AAPA 2024 Adult Hospital Medicine Bootcamp

CriticalCare-Aoke: Procedural Hits to Sing-a-Line To Respiratory Section

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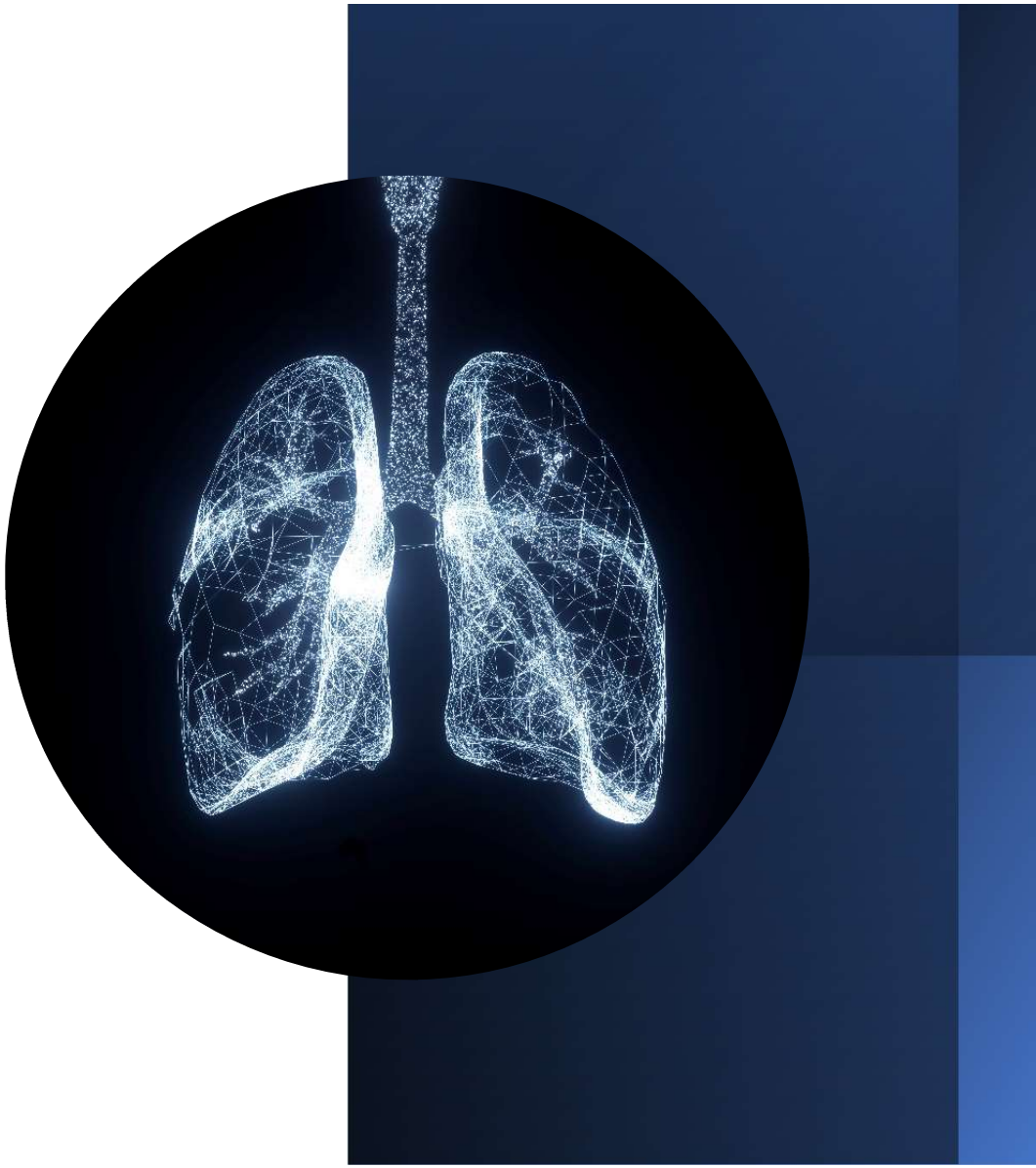
Disclosures

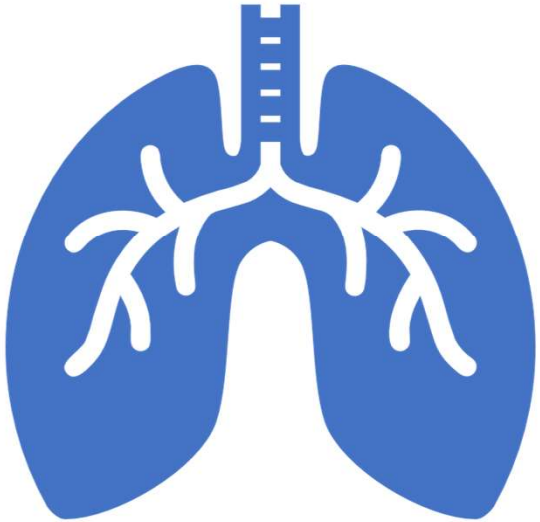
None.



