Physical Therapy Practice and Mechanical Ventilation: It's AdVENTageous!

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OBJECTIVES

After this lecture you will be able to describe:

1. Indications for Mechanical Ventilation
2. Basic ventilator anatomy and purpose
3. Ventilator Modes, variables, and equations
4. Safe patient handling
    a. Alarms and what to expect
    b. Considerations for mobilization
5. Ventilator Liberation
6. LAB: Suctioning with Bob!

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INDICATIONS FOR MECHANICAL VENTILATION

Cannot Ventilate

Ventilation: the circulation of air

Airway protection

- Sedation
- Inflammation
- Altered mental status

Cannot Respirate

Respiration: the movement of O2 from the outside environment to the cellular level, and the diffusion of CO2 in the opposite direction

Respiratory Failure/Insufficiency

- Hypercarbic vs Hypoxic
- Vent will maintain homeostasis of CO2 and O2
- Provides pressure support in the case of fatigued muscles of ventilation

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VENTILATOR ANATOMY

- Power supply/no battery
- O2 supply and Air supply
- Inspiratory/Expiratory Tubes
- Flow Sensor
- Ventilator Home Screen
- ET tube securing device- hollister
- Connection points - ET tube and trach

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HOME SCREEN

What to observe:

- Mode
- Set rate
- RR
- FiO2
- PEEP
- Volumes
- Peak and plateau pressures

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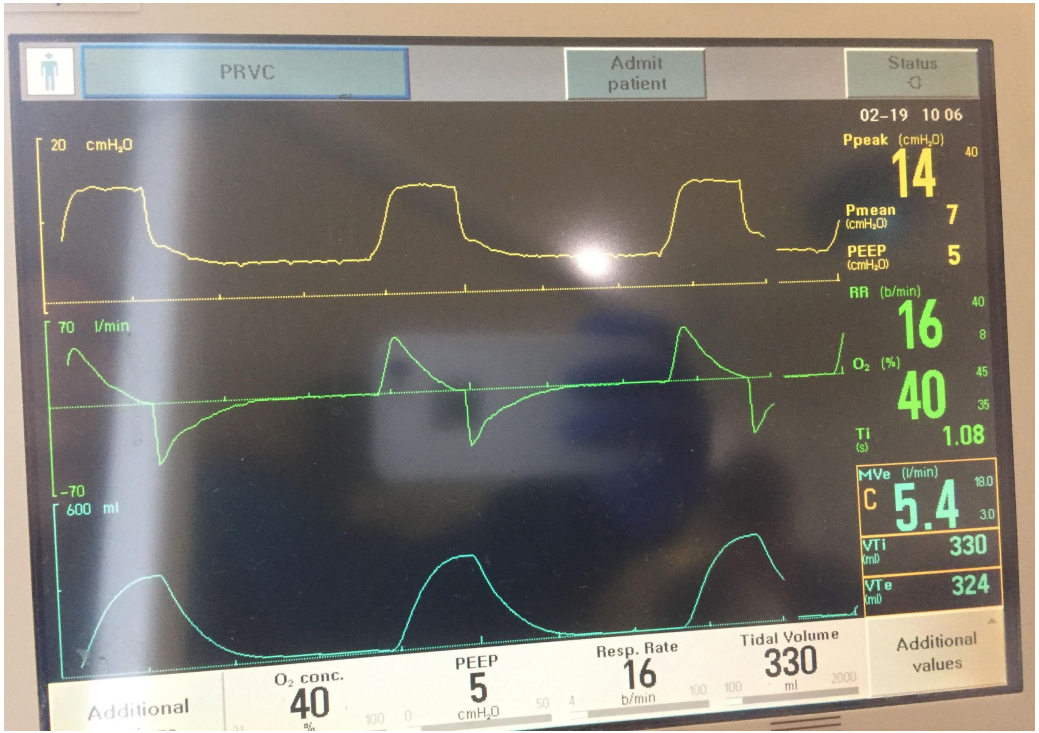

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VENTILATION VARIABLES, EQUATIONS, & MODES

Break it down ...

