HALITUS EST VITA: BREATH IS LIFE

RESPIRATORY FAILURE AND SUPPORT DEVICES

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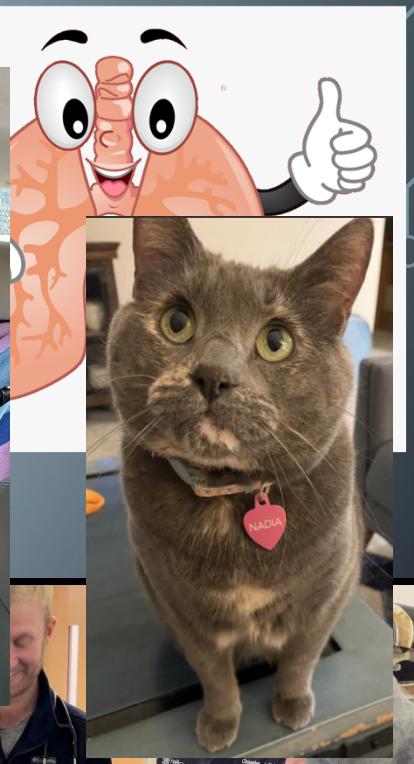
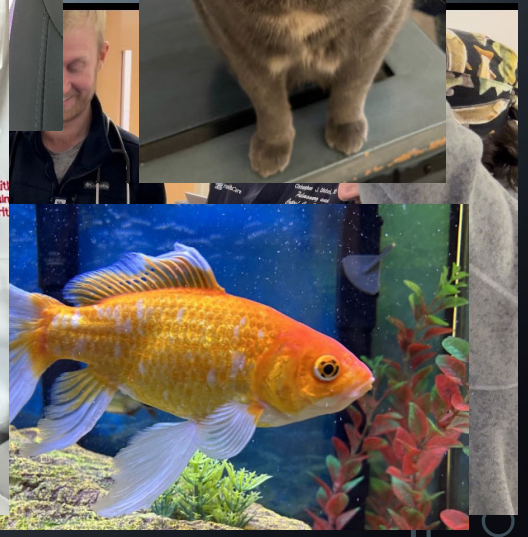
DISCLOSURES

- None

GET TO KNOW ME!





EDUCATIONAL NEED/PRACTICE GAP

- Mind the **GAP**:
  - Current practice is to defer most, if not all, knowledge and management of respiratory support devices to RTs
- **NEED** I say more?:
  - Respiratory compromise and supportive devices are commonly encountered by hospitalist providers.
  - Having basic knowledge of respiratory devices and their use, and limitations, for respiratory failure allows the provider to make fully informed decisions for the care and support of their patients.

OBJECTIVES

Upon completion of this educational activity, you should be able to:

1. Identify the flow or FiO2 limitations for the most-used oxygenation devices
2. Recognize indications and contraindications for non-invasive positive pressure ventilation
3. Explain the cardiovascular implications of positive pressure ventilation
4. Apply knowledge to real-life patient scenarios

OUTLINE

- “Passive” oxygen devices
- “Active” oxygen devices
- Tracheostomy rundown
- ★What would you do?!★

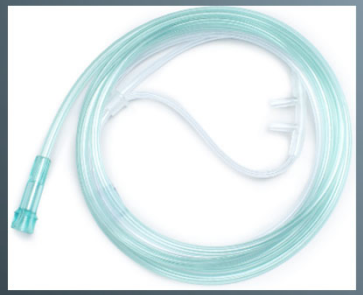
“PASSIVE” SUPPORT

1. Nasal Cannulas
2. Masks

NASAL CANNULAS

NASAL CANNULAS

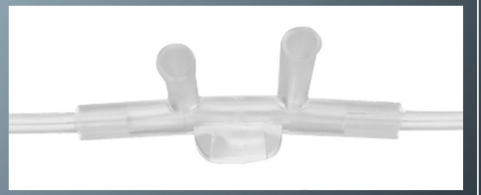
Standard Nasal Cannula



1-6L

(24-40%)