Objectives

Understand and choose the appropriate intervention for respiratory failure

Review basics of mechanical ventilator management



- Oxygen Delivery Devices
- Minute Ventilation (VE) = Tidal Volume (Vt) x Respiratory Rate
- Normal VE = 5-8 L/M
- Normal Respiratory Rate = 12-20
- Normal Tidal Volume = 5 ml/Kg IBW

James Thompson
Age 72
MRN 361-440-57

ARTERIAL SAMPLE
09/25/2013 11:18
System Name RC4
System ID 0405-10484
Acc No [redacted]
Patient ID
[redacted]
Operator 32112

ACID/BASE		
pH	7.35	
pCO_2	55	mmHg
pO_2	55	mmHg
HCO_3-act	29	mmol/L
BE(B)	2.9	mmol/L

CO-OXIMETRY		
Hct	36	%
tHb	12.4	g/dL
sO_2	96.4	%
FO_2Hb	95.5	%
FCOHb	0.7	%
FMetHb	0.2	%
FHHb	3.6	%

CORRECTED 37.0 °C
pO_2(A-a)(T) 92.1 mmHg
pO_2(a/A)(T) 0.50

Temperature 37.0 °C
F_IO_2 36.0 %
pAtm 740 mmHg

PATIENT RANGES	
pH	7.350 - 7.450
pCO_2	35.0 - 45.0
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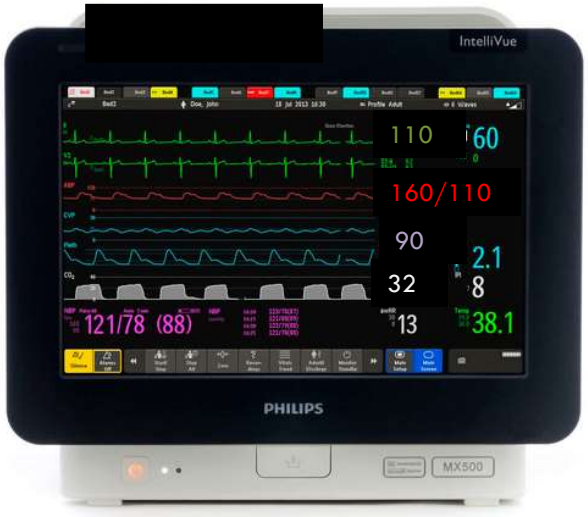
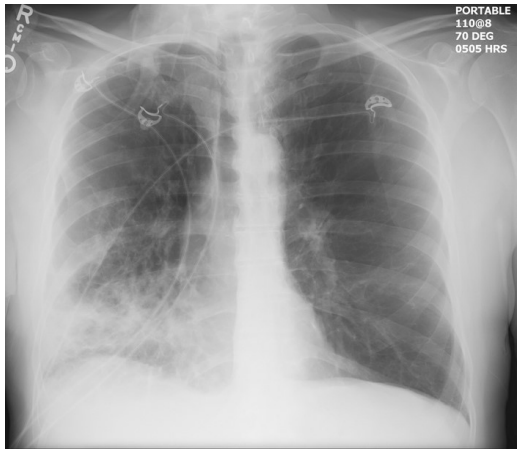
↓,↑=Out of range

