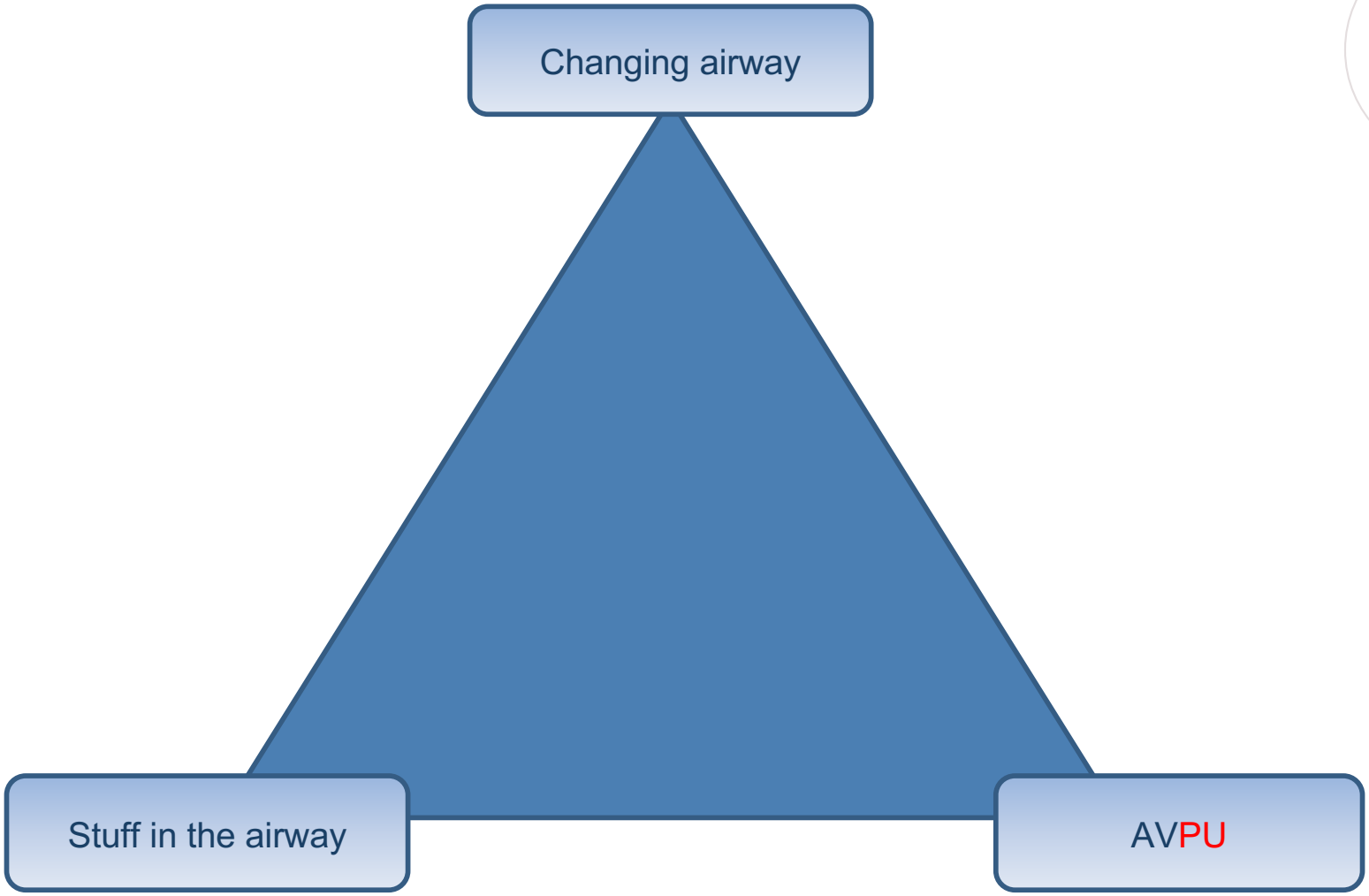
Stridor, snoring or gurgling

FEEL

- Swelling of tissues or
- resistance if using BVM

02

Airway Framework



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03

Airway Strategies

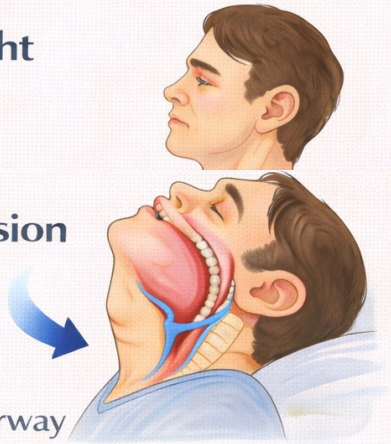
Ways to improve patency

1. **Keep patient upright**

2. **Keep neck in extension**

   Hyoid and tongue move anteriorly

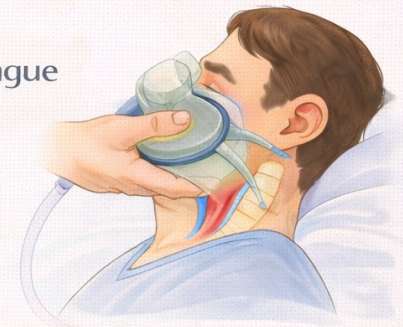
   Opens the pharyngeal airway



3. **Jaw thrust**

   (move mandible and tongue forward)

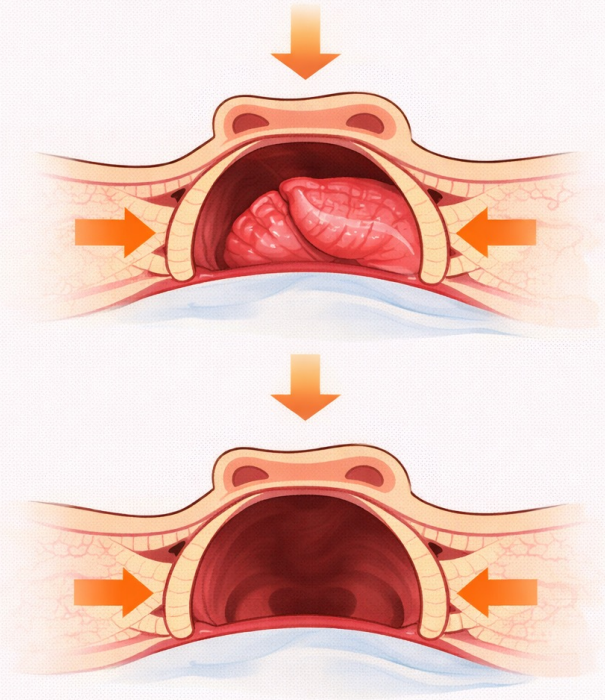
   Prevents tongue from blocking airway



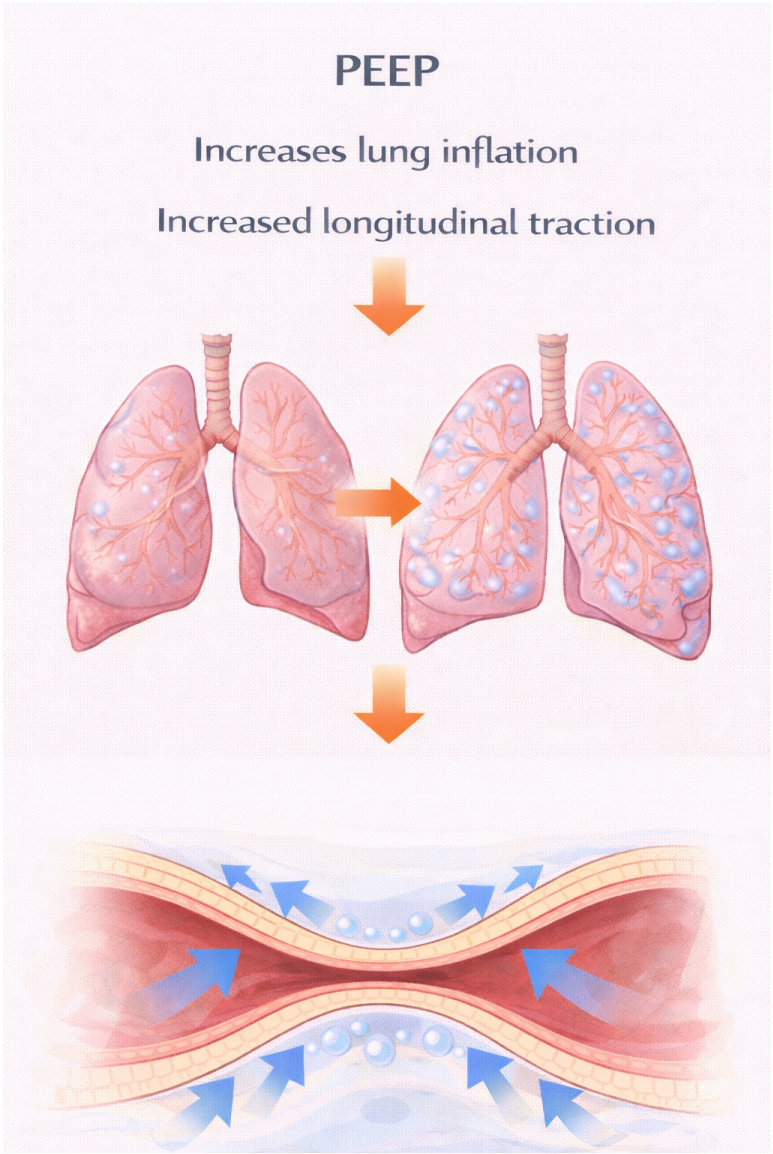
4. **Suction airway**

   (if altered mental status and secretions)

Reduce mucosal swelling



- IM epi
- Dexamethasone
- Decongestants


PEEP
Increases lung inflation
Increased longitudinal traction

Ways to Reduce Excessive Respiratory Effort

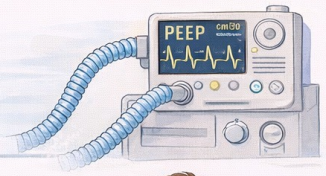
(↓Work of Breathing)

1. Add Oxygen

- ↓ Hypoxia
- Air hunger
- ↓ Respiratory drive

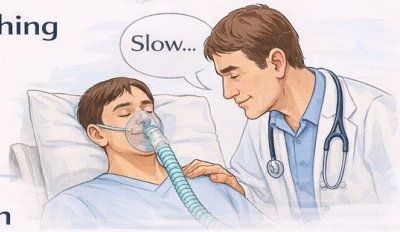
2. Add Positive Pressure Ventilation (PPV)

- → Supports ventilation
- ↓ Muscle effort
- ↑ Tidal volumes



3. Coach Slow Breathing

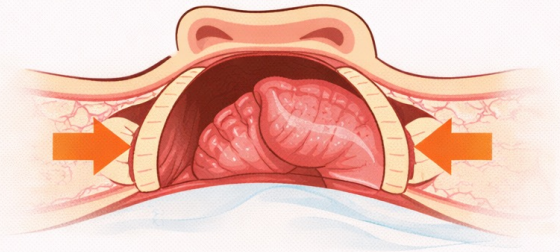
- ↓ Respiratory rate
- Turbulent flow
- ↓ Work of breathing



4. Ketamine Sedation (if needed)

- ↓ Anxiety / distress
- Maintains airway reflexes
- ↓ Excess respiratory effort

Take away muscle tone thru sedation or paralysis



Airway collapses

Best Airway Rescue

PREVENTION

Position airway properly

+

Maintain muscle tone

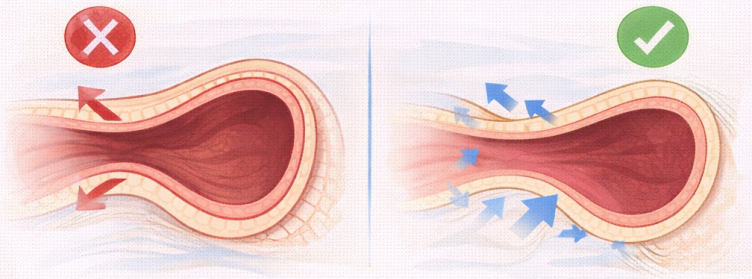
+

Reduce swelling

+

Apply positive pressure

AIRWAY STAYS OPEN



"Don't let the airway collapse in the first place."