Low-resistance* Nasal Cannula

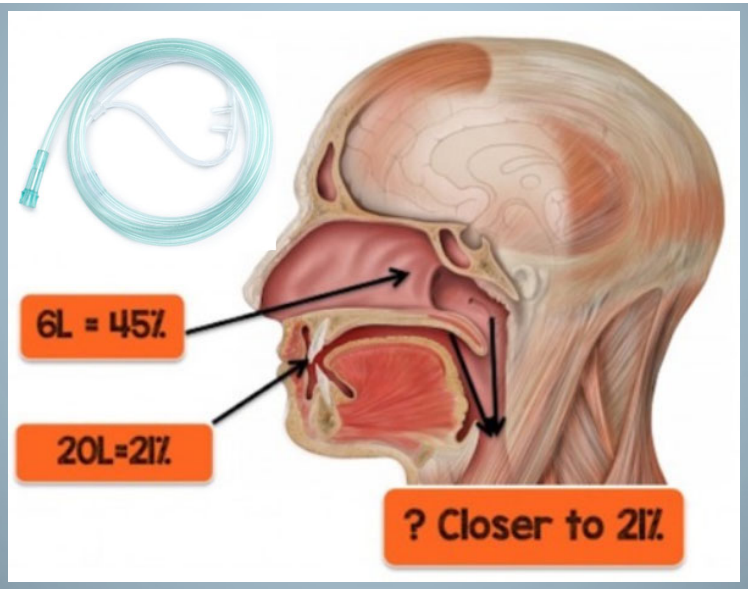


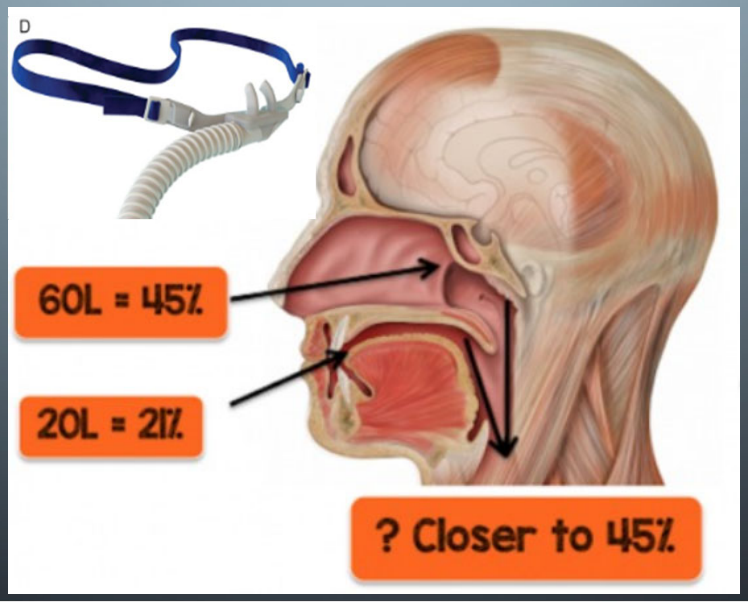
7-15L

(44-60%)

HIGH FLOW NASAL CANNULAS (HEATED & HUMIDIFIED)

- Most common brands: Airvo, Optiflow, Vapotherm
- Provide accurate oxygenation and modest ventilation
- Higher FiO2 levels achieved thanks to FLOW!


6L = 45%
20L=21%
? Closer to 21%


D
60L = 45%
20L = 21%
? Closer to 45%

H: Heated & Humidified - Provides heated and humidified gas

I: Inspiratory Demands - Can better meet elevated peak inspiratory flow demands

F: Functional Residual Capacity - Increases FRC likely via delivery of PEEP

L: Lighter - More easily tolerable than CPAP or BiPAP

O: Oxygen Dilution - Can minimize oxygen dilution by meeting flow demands

W: Washout of dead space - Provides high flow rates leading to wash out of pharyngeal dead space (CO_2 removal)

MASKS

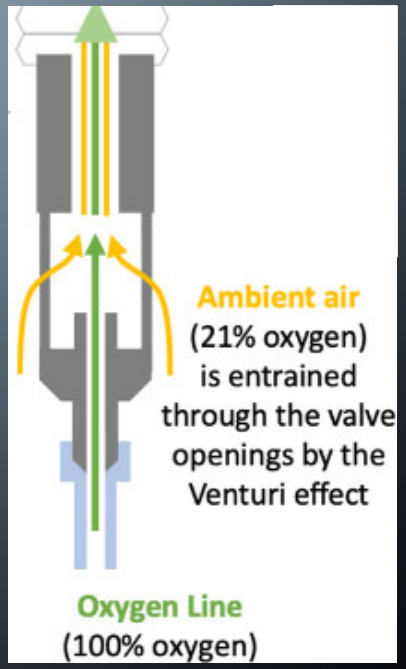
SIMPLE FACEMASK

6-10L

(35-50% O2)

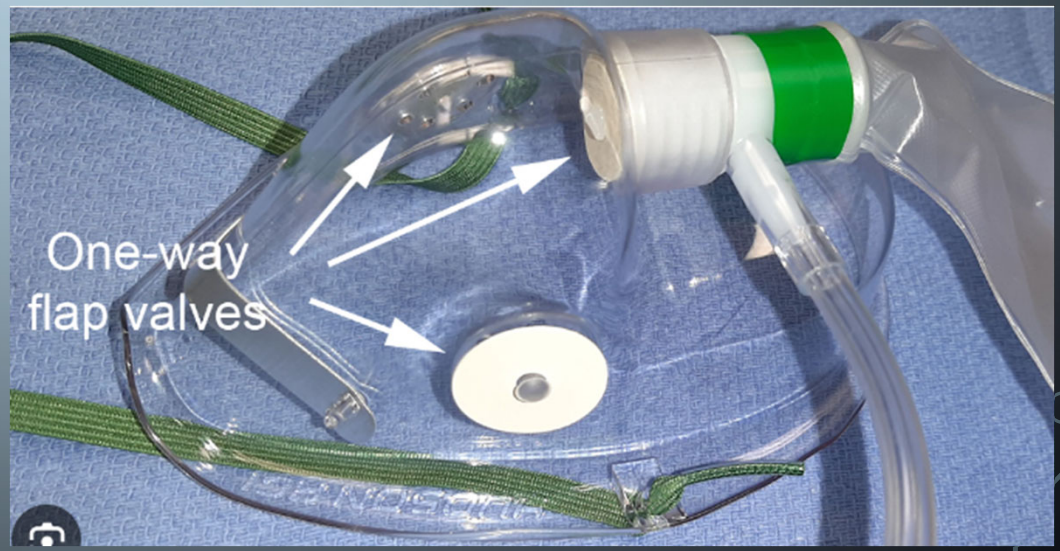
VENTURI MASKS

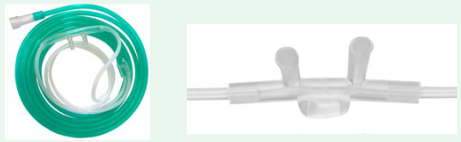
- 28-60% FIO2
- Fixed vs Adjustable mechanism
- Precise O2 titration via the Bernoulli principle (venturi effect)



NON-REBREATHER MASKS

- 10-15L
- (60-100% FiO2)
- *This is a bridge to more definitive therapy*
- *risk of suffocation if valve to reservoir bag malfunctions*