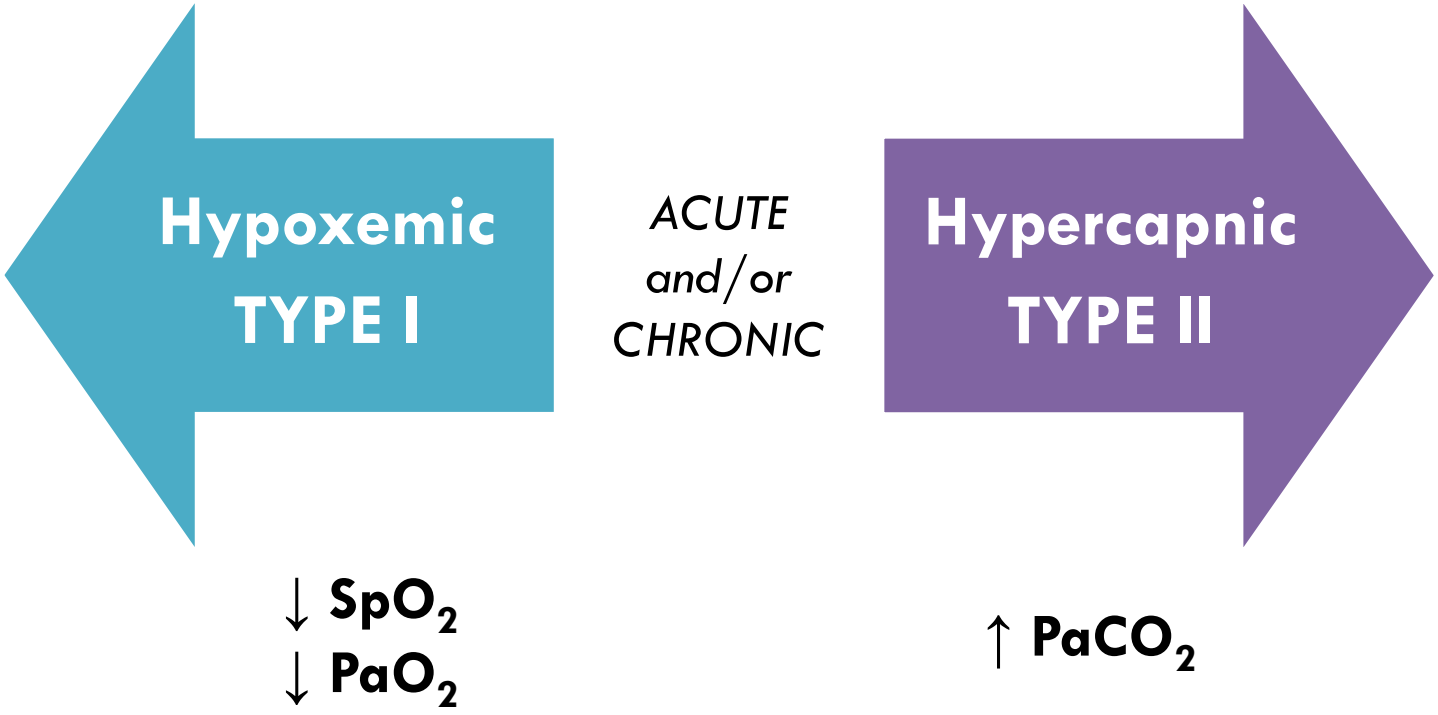


COPD Exacerbation
FEV_1 55%
70 pyh smoker
Increased green sputum production

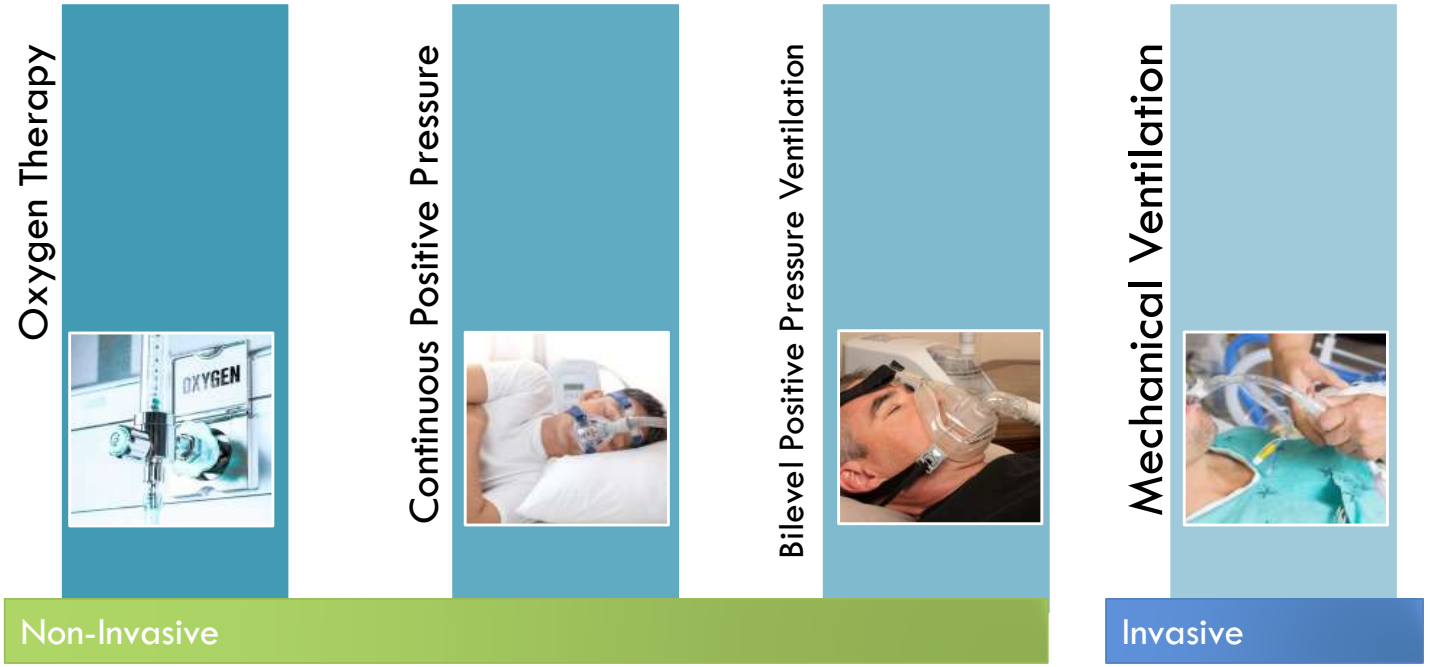
ORDERS
- ✓ SVN-Albuterol/Atrovent x 3
- ✓ ABG
- ✓ Chest X-ray
- ✓ 0_2 Therapy