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04

Breathing Physiology

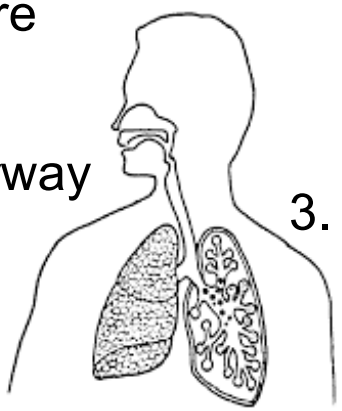
How do lungs actually work?

- O_2
  - Flows down a shallow gradient (21% to 15% ie ~30%)
  - Poorly soluble (1)
  - Protein bound (98%)
- CO_2
  - Flows down a steep gradient (0.04% to 4% ie ~10,000%)
  - Very soluble (28)
  - Mostly dissolved (80%)

1. O2 in atmosphere

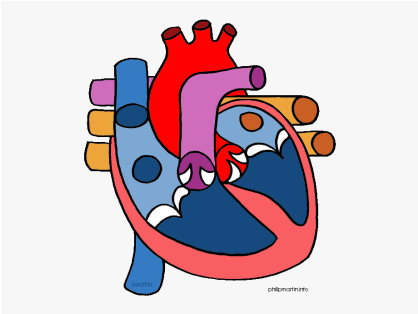
O2

2. Patent airway



3. Moving air in and out

4. Thin membranes



5. Good forward bloodflow

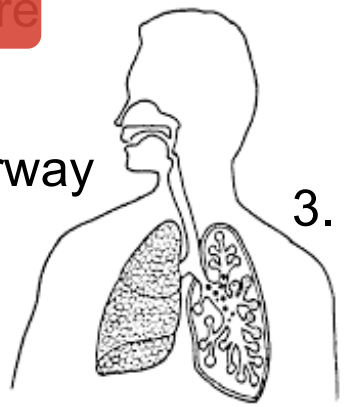
6. Enough Hgb

7. Functional Hgb

1. O2 in atmosphere

CO2

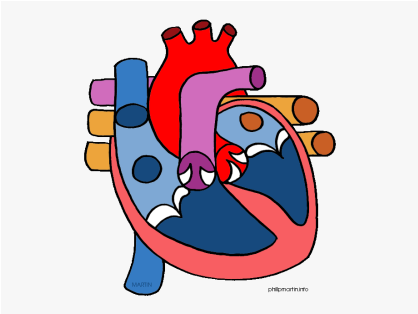
2. Patent airway



3. Moving air in and out

CO2 removal = VENTILATION

4. Thin membranes



5. Good forward bloodflow

6. Enough Hgb

7. Functional Hgb

05

Breathing Framework

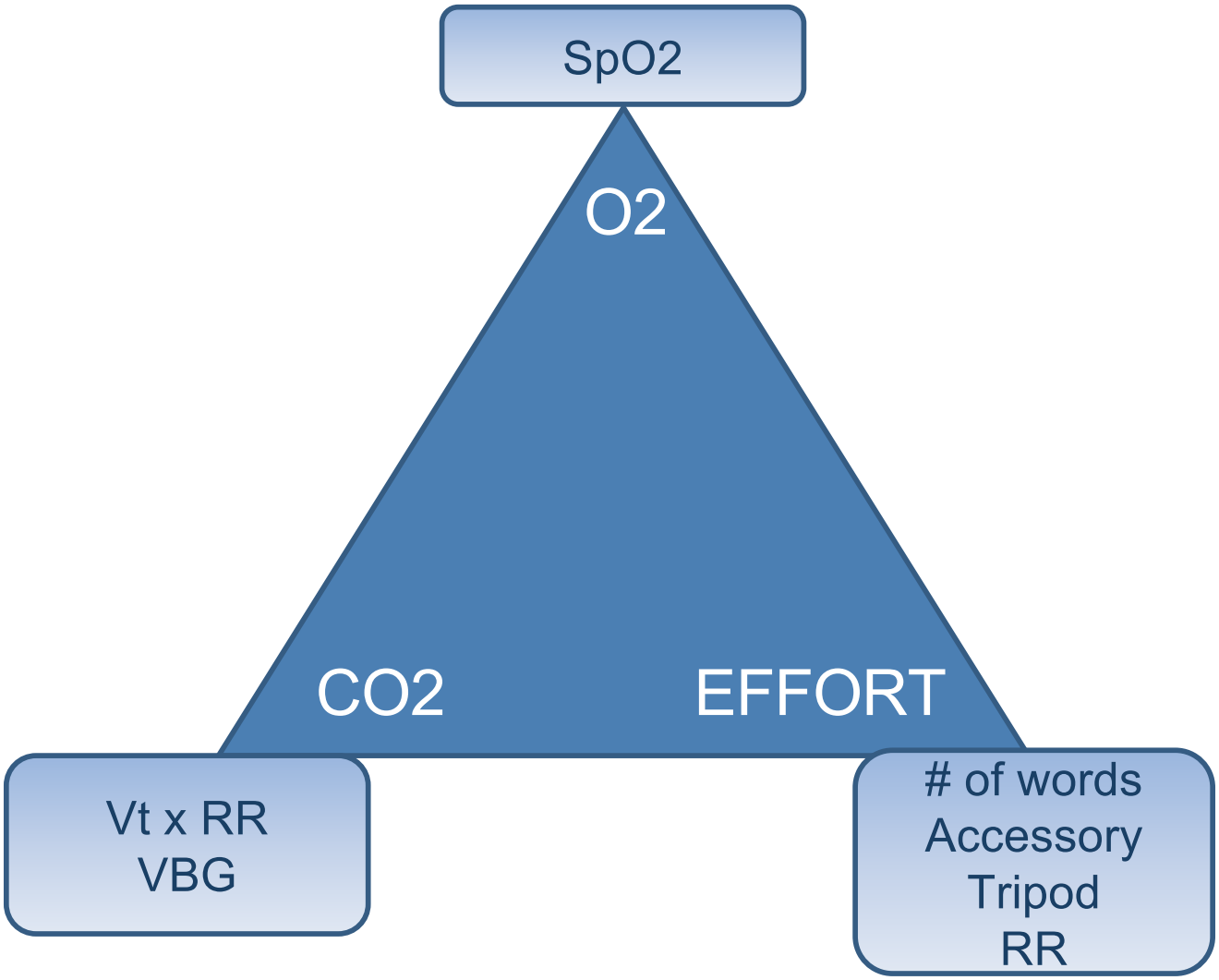
Base Case

50yo M
Found down, altered
IS protecting airway

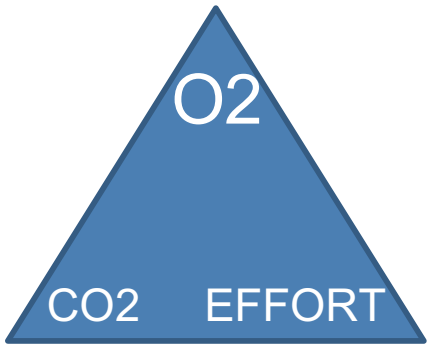
- GCS 12
- 120/80
- HR 110
- Sat 88%
- Afebrile

What do the lungs do again?

- Add O_2
- Remove CO_2
- Use muscle effort to achieve the above

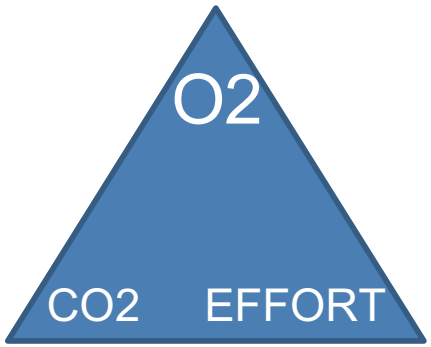

SpO2
O2
CO2
EFFORT
Vt x RR
VBG
# of words
Accessory
Tripod
RR

O2?