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VARIABLES IN DELIVERY

Volume

Closed loop system

Pressure

Needed for air circulation (tubing resistance)

Alveolar recruitment

PEEP - positive end expiratory pressure

Rate

Number of breaths per minute

Directly affects minute volume

Flow (speed of volume delivery) in L/min

- No flow adjustment on G5
- Adjust by altering I: E ratio (faster I time = more flow)

Oxygen concentration

- FiO2: Fraction of Inspired Oxygen
- Reported in percentage (room air 21%)
- Supplemental O2 is always delivered at 100% FiO2
- Diluted by atmospheric air unless closed loop system

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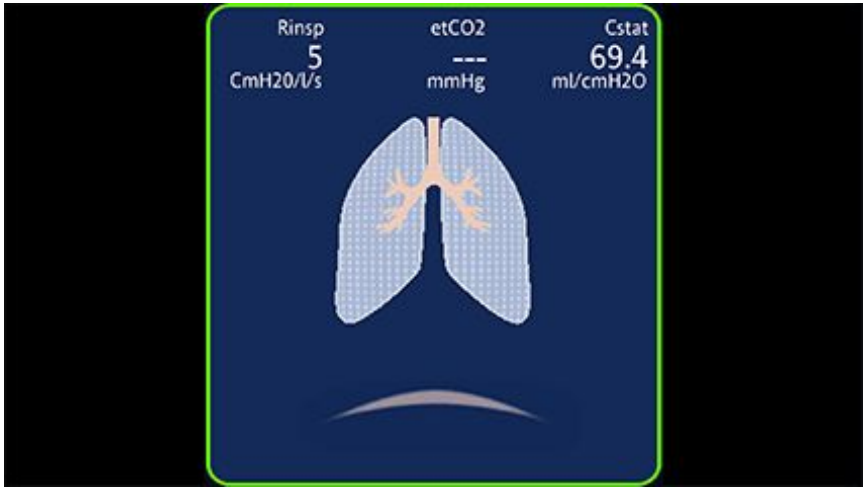
EQUATIONS

Ideal Gas Law PV = nRT

- nRT are all constants (amount of gas in moles, ideal gas constant, and temperature)
- Pressure and Volume are variables that are inversely proportional

Compliance = $\frac{\text{change in volume}}{\text{change in pressure}}$



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VENTILATION CONTROL

VS.

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Modes of Mechanical Ventilation

- **Adaptive Pressure Ventilation/Continuous Mandatory Ventilation (APV/CMV or PRVC)**
- **Pressure Control (PC or P-CMV)**
- **CPAP/Spontaneous**

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Adaptive Pressure Ventilation/Continuous Mandatory Ventilation (APVcmv, PRVC)

- **Targeted Volume** is the set parameter
- Set a minimum respiratory rate
- Pressure is calculated by vent, which is driven by compliance
- Set alarms will alert provider if compliance is changing

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Pressure Control (PC or P-CMV)

- **Pressure** is the set parameter
- If compliance is low, get lower volumes
- If compliance is high get higher volumes
- Volume is calculated by vent, which is also driven by compliance
- Set alarms will alert provider if compliance is changing (volumes drop)

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CPAP/Spontaneous

- **PEEP and Pressure Support** are set parameters
  - PEEP - pressure still left in lung at end of exhale- keeps alveoli open/recruited (5-20)
  - Pressure support - pressure that only occurs on inhalation
  - Patient drives RR and TV

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SAFE PATIENT HANDLING

- Alarms and other unnerving sounds
- What to consider when mobilizing a ventilated patient

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ALARMS AND WHAT THEY MEAN

Peak Pressure

Plateau Pressure

Oxygenation

Volume/Rate

Other Unnerving Sounds

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Peak and Plateau Pressures

Peak Pressure

- The highest level of pressure applied to the lungs during inhalation
- Increases with any airway resistance
- Peak pressures are considered elevated if difference in peak to plateau is > 5 mmHg
- Reasons for elevated peak pressures: (Think blocked airway)
    - Coughing
    - Bronchospasm
    - Secretions
    - Mucous Plug
    - ET tube occluded