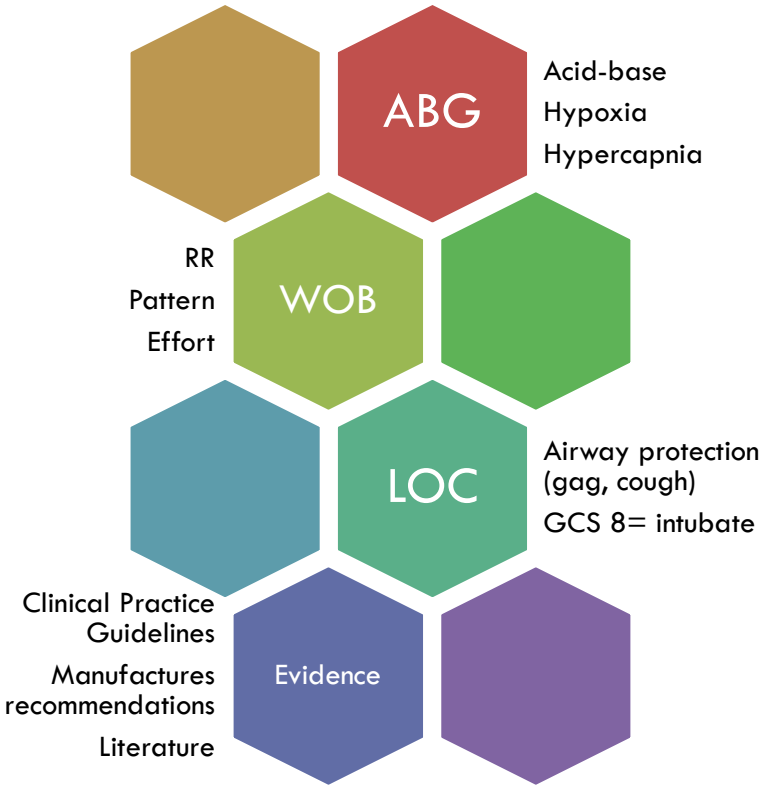
RESPIRATORY FAILURE



INTERVENTIONS



HOW TO CHOOSE THE INTERVENTION



Hypoxia

- Oxygen Therapy
- CPAP

Hypercapnia

- Bilevel NIV
- Mechanical ventilation

↑WOB

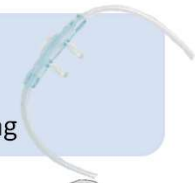
- High Flow O_2
- Bilevel NIV
- Mechanical Ventilation

Airway Protection

- Mechanical Ventilation

NASAL CANNULA

- **1-6 LPM**
- FiO2 variable
- Not appropriate for patient with high work of breathing



SIMPLE MASK

- **7-12 LPM**
- FiO2 variable
- Cannot be humidified
- Not a great choice for patients with high work of breathing

NRB

- **10-15 LPM**
- FiO2 variable
- Cannot be humidified

SALTER

- **6-15 L Flow**
- Fill with sterile water
- Low humidity, can be drying to mucosa

OXYMASK

- **1-15 LPM**
- "Open mask". No rebreathing CO2
- .24-.90 FiO2
- Cannot be humidified

Heated High Flow Nasal Cannula

- **0.21-1.0 FiO2/ 20-70 LPM Flow**
- Optimum humidity, gas heated to 37 C 100% relative humidity
- Meets and/or exceeds patient inspiratory demand

High Flow Nasal Cannula (HFNC)

- Treats both Type 1 (hypoxemic) and Type 2 (hypoxemic / hypercapnic) ARF
- HFNC significantly reduced intubation in patients with a PaO2/FiO2 ratio ≤ 200
- Variable flow rates (30-70 lpm) exceed minute ventilation (VE).
- Variable FiO2s .21 -1.0
- High flow may generate positive end expiratory pressure (PEEP)*
- High flow flushes CO_2 from the anatomical dead space.

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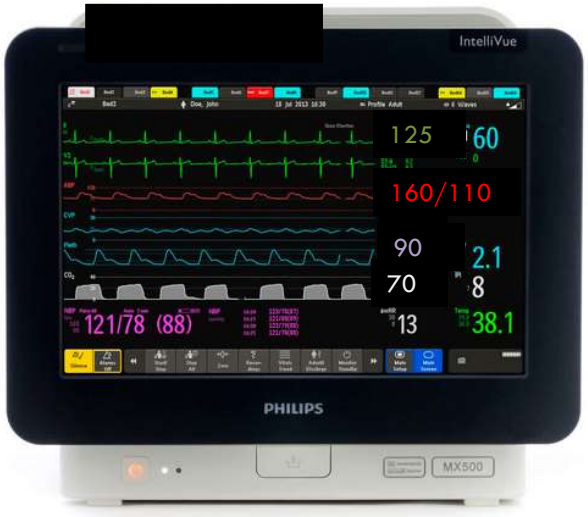