- Pulse oxymetry
- Preferably in the 90s but 80+ will do in a pinch
- At the top because brain hypoxia reliably kills in 6-10 minutes
- Tools required: O2 sat probe

CO_2



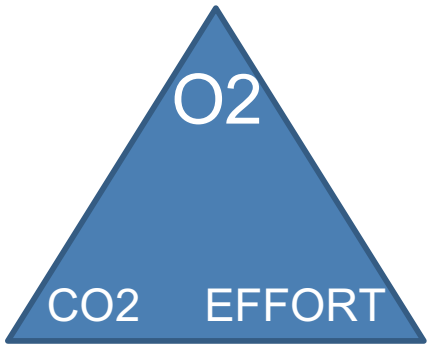
- RR we can count
- VT we can estimate by looking and listening
- Tools required: Mk 1 eyeball, stethoscope, EtCO2 if available

Effort

- # of words

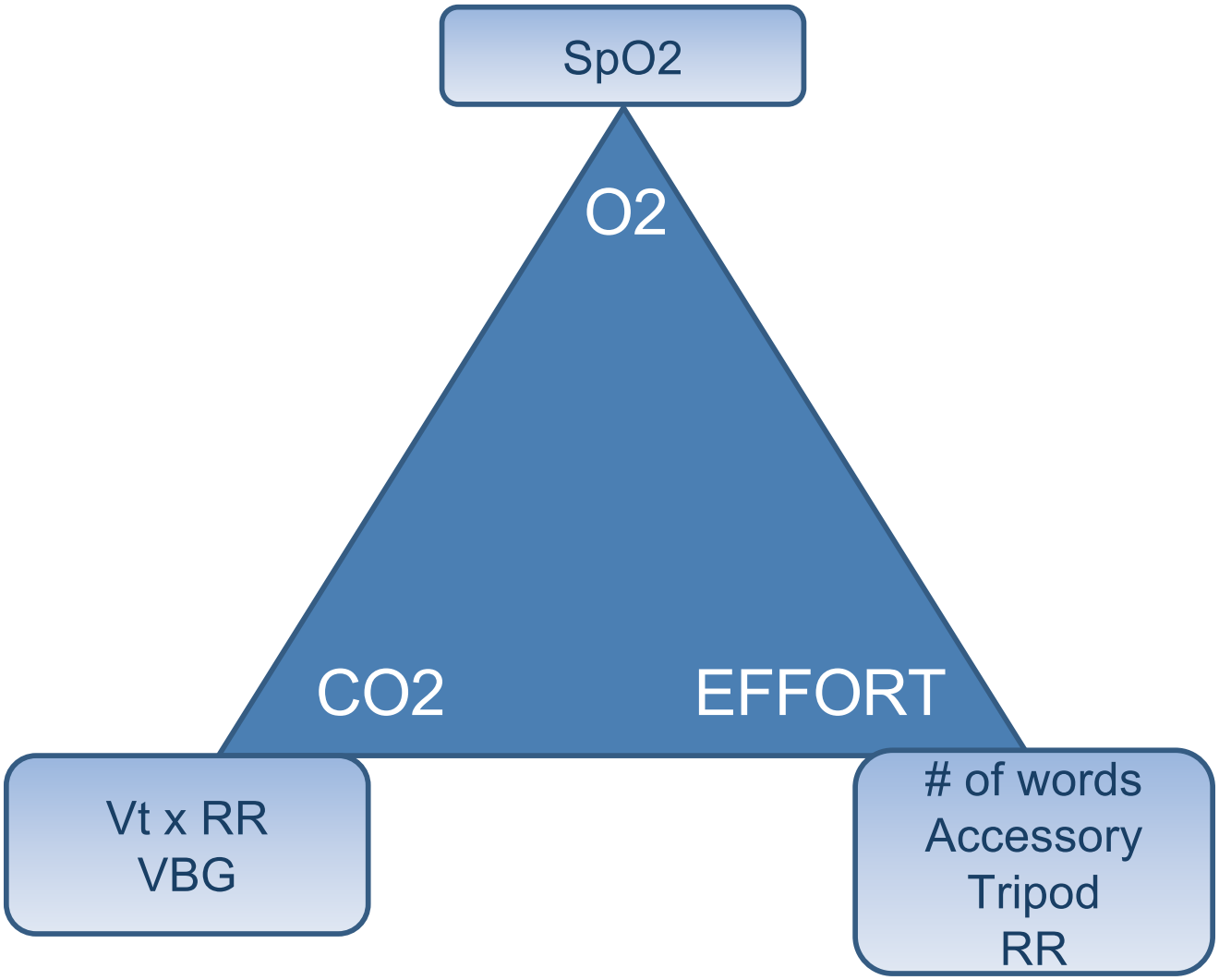
- RR
- Accessory use
- Tripoding

- Tools required: Mk 1 eyeball

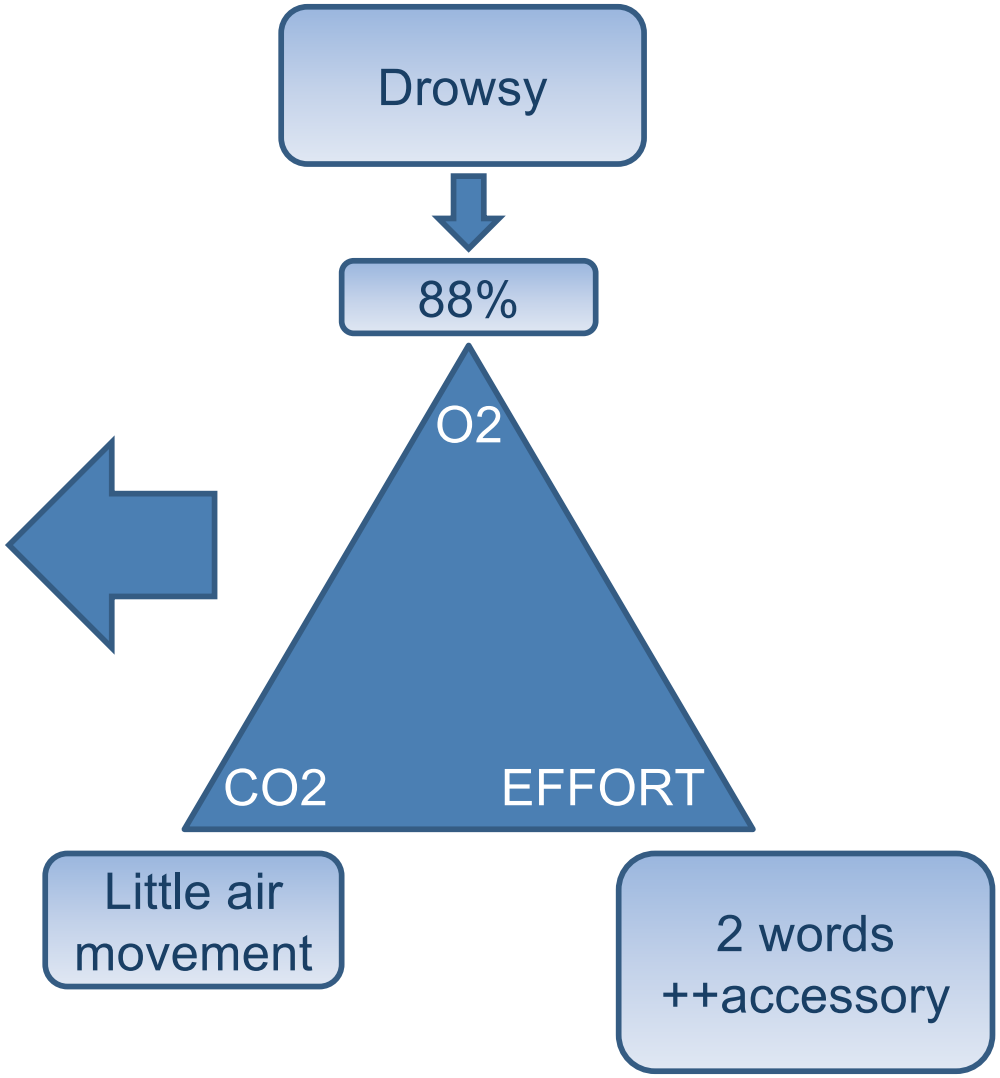


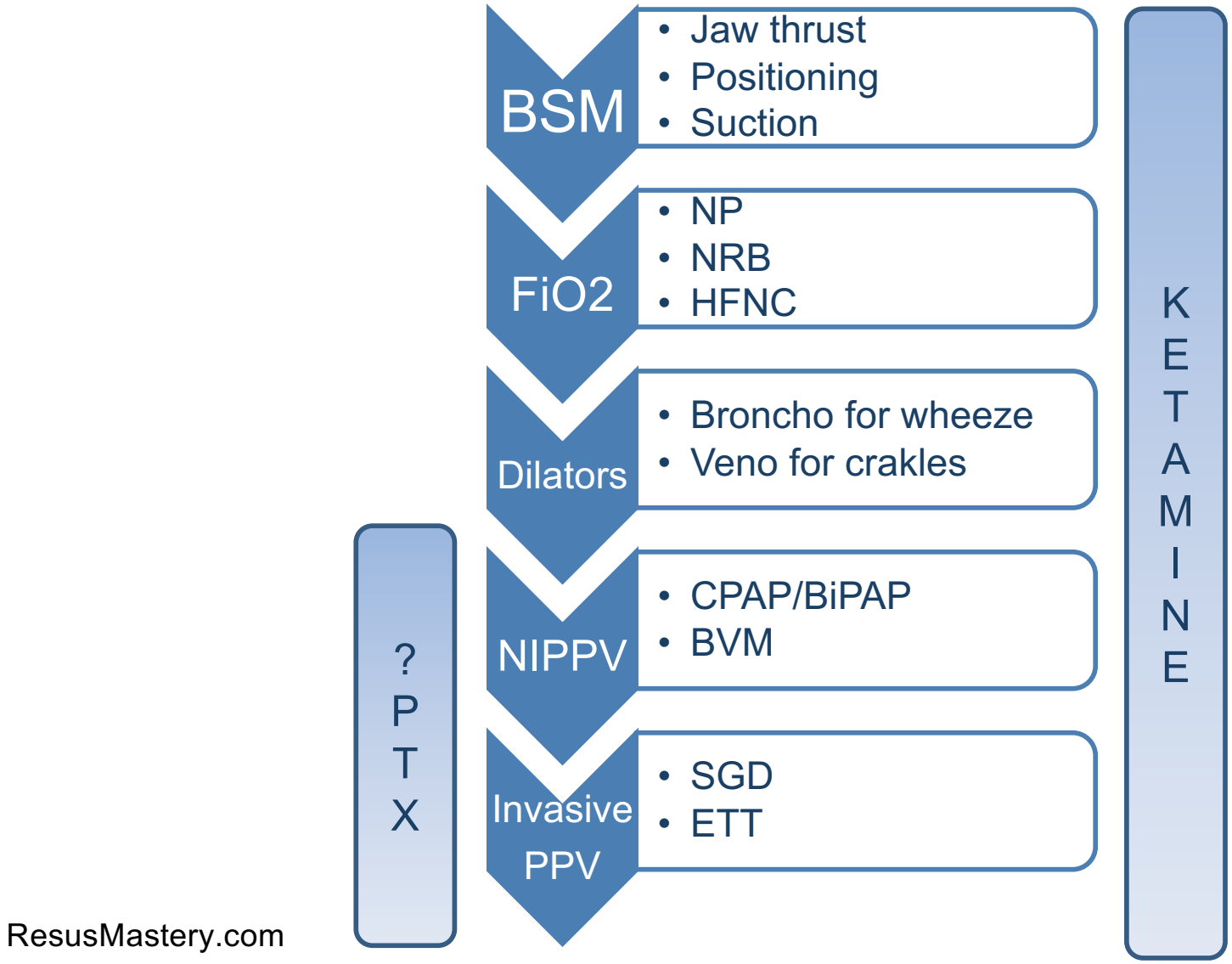
06

Breathing Strategies


SpO2
O2
CO2
EFFORT
Vt x RR
VBG
# of words
Accessory
Tripod
RR

?