Oxygen Delivery Method	Flow/O2 ranges	Benefits	Limitations
Standard Nasal Cannula 	1-6L *(24% - 40% FiO2)*	• Comfortable	• Flow, O2 • Nasal passages must be clear • Mouth breathers
Low-resistance Nasal Cannula 	7-15L *(40 % - 60%)*	• Comfortable	• Flow, O2 • Nasal passages must be clear • Mouth breathers
(Heated) High Flow Nasal Cannula 	30-100% FiO2 30-60L	• WOB assistance • Ventilation asst. • *Small* amount of PEEP	• Bulky/less comfortable • Rhinorrhea, congestion, nose bleeds
Simple Facemask 	6-10L 35-50% FIO2	• Covers nose and mouth	• Less comfortable than NC
Venturi "Venti" Mask ***Fixed vs Adjustable***  	24-60% FiO2	• Covers nose and mouth • Can accurately titrate O2	• Heavier than simple facemask
Partial rebreather **Non-rebreather** 	60-80% FiO2 80-100% FIO2	• Covers nose and mouth • Higher FiO2 concentrations	• Mostly used as a bridge to more definitive therapy
NIMV ***BiPAP & CPAP*** 	21-100% FiO2	• Closed circuit • Provides pressure → ventilation, oxygenation, WOB	• Mental status • Secretions/aspiration/vomiting • Limited timeframe

“ACTIVE” SUPPORT

1. CPAP
2. BiPAP
3. Trilogy
4. Cuirass
5. Trachs

THE POSITIVE PRESSURE ALPHABET SOUP…

- NIMV = NIV = NIPPV = NPPV = PPV
- Bilevel = Biphasic = BiPAP = BPAP = S/T mode
- CPAP ≠ BiPAP ≠ Trilogy
- Trilogy ≠ Trelegy

PPV CONSIDERATIONS

How is PPV **helpful**?

- Recruitment
- WOB
- Ventilation/oxygenation
- Dec LV afterload

How can PPV be **harmful**?

- Inc PVR/RV afterload
- Dec RV and LV preload
- Aerophagia and aspiration risk
- Prevents enteral access

RV Preload	↓
RV afterload (PVR)	↑
LV preload	↓
LV afterload	↓

NIPPV
(BiPAP/CPAP)

Indications

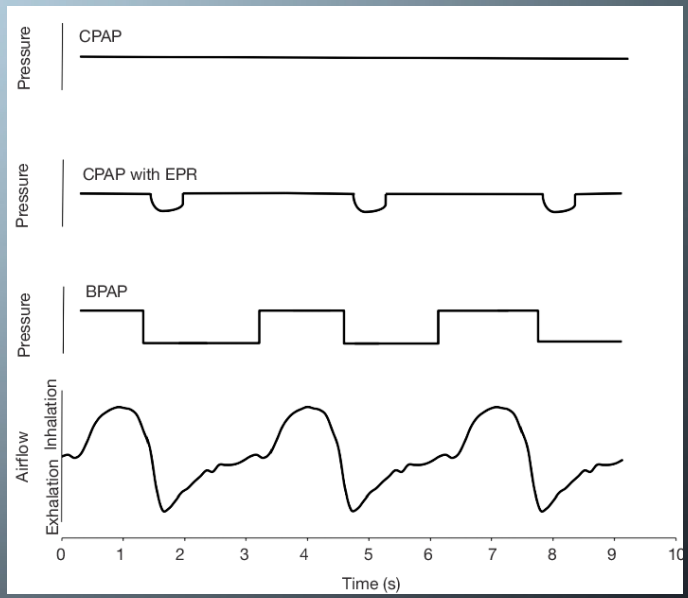
- Readily reversible pathologies
  - ***Pulmonary edema***
  - ***COPD***
- ***OSA***
- Post-op or post-extubation
- Respiratory failure in the immunocompromised
- AHRF, to delay or prevent intubation

Contraindications

- Obtundation
- Unable to protect airway
- Respiratory arrest
- Shock
- Active vomiting or copious secretions
- Facial burns/trauma
- Bowel obstruction
- PTX

CPAP VS BIPAP SETTINGS AND FUNCTIONS

	CPAP	BiPAP
Resp Rate		✓
FiO2	✓	✓
EPAP	✓	✓
IPAP		✓
Oxygenation	⇧	⇧
Ventilation		⇧
Patient's WOB		⇩