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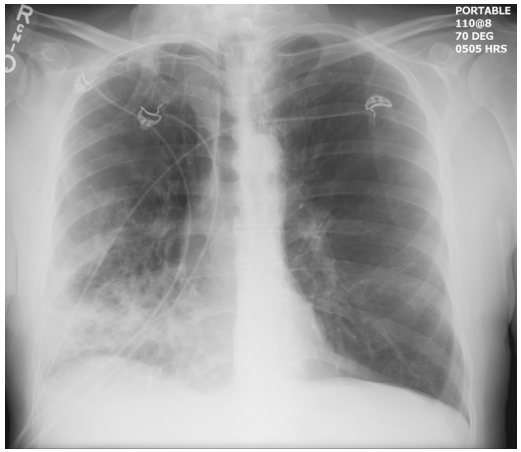
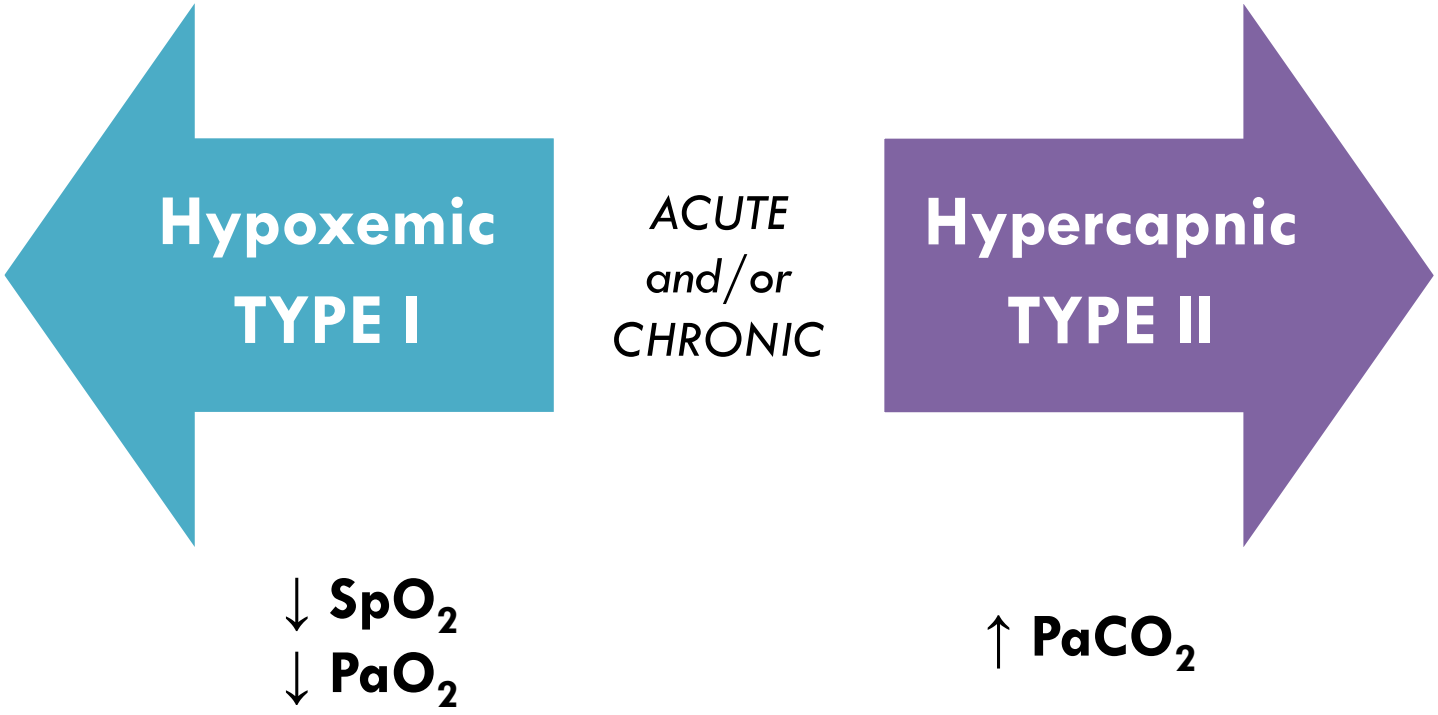


NON-INVASIVE POSITIVE PRESSURE VENTILATION

RESPIRATORY FAILURE



Non-Invasive Ventilation (NIV)

NIV is utilized to treat both type 1 (hypoxemic) and type 2 (hypoxemic / hypercapnic) Acute Respiratory Failure (ARF)

NIV utilizes an expiratory pressure (EPAP) and an inspiratory pressure (IPAP)

NIV delivers pressure support (PS) to the patient

- *IPAP should always be set at least 4 cmH2O above EPAP to achieve meaningful PS