Drowsy
88%
O2
CO2
EFFORT
Little air movement
2 words ++accessory



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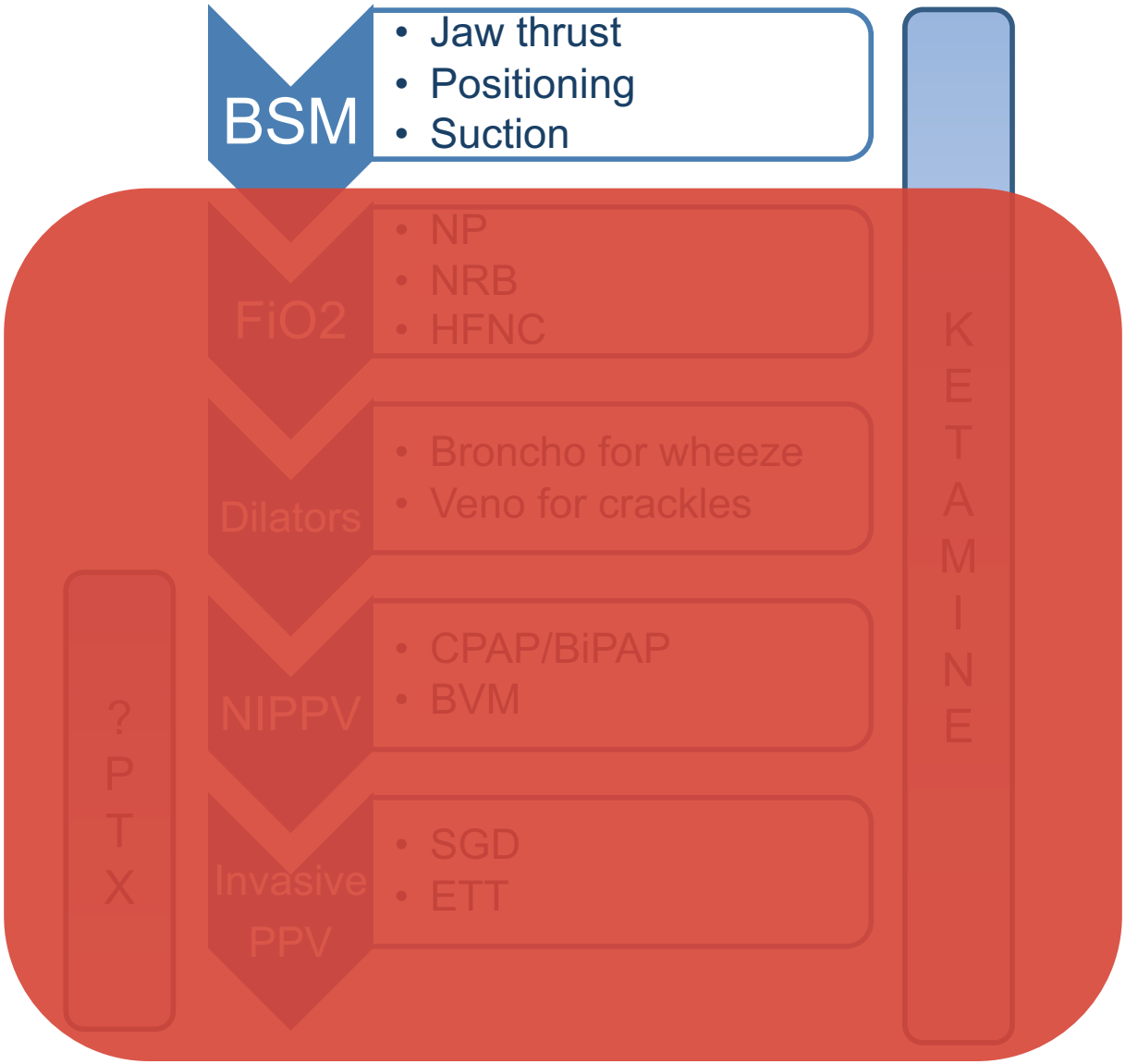

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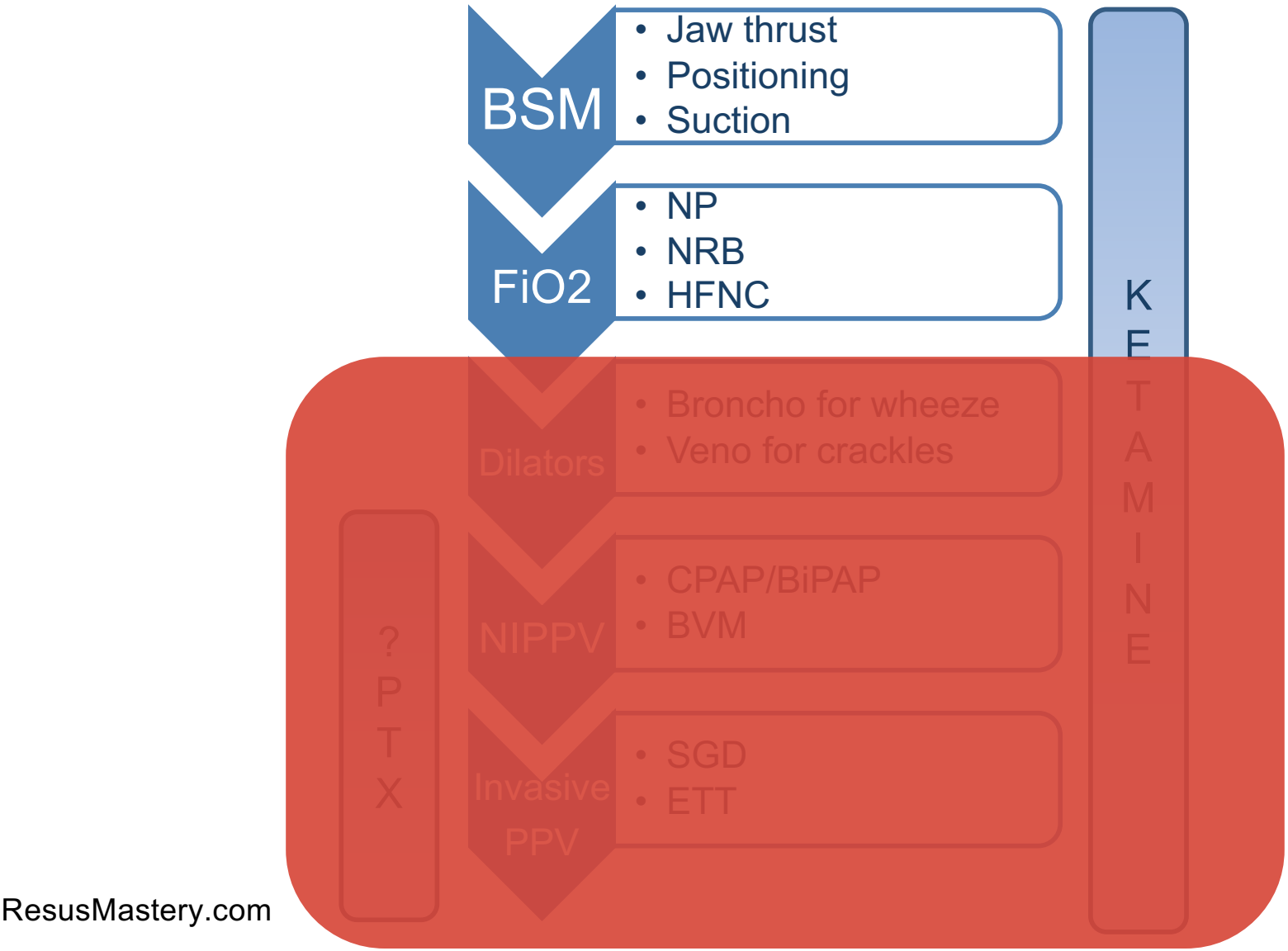
Basic supportive maneuvers

Sitting upright:
FEV1, FVC, FRC, etc ~

+20%

Col. Cloonan, “Immediate Care of the Wounded”, pg 11, operationalmedicine.org



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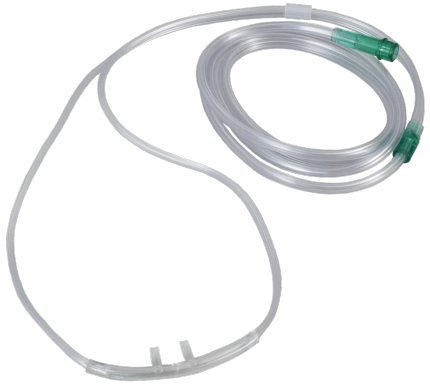
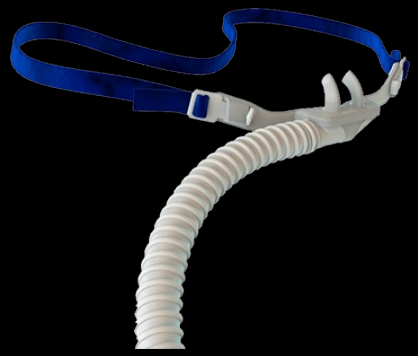
True 100% FiO2