Plateau Pressure

- Pressure due to lung compliance once air is in lungs and no longer moving (holding their breath after inhalation)
- Reasons for Elevated Plateau pressures: (Think decreased lung compliance)
    - Pneumothorax
    - Pulm edema
    - ARDS
    - PNA
- You likely will NOT see an alarm for this - monitored by MD and RT

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Oxygenation

- Monitor SpO2

- Consider
  - FiO2
  - Pre-hyperoxygenation
  - Cues for breath control

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Tidal Volume and Respiratory Rate

- **Respiratory Rate**
  - Increased RR - stimulation vs work of breathing
  - Apnea ventilation - is patient on spont/CPAP mode?
  - Good or bad time to work with this patient?
- **Tidal Volume/Minute Ventilation**
  - Reasons for *High* alarms
    - Is patient taking larger breaths?
    - Is patient breathing faster?
    - Breath stacking
  - Reasons for *Low* alarms
    - Vent dyssynchrony
    - Small breaths immediately after a large breath
  - Watch for trends, not fleeting alarms

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Other Unnerving Alarms and Sounds

1. Loss of PEEP - Usually due to the flow sensor being disconnected or gunked up *
2. Check Flow Sensor - sensor likely has patient secretions on it *
3. Disconnection Patient Side - coughing vs actual disconnection - check tubing (occurs when vent isn't able to sense a breath) *
4. Cuff Leak *
5. Silence (Apnea alarm) - this is set for 20 sec or longer and then will convert back to PC mode with RR, FiO2, and PEEP same as initial settings *

* NOT AN EMERGENCY, talk to your RT

* MAY BECOME AN EMERGENCY, you will hear the air flow if tubing is disconnected

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CONSIDERATIONS FOR MOBILIZATION

- **Initiating Session**
  - Communication
  - Initial MV settings
  - Trends
- **RASS**
  - Coordination with RN
- **Equipment/Set up**
- **O2 Requirements**
  - Coordination with RT
  - Can we assist if pt desaturates?
- **Airway Clearance**
  - Cough
  - Suctioning
- **Ambulation**

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ARE YOU GOING TO WALK THEM ON THE VENTILATOR?!

- **Great photo op, but…**
  - Coordination, time, equipment, multiple people to assist

- 1.7 % of sessions – Patients ambulate 10 ft or more (1.4% ambulate 100 ft or more)

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VENTILATOR LIBERATION

MICU – Mechanical Ventilation Liberation Protocol

Key	
	RT: Respiratory Therapy = Yellow
	RN: Registered Nurse = Green
	MD: Medical Doctor = Blue
	★Data Collection Point

Owner: MICU QI
Revised: 2017.09.26

START: For ALL intubated patients. Reassess every 12 hours thereafter (minimally once a shift).

Assess for SBT readiness — RT | RN

- ❑ HD Stable? (MAP > 55,minimal vasopressors).
- ❑ Intact Airway Reflexes?
- ❑ FiO2 ≤ 50%, peep ≤ 8?
- ❑ Sat ≥ 88%?

Not Ready → **If NO to any SBT readiness question, STOP!**

Ready ↓

Assess Mental Status and Sedation ★ — RN

Ensure sedation vacation is occurring.

- ❑ Is the RASS -2 or higher?
- ❑ No Propofol? No Continuous benzo drips?
- ❑ Ideally, no continuous analgesic or precedex drips. However, special cases are allowed.

↓

★ DOCUMENTATION Location:

- ICU Flowsheet> ICU Vitals> Sedation> RASS.
- ICU flowsheet> ICU Vitals> Sedation> SAT safety screen and SAT (PASS/FAIL) and reason why.
- Continuous drip information can be found on the MAR.