NIV Evidence Based Practice

Acute Care

- Improve gas exchange
- Avoid Intubation
  - Decrease mortality
  - Decrease ventilator length of stay
  - Decrease length of hospitalization
  - Decrease incidence of ventilator associated pneumonia
- Relieve symptoms of respiratory distress
- Improve patient-ventilator synchrony
- Maximize patient comfort

Long-Term Care

- Relieve or improve symptoms
- Enhance quality of life
- Avoid hospitalization
- Increase survival
- Improve mobility

Kacmarek, R., & Stoller, J. (2014) *Egans Fundamentals of Respiratory Care* (10th ed.). London: Elselvier Health Sciences

INITIATION

- Determine mask/interface
- Determine MODE
- Choose INTIAL SETTINGS based on GOALS
- Apply Necessary Monitoring
- Adjust Settings as needed

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INITIAL SETTINGS

Ventilation	Oxygenation
IPAP (tidal volume)	**EPAP**
Minute Ventilation (spontaneous RR x Vt)	**FIO_2**

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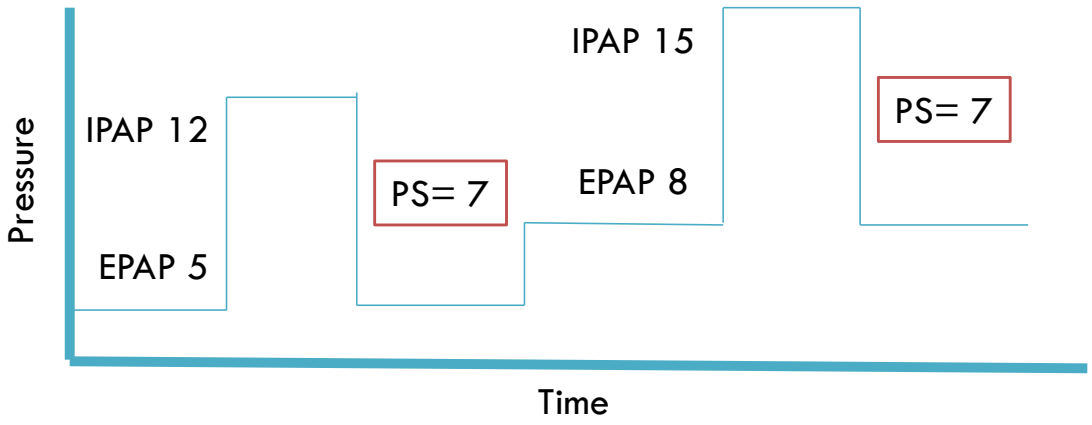
ADJUSTMENTS



Ventilation (CO_2)

- Driving pressure to deliver gas (creates the artificial pressure gradient)
- Increase Vt/alveolar ventilation
- Reduce $PaCO_2$

Oxygenation (O_2)

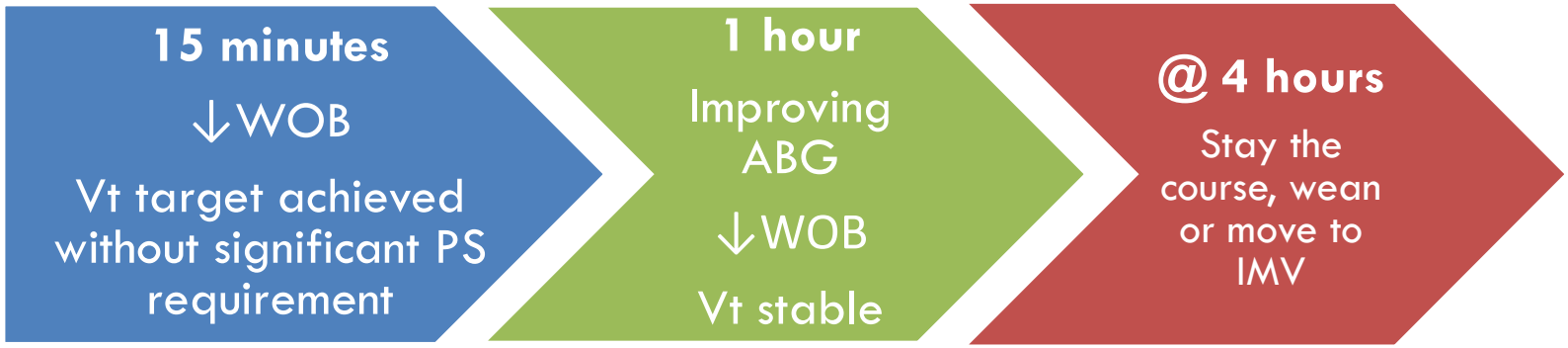
- Increased resistance to exhalation
- Increased alveolar surface area
- Reduce opening and closing of alveoli each breath
- Mimic physiologic end-expiratory pressure

Who should **NOT** go on NIV?