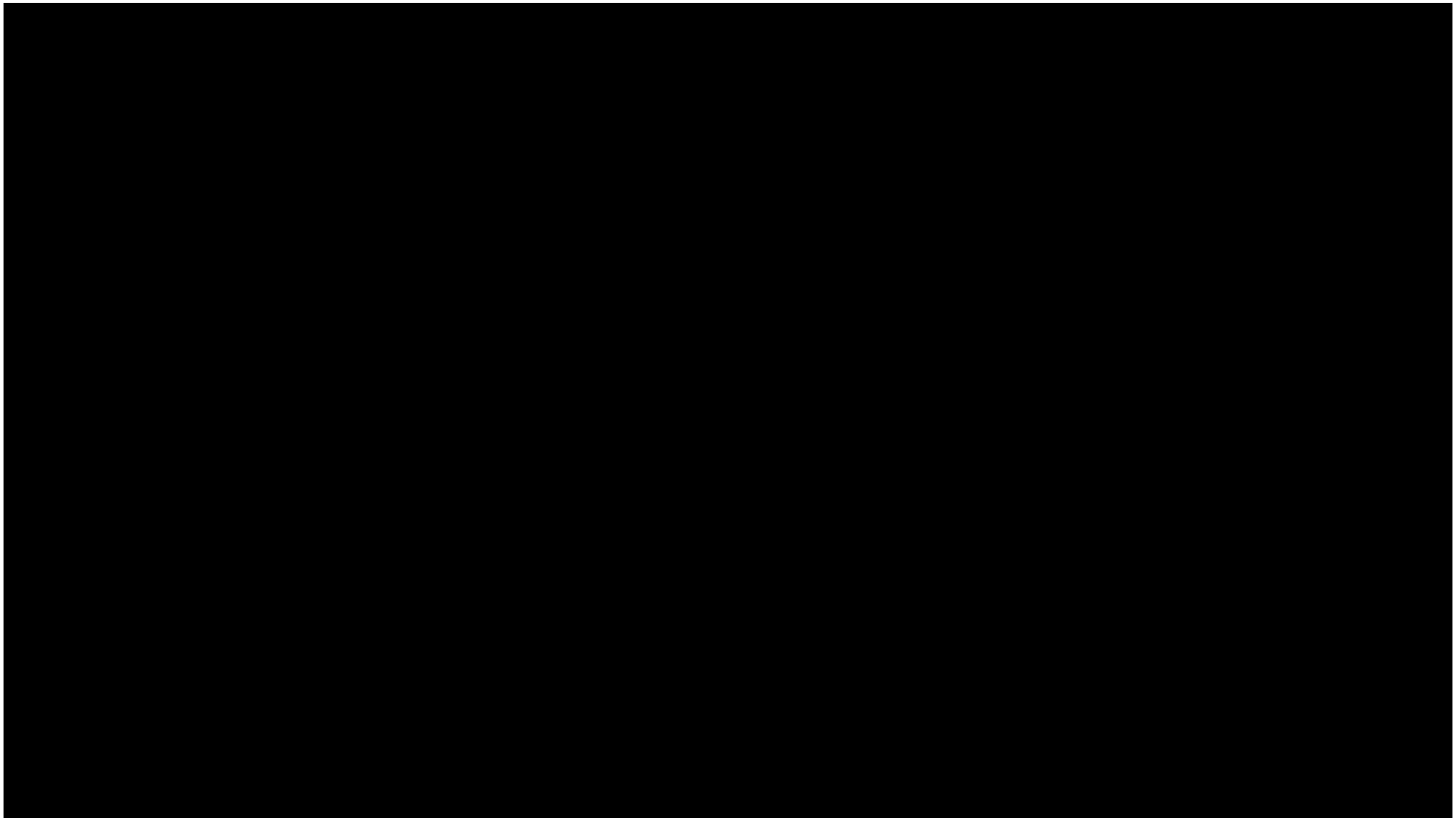
+

~60L flow each

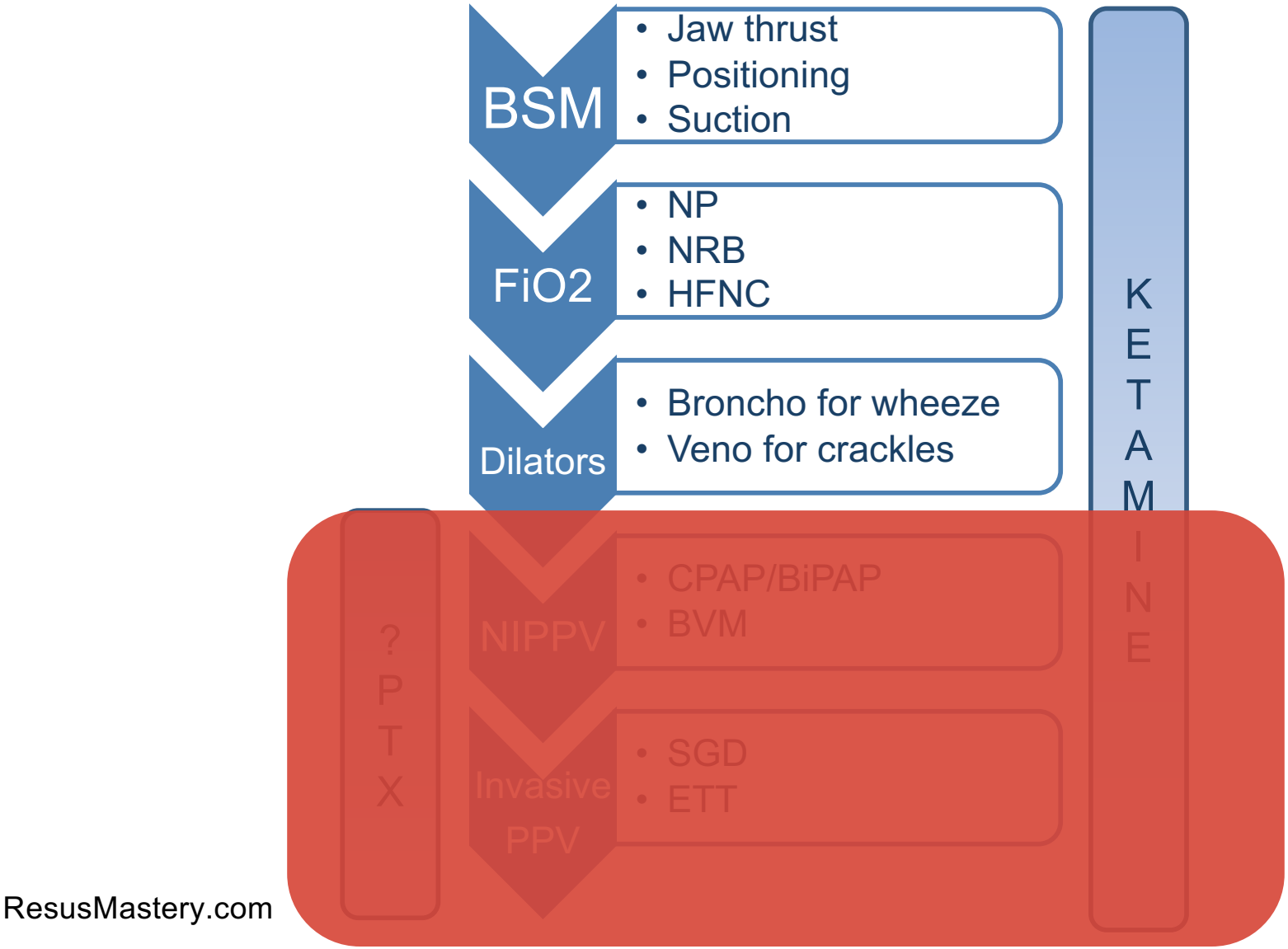
…why?



High flow nasal cannula (HFNC)



Credit: Andreas Schibler, University of Queensland


BSM
• Jaw thrust
• Positioning
• Suction
FiO2
• NP
• NRB
• HFNC
Dilators
• Broncho for wheeze
• Veno for crackles
NIPPV
• CPAP/BiPAP
• BVM
Invasive PPV
• SGD
• ETT
? PTX
KETAMINE

Dilators

- Bronchodilators
  - 5mg neb = 4-6 puffs
  - Realize that nebulizer is a low FiO2 device

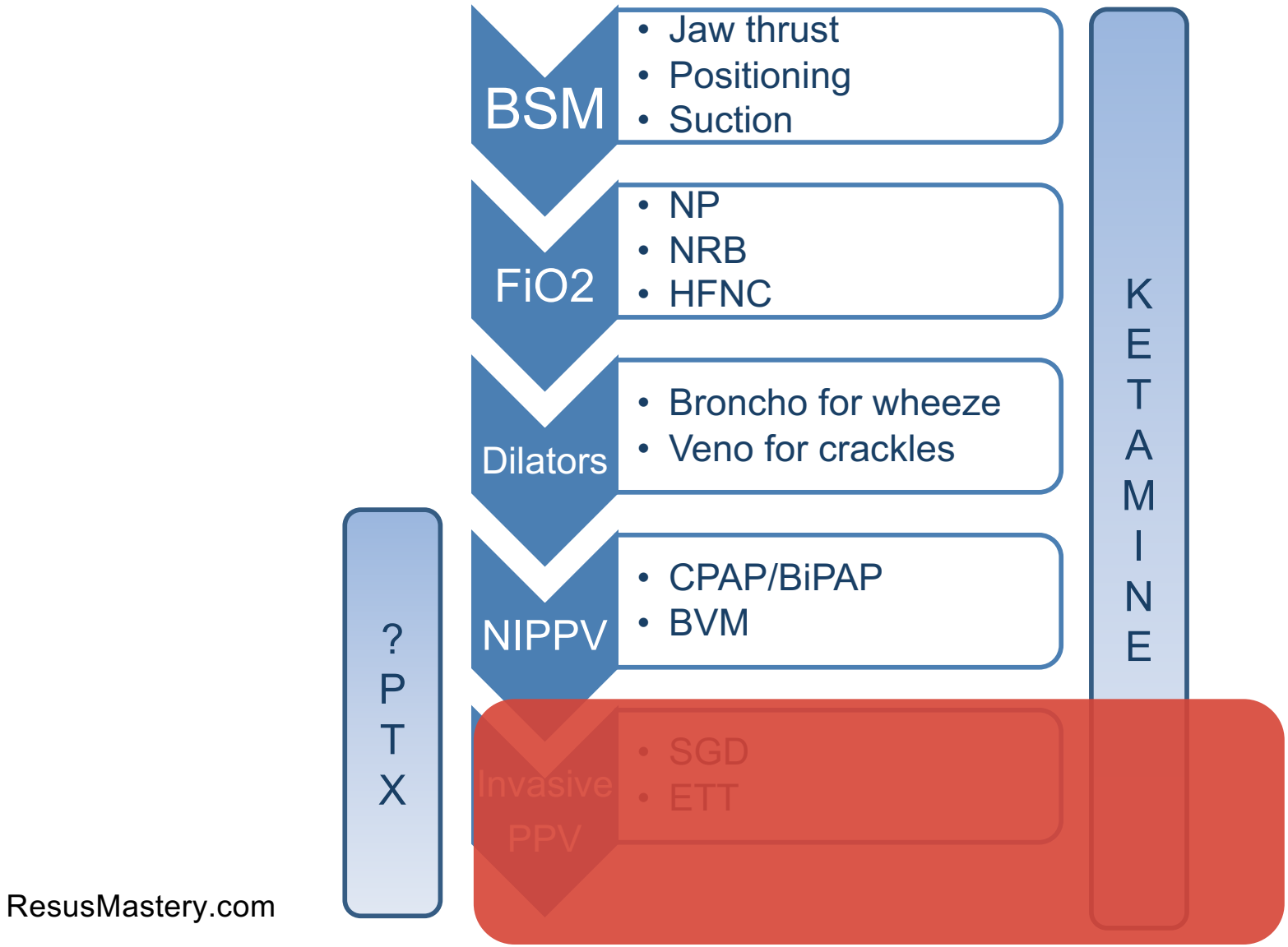
- Give as much as HR will allow
- 0.6 meq drop in K with every 10mg neb Ventolin

Dilators CHF

Nitro >> Lasix

- Give as much as BP will allow
- SL Nitro sprays have ~30-40% absorption (120-150mcg per spray)

- Lasix takes 30-120 min to produce any preload effect
- 50% of acute CHF are euvolemic