POSITIVE PRESSURE INTERFACES

Nasal Pillows

Nasal

Full Face

Hybrid

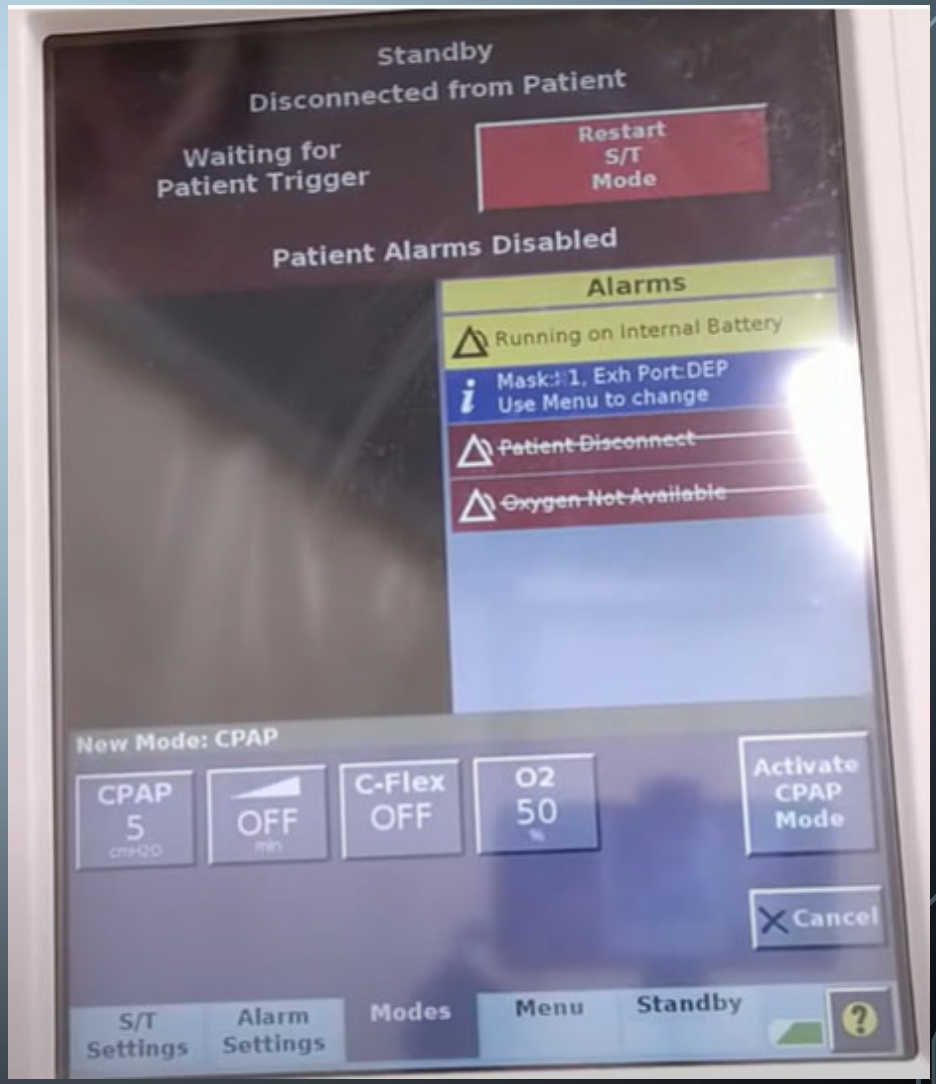
Oral

Patient dependent variables

Set variables

CPAP SETTINGS

1. Set the **pressure**
   - 5-8cm H2O is a typical starting pressure
2. Set the **FiO2**
3. Leave ramp and C-Flex OFF



BIPAP SETTINGS

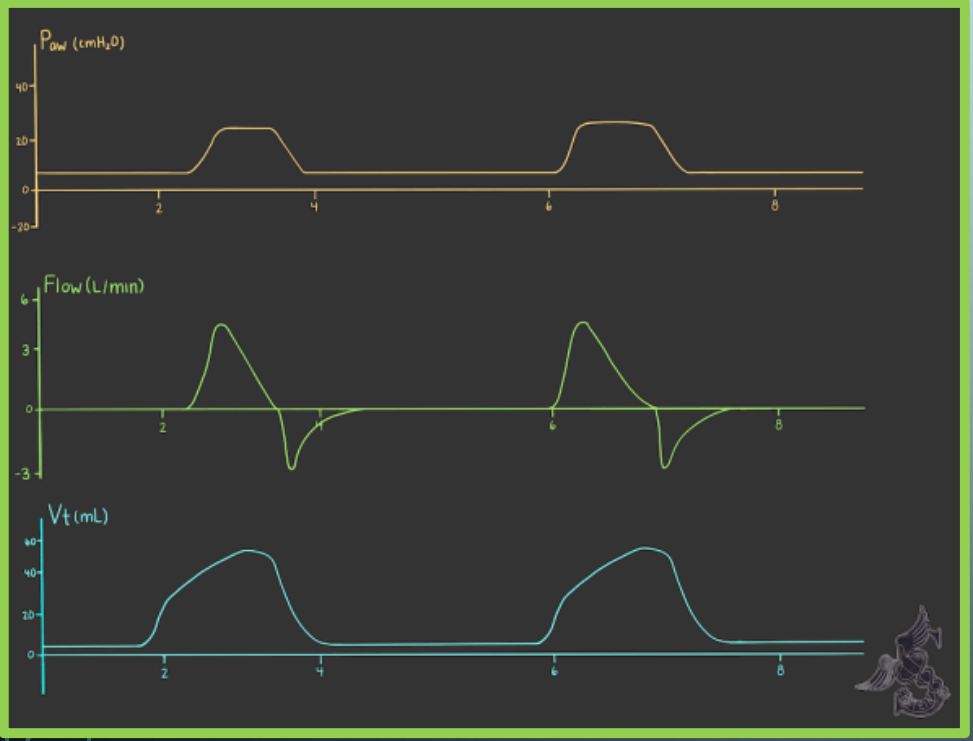
1. Select S/T as the mode (this is BiPAP)
2. Set the RR, FiO2, EPAP, and IPAP:
   - RR = 10
   - iTime = 1
   - EPAP = 5-8
   - IPAP = 10-14
3. Leave Ramp and Rise alone

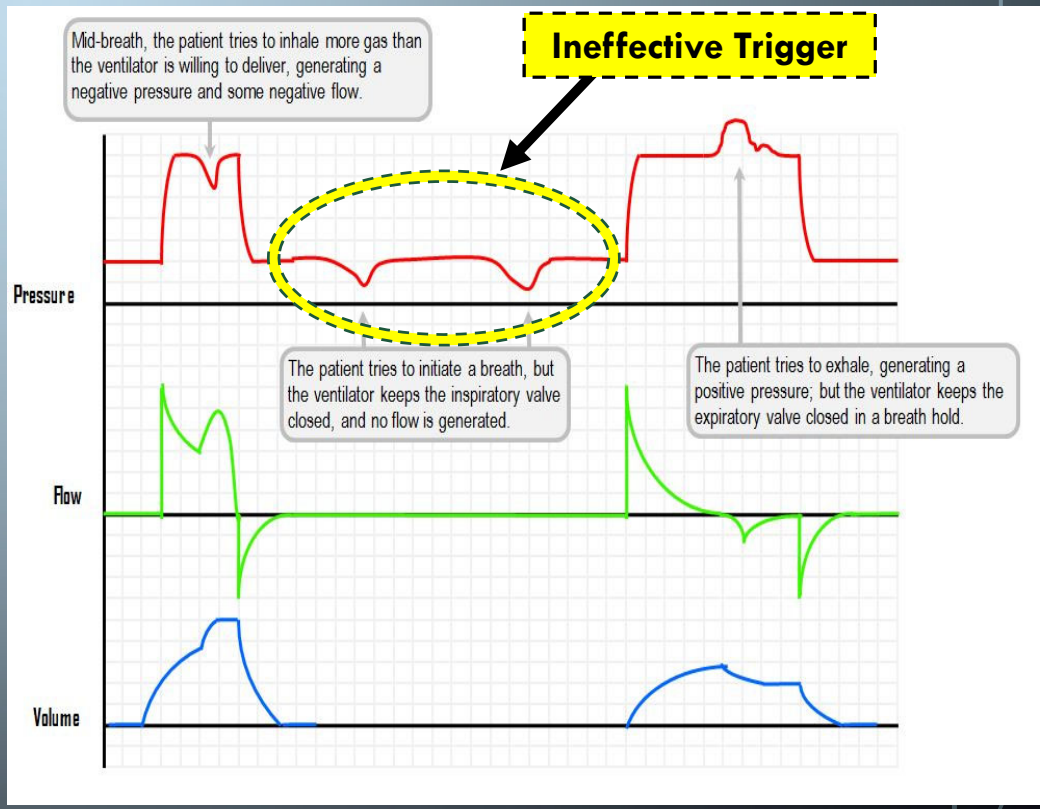
HOW DO YOU KNOW IT'S WORKING AND YOUR PATIENT IS COMFORTABLE?