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RT

Initiate SBT for up to two hours maximum ★

Ensure the following parameters are met. If YES, proceed.

If NO, return to Step to assess for SBT readiness.

SBT:

- ❑ RSBI < 105, Pressure Support 5-8, PEEP 5-8 for <120 minutes.
- ❑ Hemodynamics remain stable.

★ DOCUMENTATION Location:

- SBT is documented in two places, the "RT Vent" flowsheet *and* summarized in the "Shift Note."

MD RT RN

Successful SBT? ★

Defined as Pulmonary Fellow/Attending agrees with extubation readiness. RT communicates plan to RN.

★ DOCUMENTATION Location:

- This is documented in both "RT Vent" flowsheet, specifically under the category "Standard Vent Weaning" *and* in the "Shift Note."

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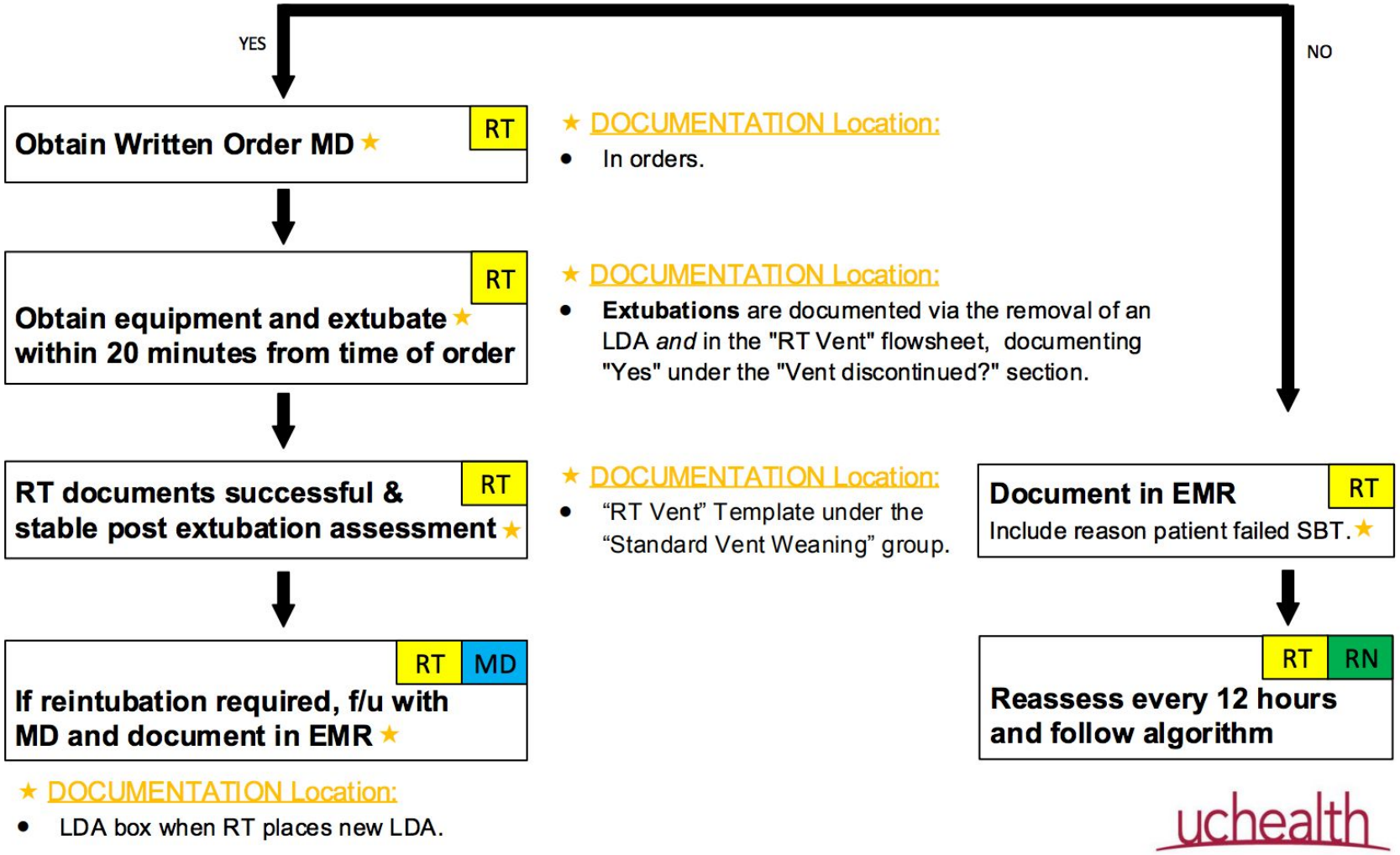
YES
NO