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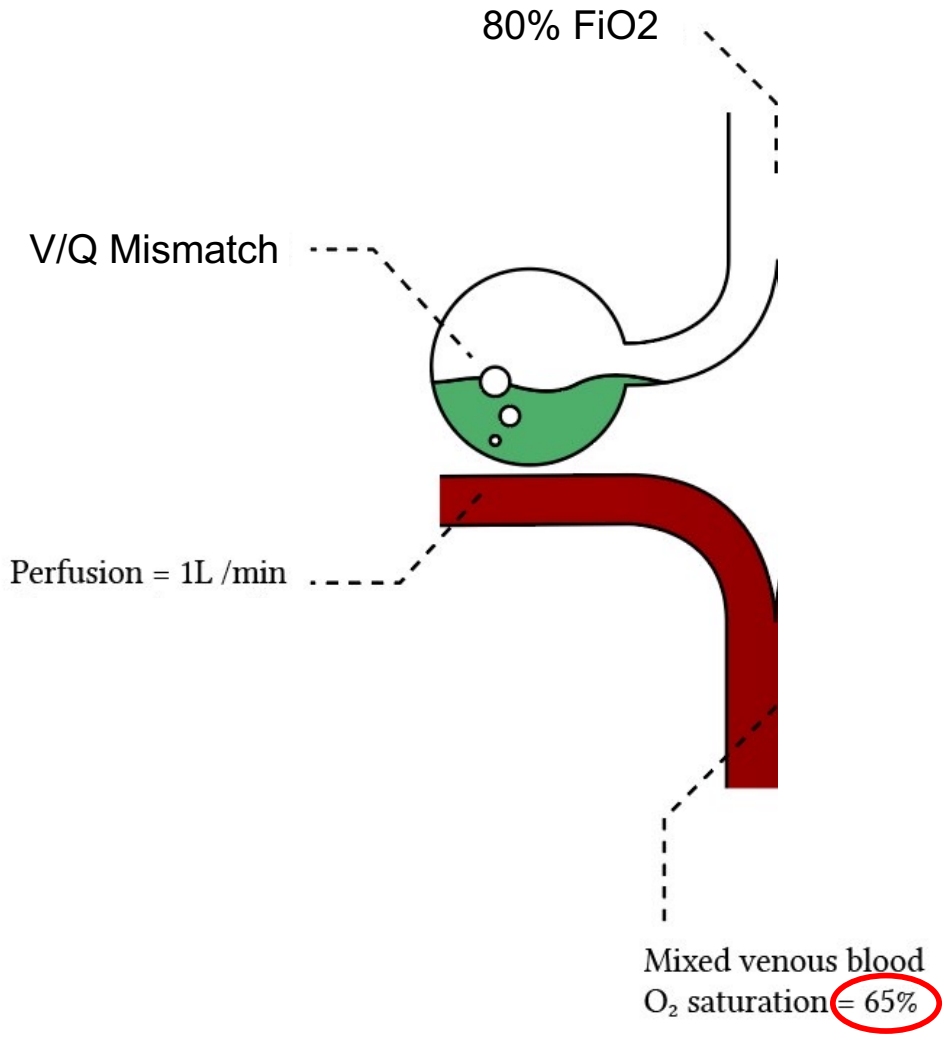
BVM with PEEP valve

Crap in lung?

aka V/Q mismatch



Crap in lung?

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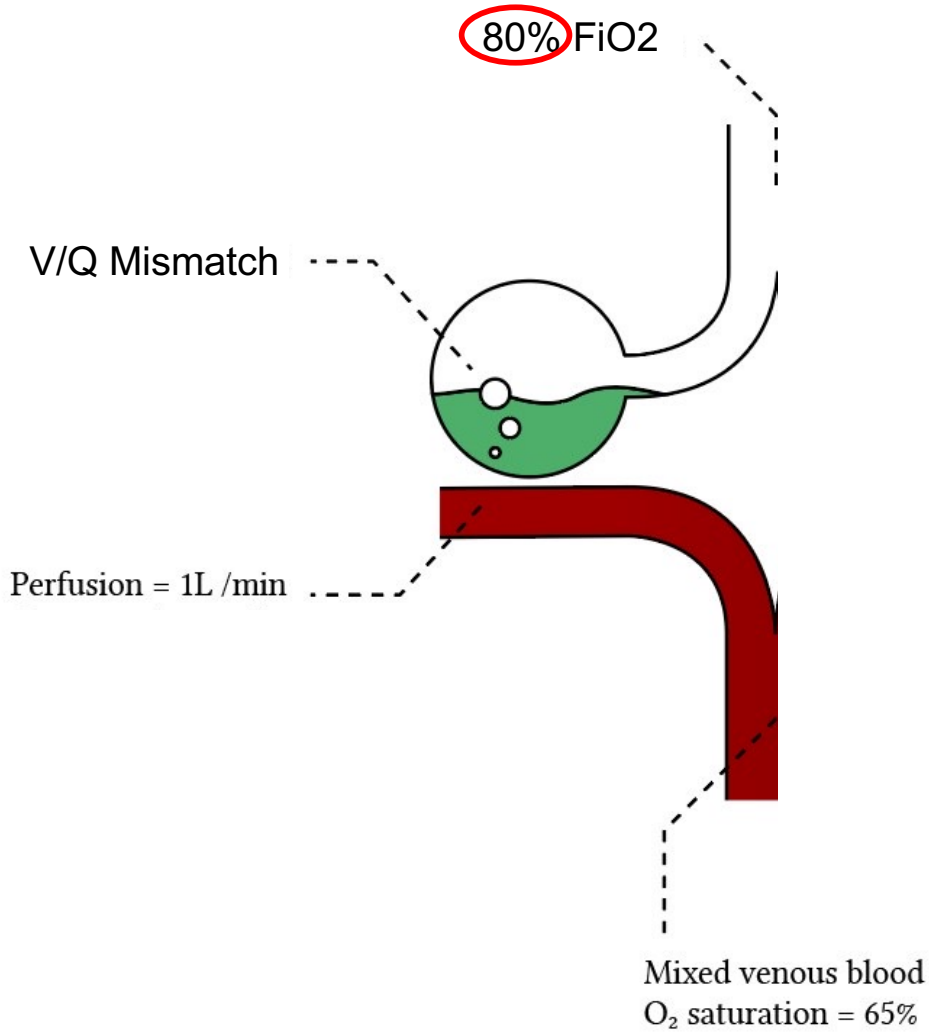

Crap in lung?