- Cardiac arrest/respiratory arrest
- Untreated pneumothorax
- Non-respiratory organ failure
- Facial surgery or trauma
- Upper airway obstruction
- Inability to protect the airway
- High risk for aspiration

Mechanical Ventilation: Trends in adult and pediatric practice. (2009). Mount Prospect, IL: Society of Critical Care Medicine

IS IT WORKING?



Consider:

- CXR improvement/worsening
- Hemodynamic improvement/worsening
- Level of consciousness

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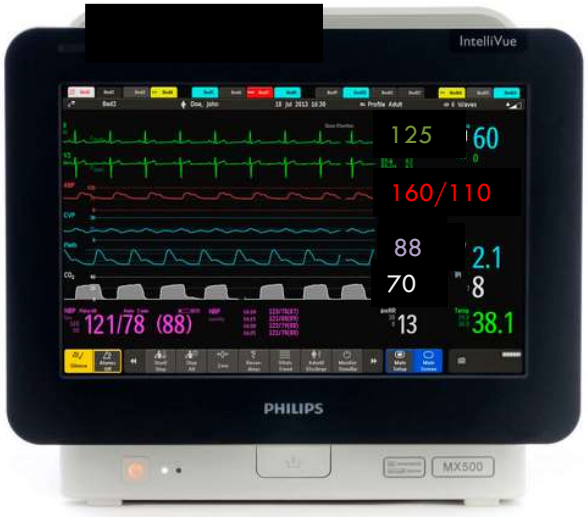

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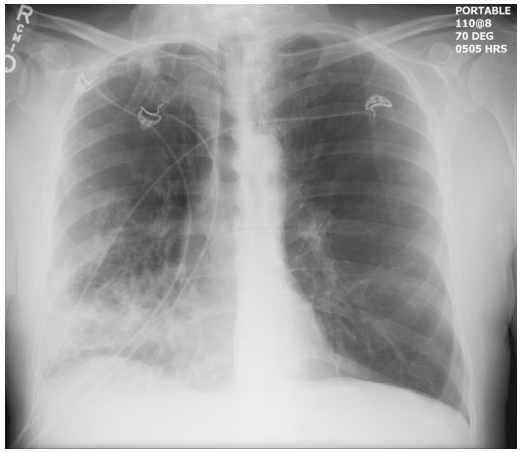


MECHANICAL VENTILATION

Basic Overview

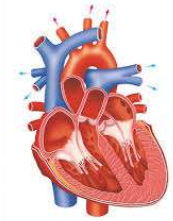
INDICATIONS FOR MECHANICAL VENTILATION

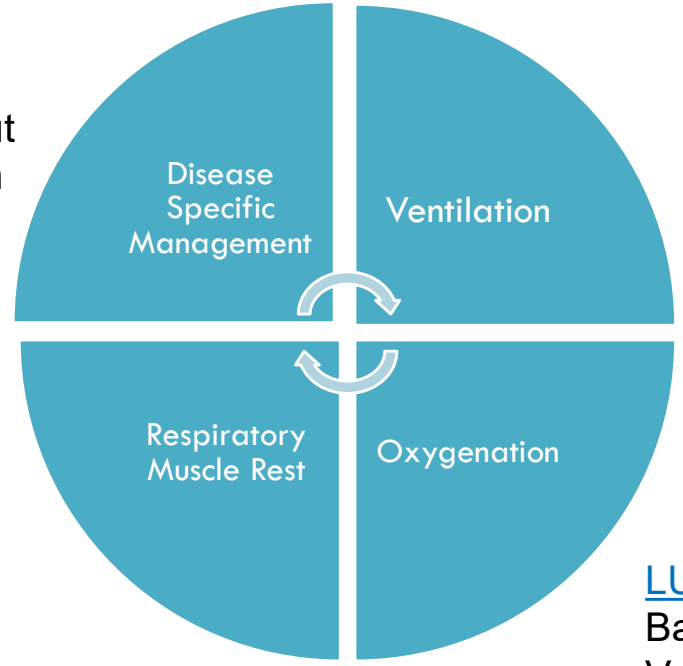
Hypoxic respiratory failure	• Reduce shunt by opening collapsed alveoli • Delivery high FIO_2
Hypercapnic respiratory failure	• Reduced work of breathing preventing fatigue • Maintain alveolar ventilation to prevent respiratory acidosis
Excessive Work of Breathing	• Metabolic Acidosis • Sepsis • Respiratory failure
Unprotected or Unstable Airway	• Altered level of consciousness • Surgery