- Assess the patient:
  - Ask if they feel comfortable and if the machine is giving them enough breathing support!
  - Look for signs of work of breathing
- Assess the BiPAP:
  - Minute Ventilation: normal adult minute ventilation (V_E) is 4-6 LPM
  - Tidal volumes: should ideally be <10cc/kg IBW (realistically, I shoot for <800 in an avg sized adult)
  - Synchrony:
    - Use your **eyes**: should see smooth waveforms
    - Use your **ears**!: should hear rhythmic breathing and no alarms. And no farting noises (mask leak)!

DYSSYNCHRONIES

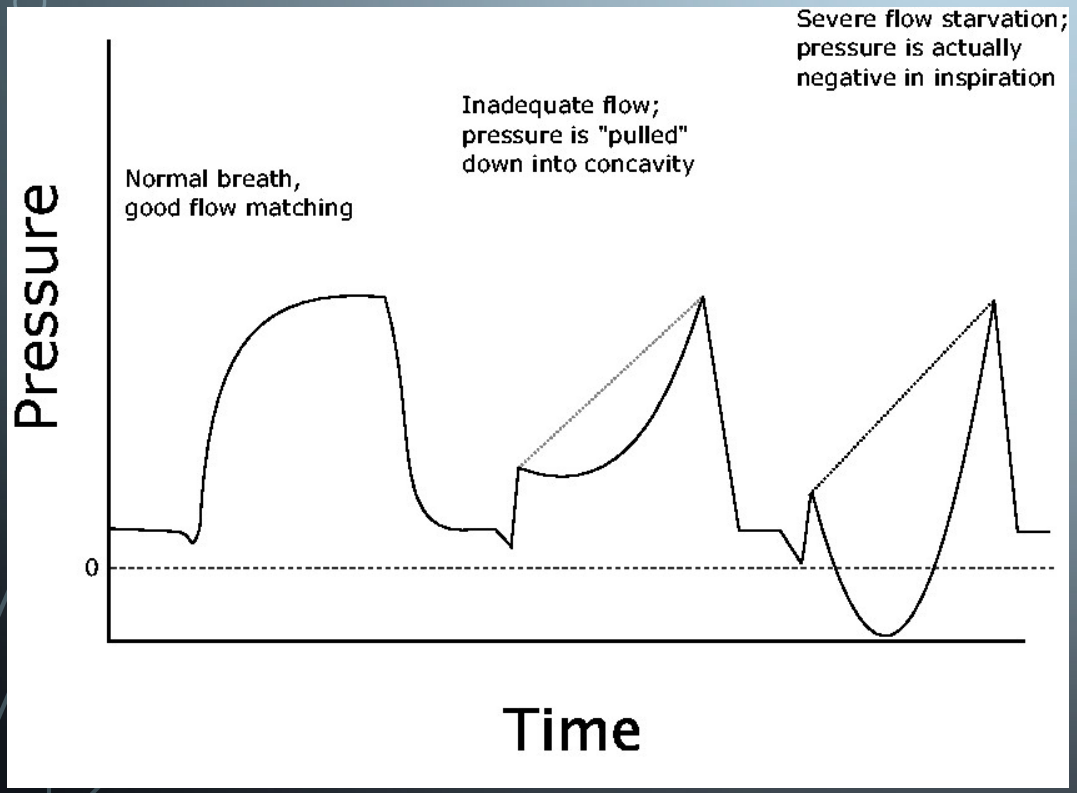
NORMAL Pressure, Flow, and Volume Waveforms



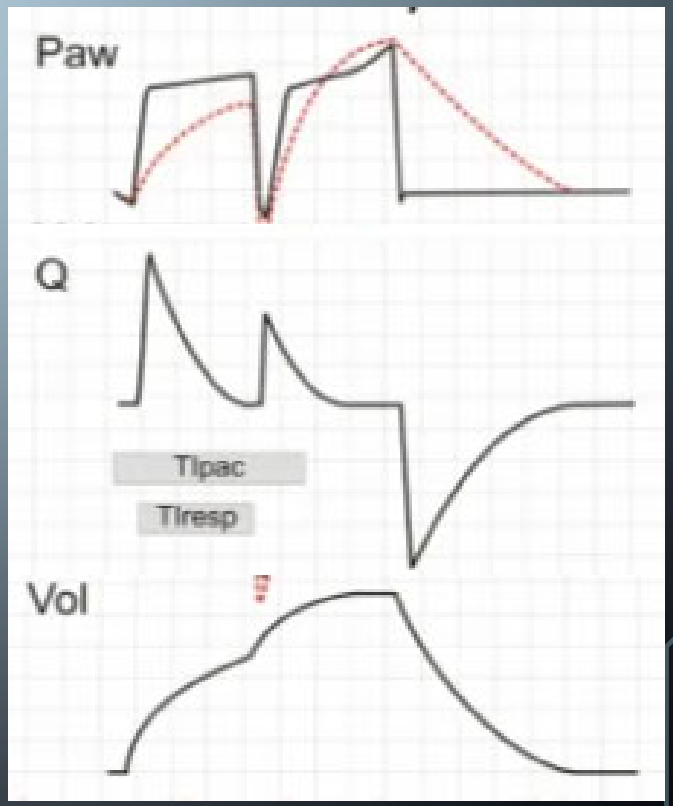


DYSSYNCHRONIES CONT.