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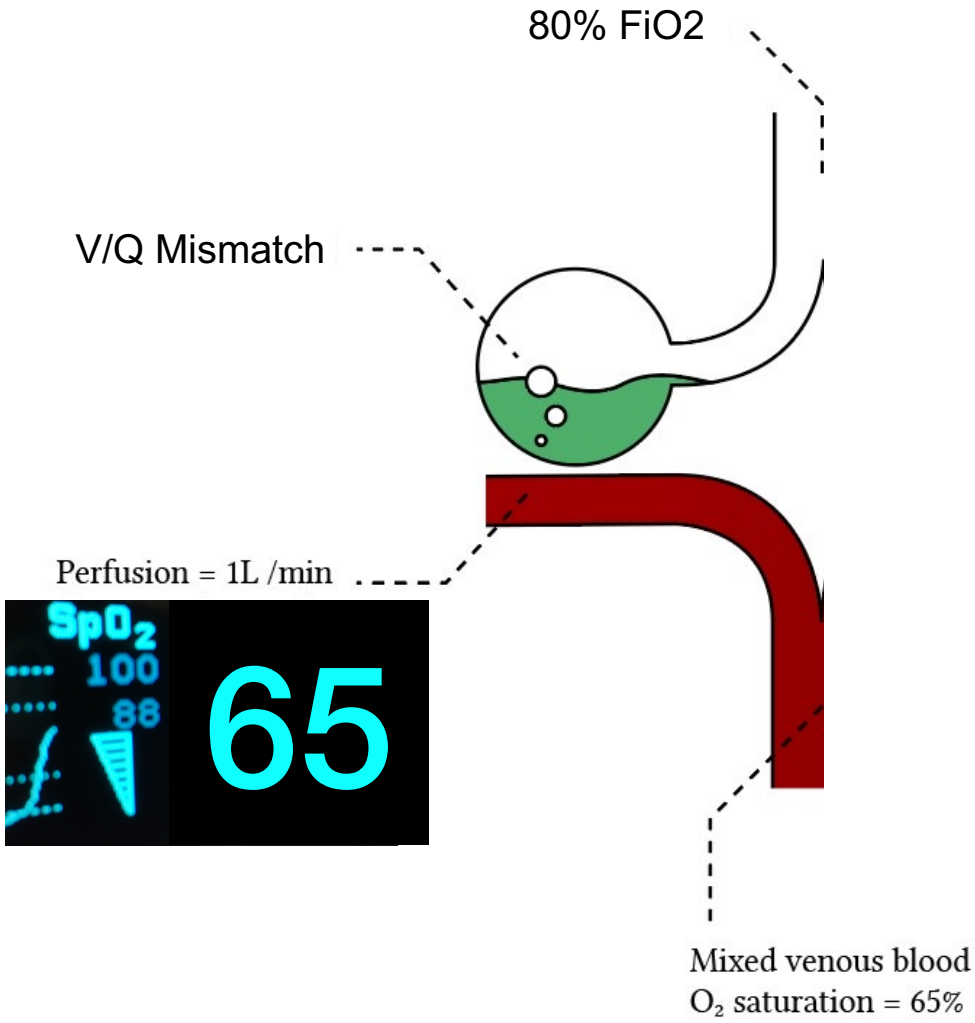
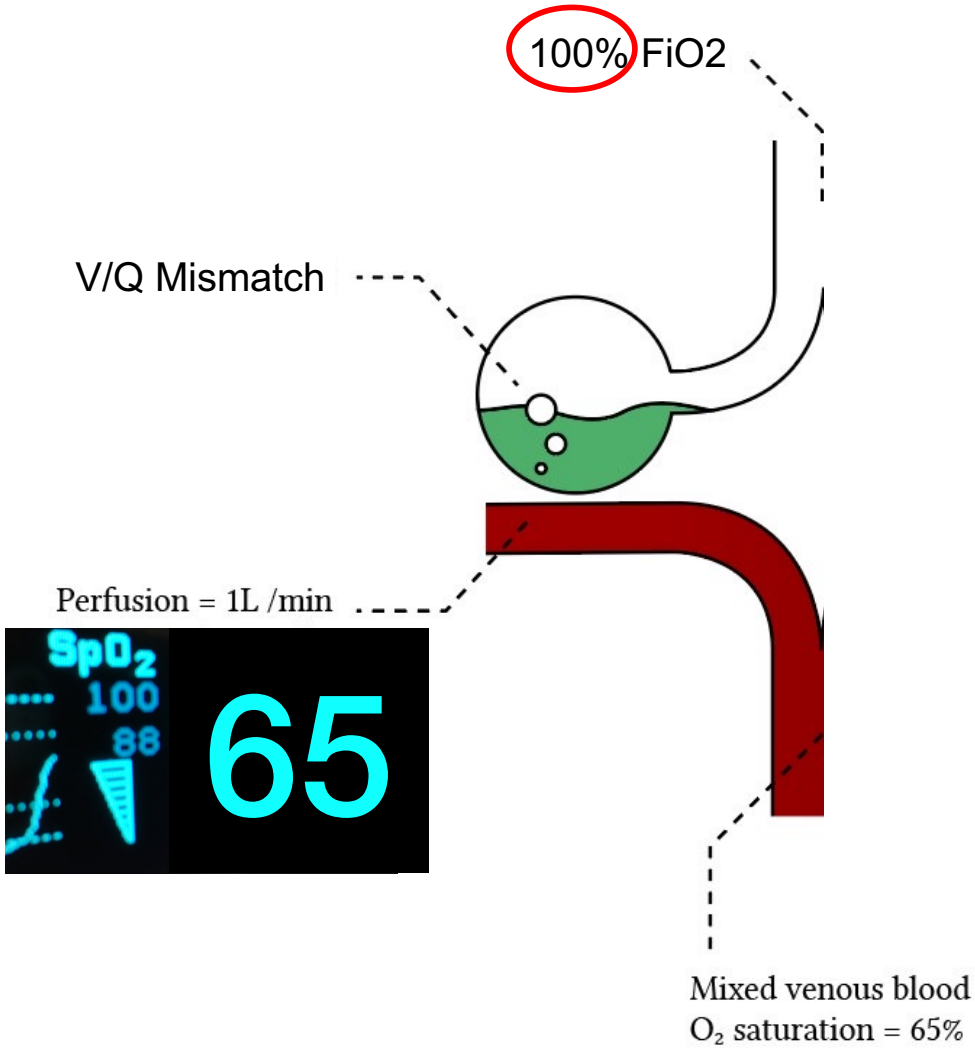
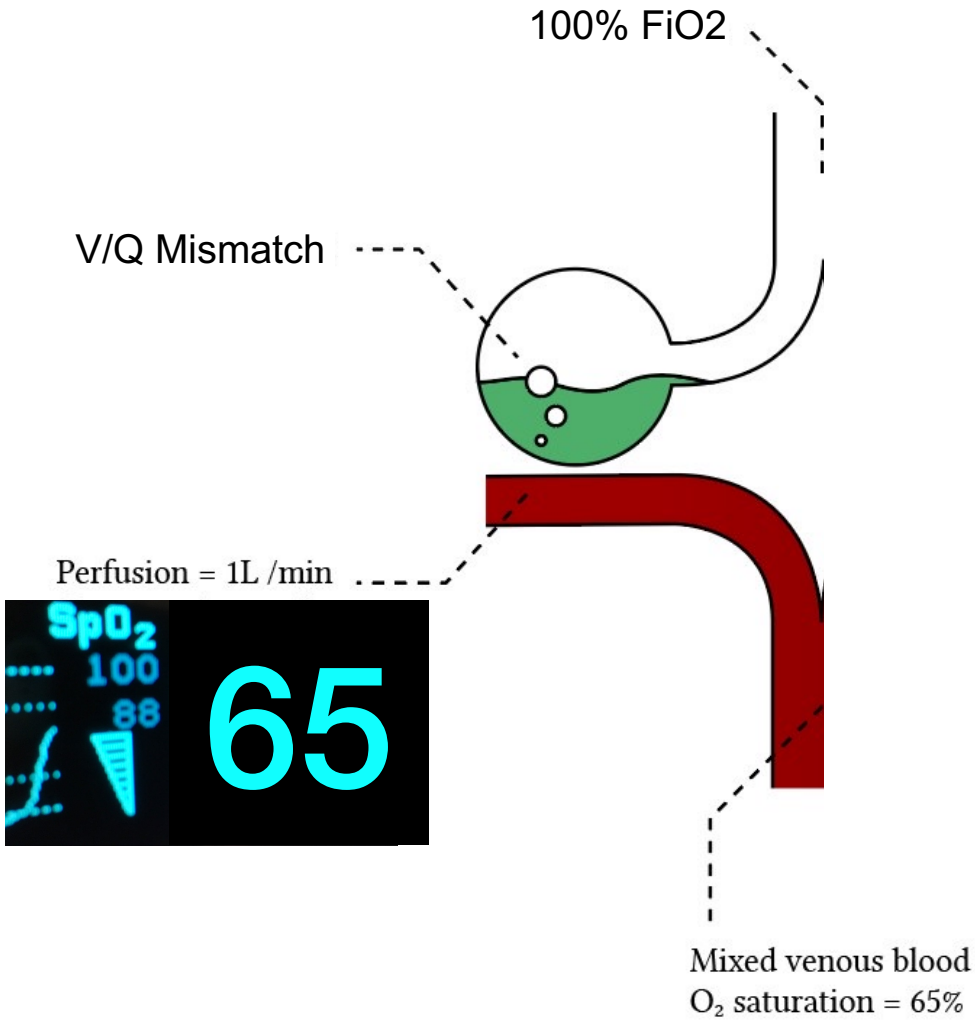




Crap in lung?

aka V/Q mismatch

Increasing FiO2 is not helpful



Crap in lung?

aka V/Q mismatch

Recruit more lung

PEEP/NIV

BVM no PEEP Valve

BVM no PEEP valve

Spontaneous breathing ~ ROOM AIR

BVM with PEEP valve

~100% FiO2 + positive pressure during expiration

BVM with PEEP valve and NP at 6-10L

+

~100% FiO2 + positive pressure during entire respiratory cycle

NIPPV

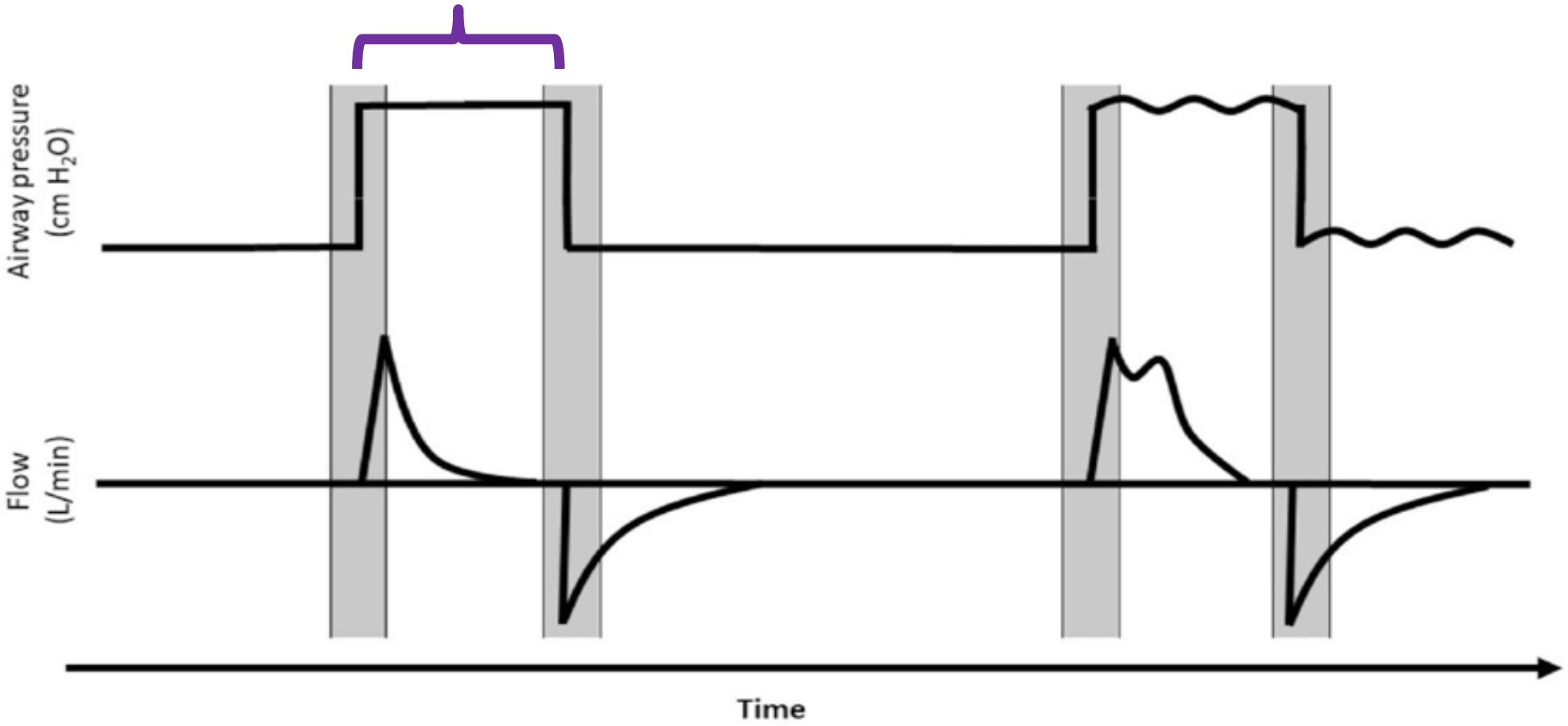
- Provides 100% FiO2
- Reduces work of breathing and increases ventilation volumes
- Splints blocked airways open and prevents alveolar collapse at end expiration.

- Makes Pneumothorax worse
- Drops BP (decr preload)
- Can cause a Pneumo (asthma/COPD)