Obtain Written Order MD ★
RT
★ DOCUMENTATION Location:
• In orders.
Obtain equipment and extubate ★ within 20 minutes from time of order
RT
★ DOCUMENTATION Location:
• Extubations are documented via the removal of an LDA and in the "RT Vent" flowsheet, documenting "Yes" under the "Vent discontinued?" section.
RT documents successful & stable post extubation assessment ★
RT
★ DOCUMENTATION Location:
• "RT Vent" Template under the "Standard Vent Weaning" group.
Document in EMR
RT
Include reason patient failed SBT. ★
If reintubation required, f/u with MD and document in EMR ★
RT
MD
Reassess every 12 hours and follow algorithm
RT
RN
★ DOCUMENTATION Location:
• LDA box when RT places new LDA.
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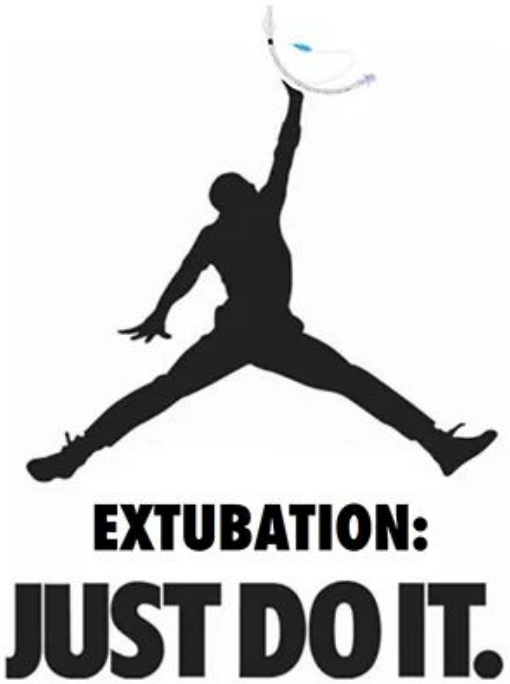
CONSIDERATIONS FOR MOBILIZING AFTER EXTUBATION