Flow Starvation



Double Triggering/ breath stacking



TRILOGY

- A true home ventilator
- "AVAPS"
  - Average volume-assured pressure support
    - Set a target tidal volume; the machine adjusts how much pressure it gives to achieve that volume based on patient effort, lung compliance, etc.

CUIRASS VENTILATOR

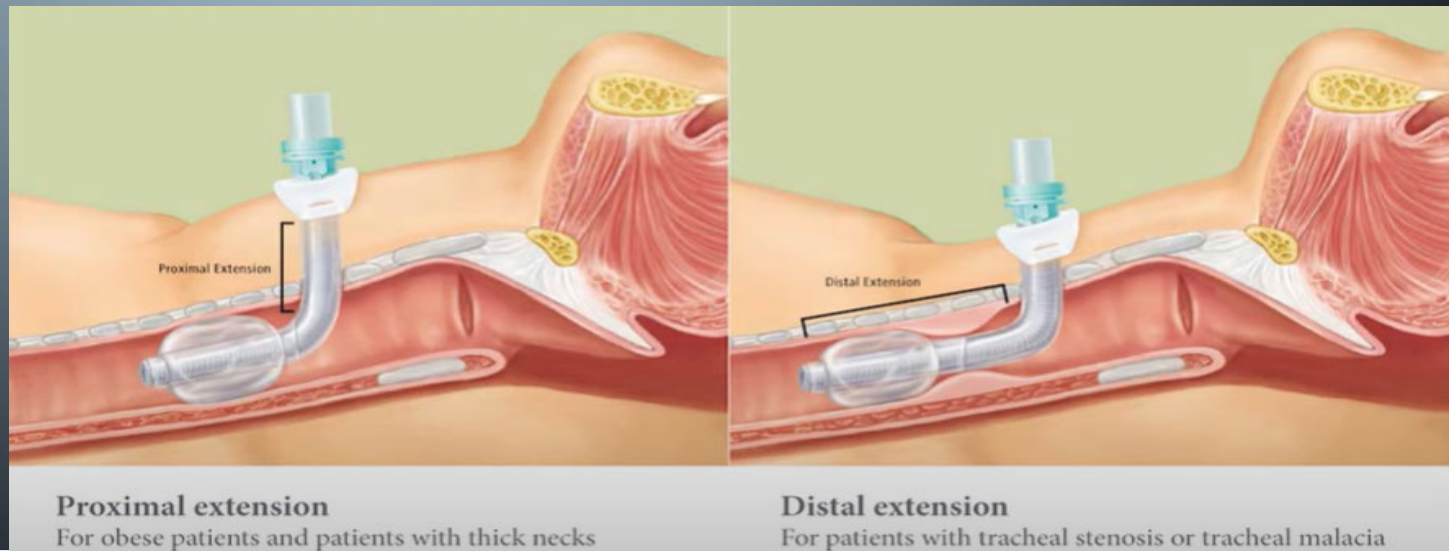
- A non-invasive, **negative** pressure “ventilator”
- Not common
- Can be used in neuromuscular weakness

TRACHEOSTOMY TUBES

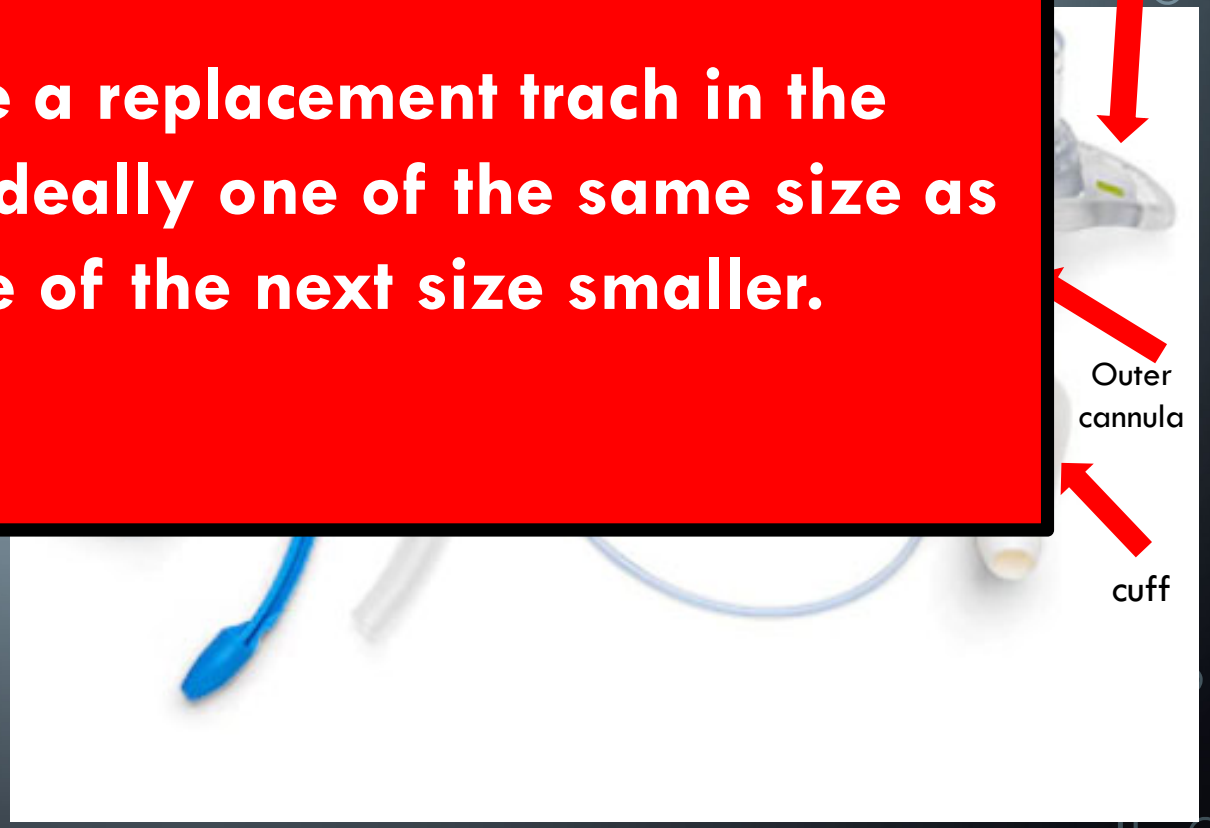
- Brands:
  - Shiley: most common
  - Bivona: "specialty"
  - Jackson: metal trachs (uncommon)