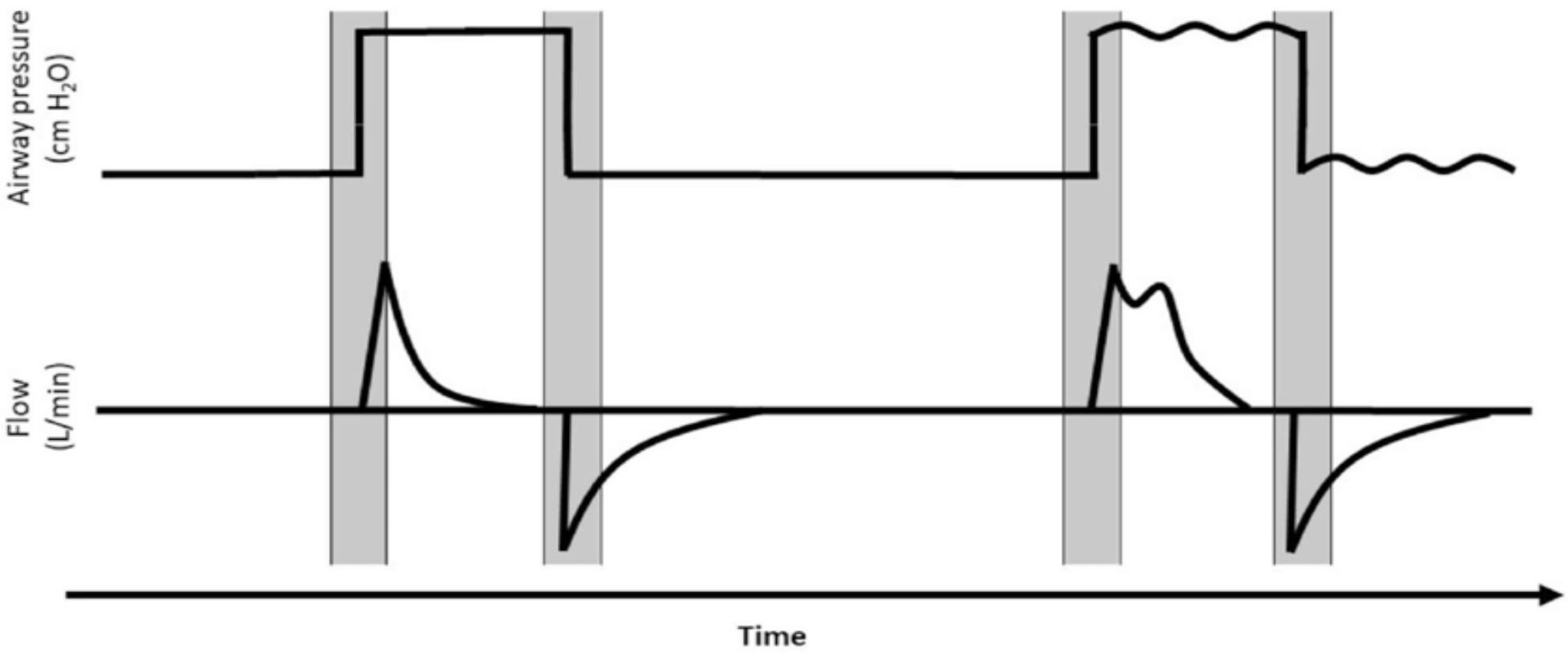

What is the
patient
telling you?

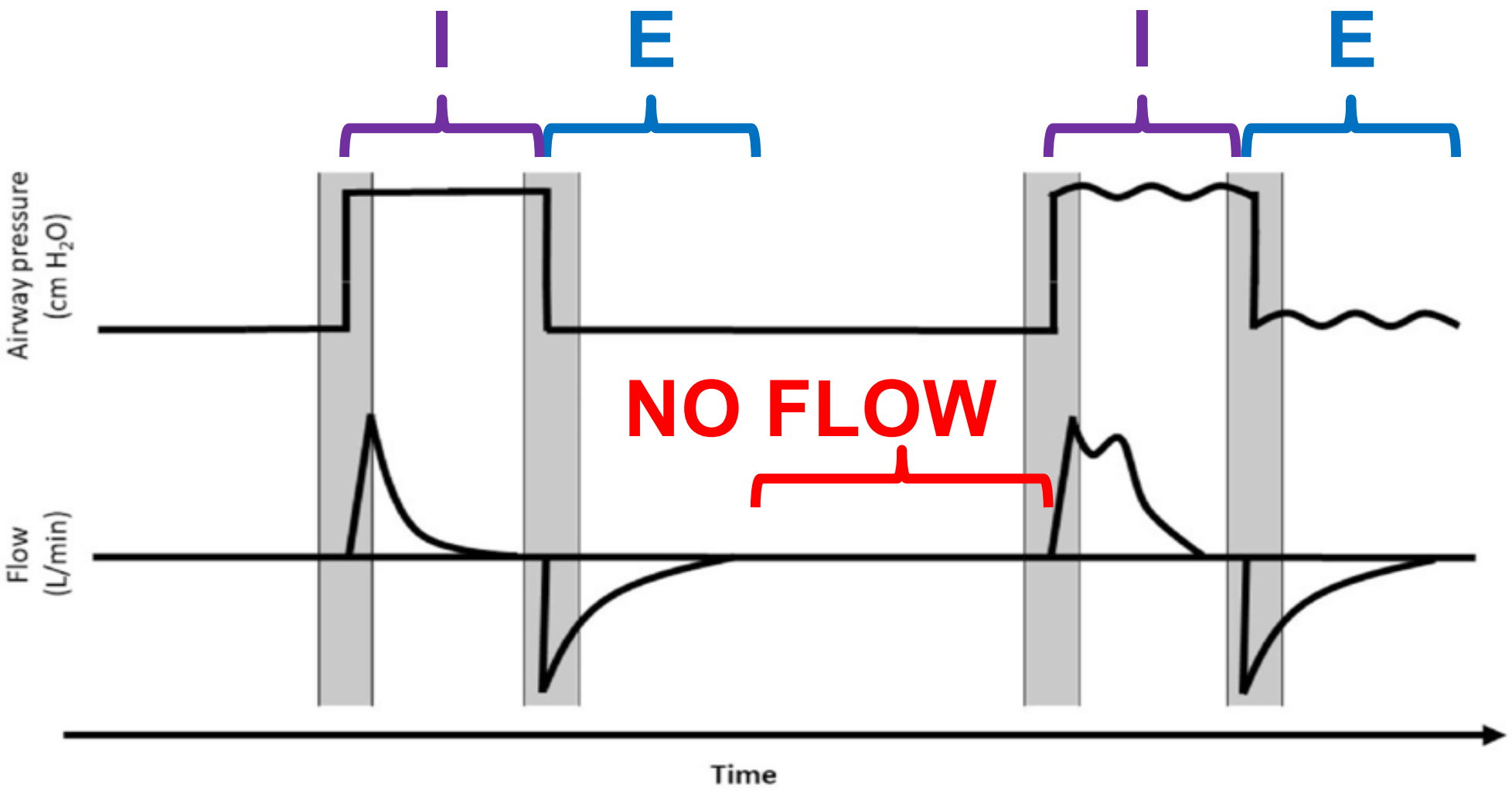

What is the patient telling you?
I'M SUFFOCATING!!!

Inhalation



Exhalation




I
E
I
E
Airway pressure
(cm H_2O)
NO FLOW
Flow
(L/min)
Time


NP under BiPAP


NP under BiPAP
The seal is fine

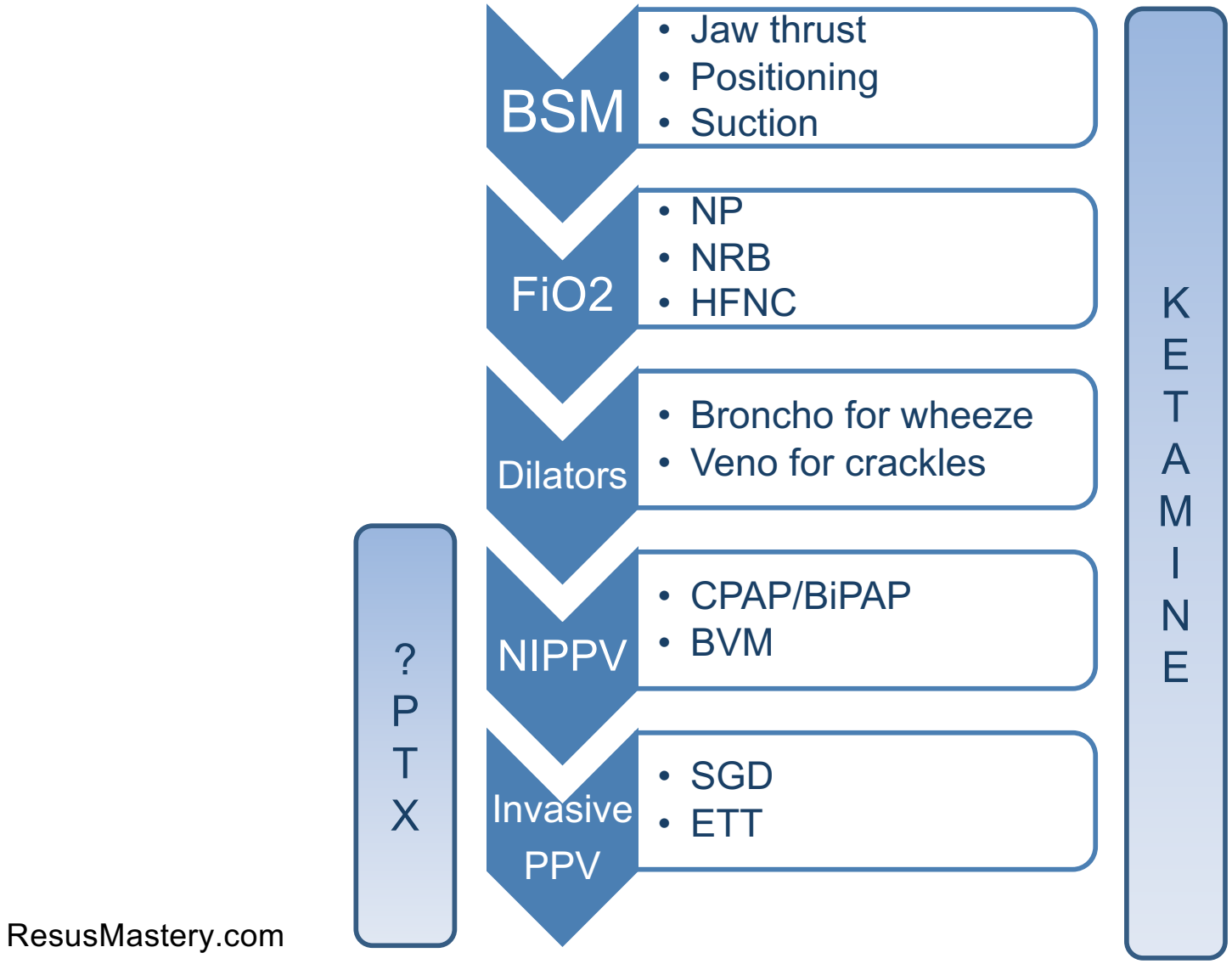
NIPPV in altered patients

+

Delayed sequence induction

+

Ketamine aliquots
20-40 mg IV
(4X IM)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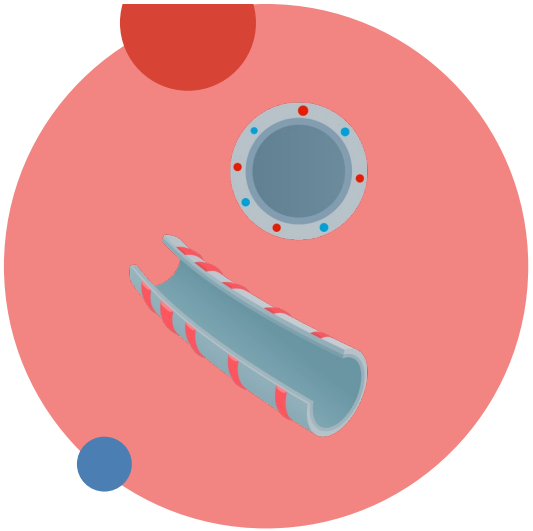

Thanks

Do you have any questions?

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