- **No definite rule, but consider:**
  1. The initial indication for mechanical ventilation
  2. WOB and O2 requirement after extubation
- **Positioning**
  1. Secretion clearance/aspiration risk?
  2. Do they ventilate better sitting up?



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SUCTIONING LAB - What about Bob?!?

*Please consider your hospital or institution's policies and procedures with regards to suctioning.

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When Does Your Patient Need Suctioning?

Examination

- **Inspection.** Look for signs of increased work of breathing (because of resistance to airflow) such as increased RR, intercostal retractions, and increased use of accessory muscles to breathe.

- **Palpation.** Tactile fremitus is increased over areas of consolidation indicating retained secretions or mucus plugging of a bronchus

- **Auscultation.** Adventitious breath sounds are a hallmark of retained secretions. A shallow- to medium-sized breath may not produce adventitious breath sounds, so ask the patient to breathe deeply. Retained secretions often cause crackles &/or wheezes.

*Slides on suctioning by Dan Malone, PT, PHD, CCS - DPTR 7212 Acute Care Elective

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Consider other options before suctioning

- **Consider assisted cough techniques prior to suctioning**
    1. Position upright: increases expiratory flows
    2. Chest bracing (i.e.: heart pillow)
    3. “Quad cough”: abdominal thrust (often used in SCI)
- **Consider airway clearance:** chest PT (percussion/ vibration/ postural drainage) &/or other “alternative” airway clearance techniques
    1. Huff cough; Active cycle of breathing
    2. Vest therapy; PEP therapy; Acapella/Flutter
- **Talk with respiratory therapy regarding:**
    1. Humidification of oxygen therapy
    2. Bronchodilator therapy

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Don’t Forget to Monitor Your Patient

Vital sign responses:

- **Oxygen saturation**
    1. SpO2 may drop but should recover with hyperoxia
    2. Don’t forget – you’re not simply suctioning out the secretions, but inspired air too!
- **Heart rate & Blood pressure**
    1. Vasovagal responses: bradycardia/hypotension
    2. Noxious stimulus: tachycardia/ HTN
- **Respiratory rate and breathing pattern**
    1. How did the work of breathing change?
- **Breath sounds**
    1. Do the BS change after secretion removal?

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Documentation

- VS responses during suctioning
- Character of secretions removed including
  - Amount
  - Color
  - Consistency

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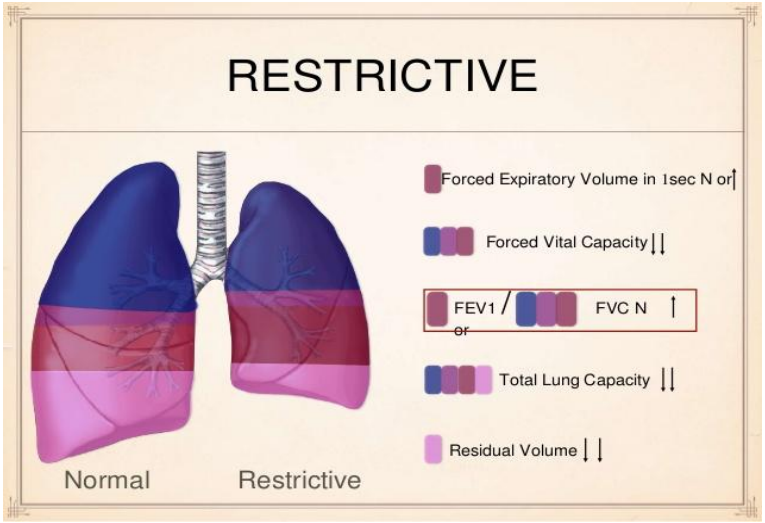
APPENDIX

RESTRICTIVE LUNG DISEASE - ARDS

Acute Respiratory Distress Syndrome

- **Inflammatory and diffuse, occurs after any type of infection**
- ***Decreased* compliance and increased plateau pressures**

- **Lung Protective Strategy**
  - **Low Tidal Volumes improve survival. High TVs causes rapid opening/closing which lead to more inflammation and mortality**
  - **High PEEP to stent open as many alveoli and maintain recruitment**
  - **Vent settings Example: APV/CMV, RR 12, TV 500, FiO2 50%, PEEP 10**



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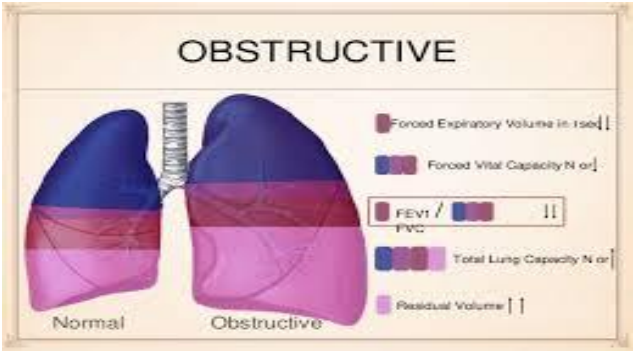
OBSTRUCTIVE LUNG DISEASE - COPD