	Cuffed	Cuffless
4	4CN65H	4UN65H
5	5CN70H	5UN70H
6	6CN75H	6UN75H
7	7CN80H	7UN80H
8	8CN85H	8UN85H
9	9CN90H	9UN90H
10	10CN10H	10UN10H

- Basics:
  - Sizes: 4, 6, 8
  - Cuffed vs Cuffless
  - Shape (XLTs)



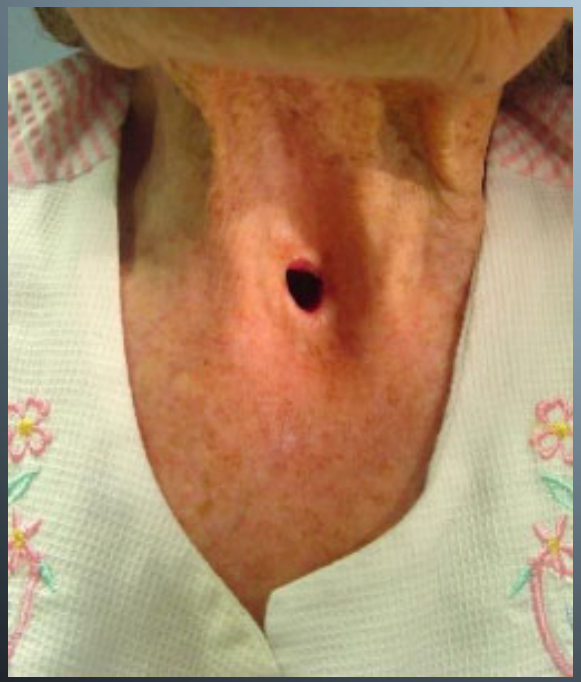
PARTS OF A TRACH



Always have a replacement trach in the patient's room, ideally one of the same size as well as one of the next size smaller.

Replacing a dislodged or malfunctioning trach

- If you see this…



Go for it!

Replacing a dislodged or malfunctioning trach

- If you see this…

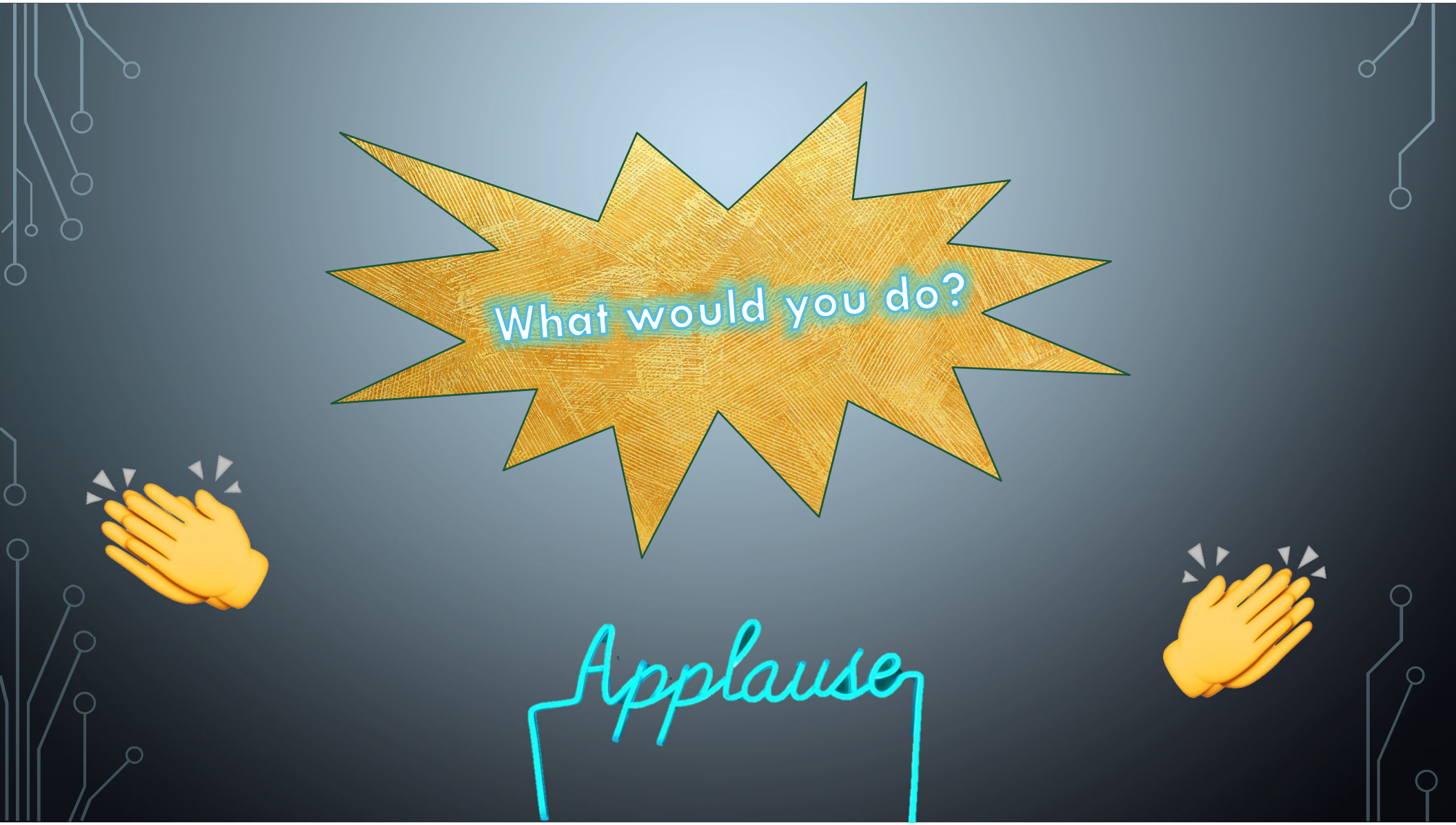
STOP!