Chronic Obstructive Pulmonary Disease

- ***Increased*** **compliance**
- **Patient has difficulty with expiration**
  - **Needs longer expiration phase on ventilator**
  - **Tendency is for elevated CO2**
    - **Would an increased RR help?**
      - **Not for patients with COPD as they need for more time to get air out**
  - **Solution- change inspiratory flow rate (typically 60L/min) to get air in quickly (inc IFR to 80-100L/min) therefore pt has more time to get air out**
    - **This is controlled by the RT**
    - **Look at flow loops- need to return to 0 before next breath otherwise pt is breath stacking**

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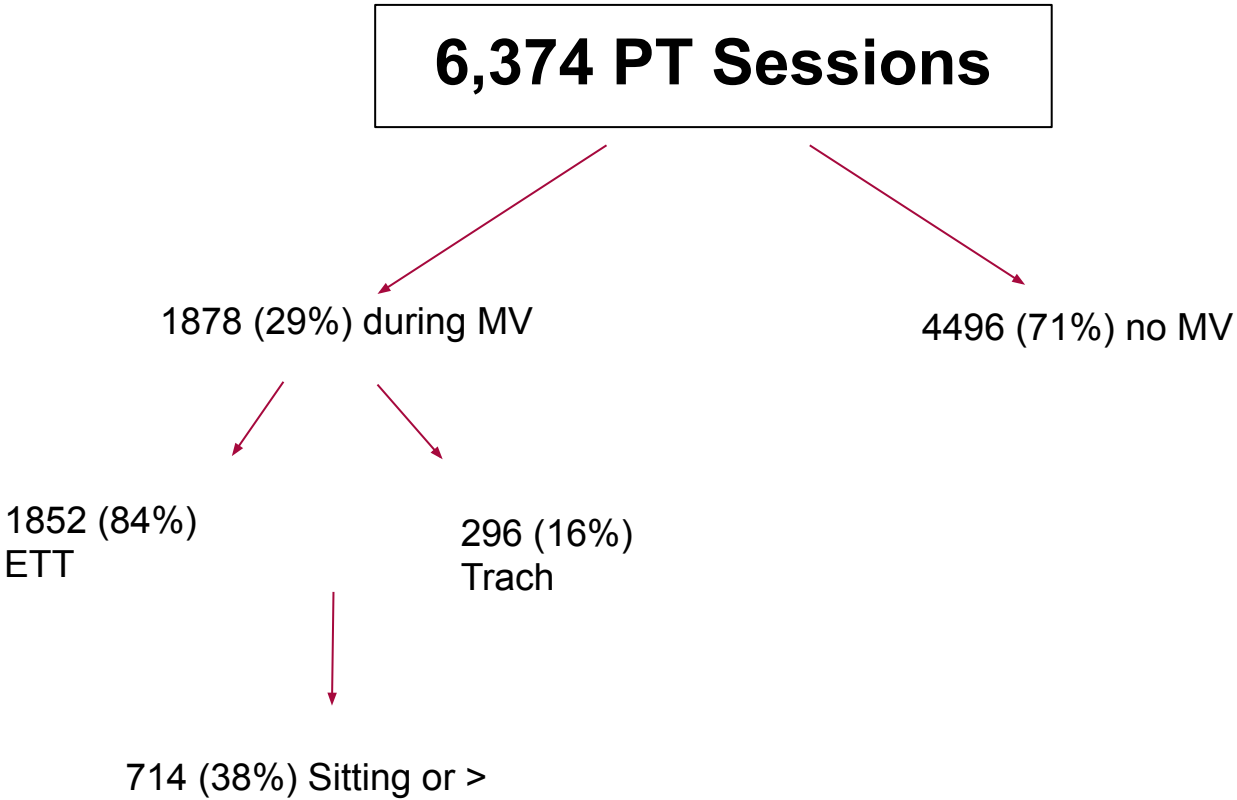
WHEN MOBILIZING A VENTILATED PATIENT...



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