REPLACING A DISLODGED OR MALFUNCTIONING TRACH

1. Assess A-B-C's
2. Prep new trach:
   - Test cuff (inflate under water), then fully deflate the cuff
   - Place obturator inside the outer canula
   - Lubricate the outside of outer cannula
3. Lay patient flat
4. Extend the neck
5. Using an 'arc' motion, insert new trach into stoma until faceplate sits flush with the skin. This should require basically no force!
6. Remove obturator
7. Insert inner cannula
8. Inflate the cuff
9. Secure trach with trach ties
10. Check placement:
    - Ask patient to cough, End tidal CO2 **pleth**, PA&L CXR, Bronch

Now that y’all are experts…

…let’s put you to the test!


What would you do?
Applause

MR. K

- Mr. K is a 58yo M with h/o CAD, HTN, HLD, and ESRD on MWF iHD. He is admitted from his PCP's office for hyperkalemia and HTN after missing his dialysis session yesterday. A rapid response is called for acute respiratory distress.
  - **Vitals**: BP 240/180, HR 133, RR 39, SPO2 84% on RA
  - **Exam**: acute distress, saying his chest hurts and he can't breathe. Leaned forward in bed, RR in the 30's, labored. Diffuse crackles on exam.
- The RT tells you they'll go grab a nasal cannula.

What is your reply?

FLASH PULMONARY EDEMA

- A perfect use for BiPAP!
  - Positive pressure (EPAP) clears edema from alveoli—start at at least 8cm H2O and go up as tolerated
  - IPAP supports WOB
  - Positive pressure decreased LV afterload and decreases both RV and LV preload
- Other interventions to consider: nitroglycerine (SL +/- drip), labetalol, nicardipine*; diuretics; morphine

MRS. M

- Mrs. M is a lovely 79yo woman with h/o COPD on 2L home O2 and Type 1 diabetes on insulin. She is admitted to progressive level of care for DKA and acute on chronic hypoxemia. She required up to 4L in the ED. Current labs show a pH of 7.14, CO2 of 45; Creatinine is 2.5 and serum bicarb is 8. Her anion gap is 18.
  - **Vitals**: HR 100, BP 130/70, RR 34, SpO2 98% on 4L.
  - **Exam**: AOx4. Not in distress. Tachypneic with diminished BS but no adventitious lung sounds. Tachycardic @104 but no murmurs. +skin tenting.
- The nurse asks you if you want to continue the 4L nasal canula when she gets to the floor.

What do you say?

"UNCOUPLING" OF ACID-BASE BALANCE

- Chronic retainers (ie. People with deadspace) rely on renal compensation to keep pH stable. If that compensatory mechanism is lost (ex. AKI 2/2 DKA and dehydration), their deadspace limits their ability to blow off excess CO2
- HFNC provides upper respiratory deadspace washout so is a great choice for mild-to-moderate hypercarbia. Also provides *slight* amount of PEEP.
- BiPAP wouldn't be wrong here, but the mild degree of her uncoupling and her appearing in no distress suggests that HFNC may be sufficient to help 'recouple' her acid-base status.

MS. S

- Ms. S is a 45yo F with OSA on nocturnal CPAP, COPD, HTN, and GERD. She is admitted for COPD exacerbation in the setting of rhinovirus infection. You are called to see her due to mild somnolence. She is on BiPAP 10/5, RR 10.
  - **Vitals**: BP 130/80, HR 86, RR 10, SpO2 97% on 30% FiO2
  - **Exam**: Asleep. Rouses to voice and says a few words but falls back asleep. Lungs with b/l wheezing.
- **Blood gas**: pH 7.2, CO2 68, PaO2 102
- You call RT but they say they just got to a code and it will be a while before they can get there.

What can you do?

USING/TITRATING BIPAP IN AECOPD

- The 'delta' is the difference between EPAP and IPAP. There's no mandatory delta BUT you have to look at how much your delta is getting you in terms of tidal volume and overall minute ventilation.
- In acute CO2 narcosis, you have to increase the minute ventilation!
  - Have to increase your delta→increase IPAP, decrease EPAP, or both. Changing from 10/5 to 15/10 doesn't help your ventilation at all…your delta is still only 5! Would change this person to 15/5 and reassess. I usually try to increase MV by at least 25%.
  - Increasing the RR alone is not usually the best option if they're already 'riding the rate', esp if they have a small delta (5 or less)


Thanks for playing!
Applause

YOUR TAKE-HOME POINTS!

- Oxygen delivery is flow dependent. If you want more oxygen, you have to increase the flow!
- PPV has many physiologic affects on both lungs and hemodynamics.
- PPV settings must be adjusted as the patient's condition changes. It's not set it and forget it!
- Always have a replacement trach in the patient's room, ideally one of the same size as well as one of the next size smaller.

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Halitus est vita

Breath is life!

Thank you!

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