MECHANICAL VENTILATION: GOALS

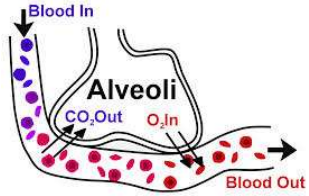
Do NO HARM

CARDIAC risk
Reduced cardiac output
Impaired venous return
Hypotension

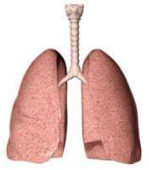


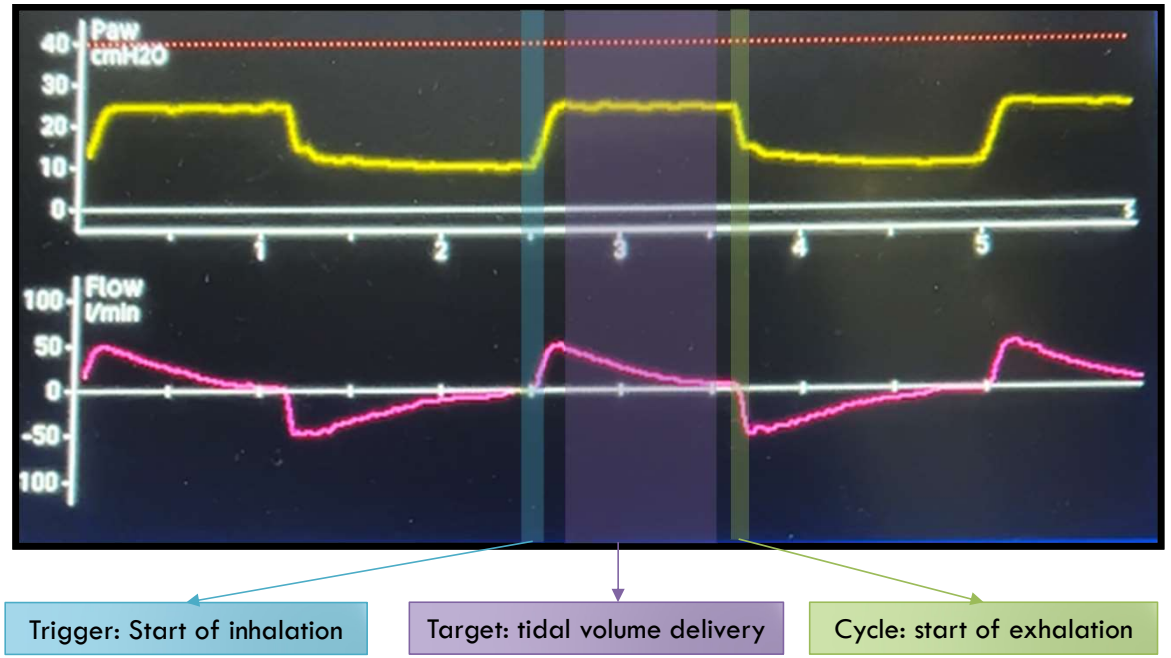


GAS EXCHANGE risk
Worsen shunt with unilateral lung disease
Increased dead space



LUNG risk
Barotrauma
Vent induced lung injury
Air trapping





VENTILATOR MODE IS DEFINED BY WHAT HAPPENS IN THE 3 PHASES OF THE BREATH

CONTROLLED MODES AND BREATH TYPES

Volume
FIXED FLOW

- Trigger: machine (set RR) or patient effort
- Target: set flow/Vt
- Cycle: set flow/Vt achieved

Pressure
VARIABLE FLOW

- Trigger: machine (set RR) or patient effort
- Target: set pressure achieved
- Cycle: set inspiratory time

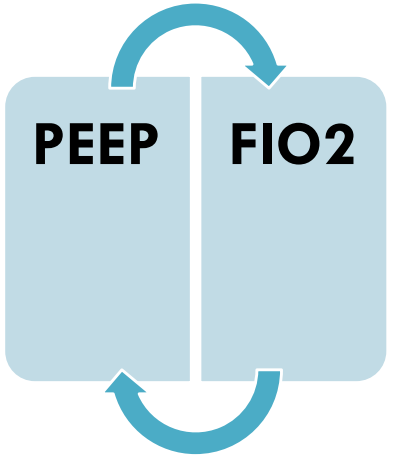
Dual
Pressure regulated; volume targeted
VARIABLE FLOW

- Trigger: machine (set RR) or patient effort
- Target: set pressure w/ target Vt achieved
- Cycle: set inspiratory time

PaO_2

OXYGENATION SETTINGS

- Select lowest FIO2 to achieve target SpO2/PaO2
- Therapeutic PEEP can be used to increase functional reserve capacity (FRC), increase surface area for gas exchange, reduce atelectrauma
- PEEP minimum should be 5 cmH2O, and titrated up to effect

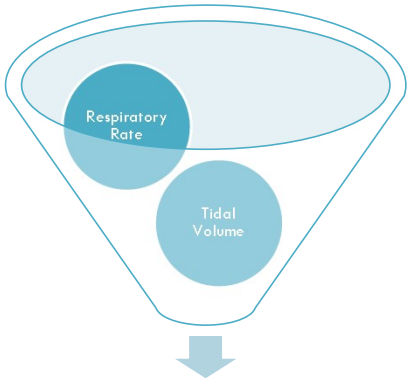


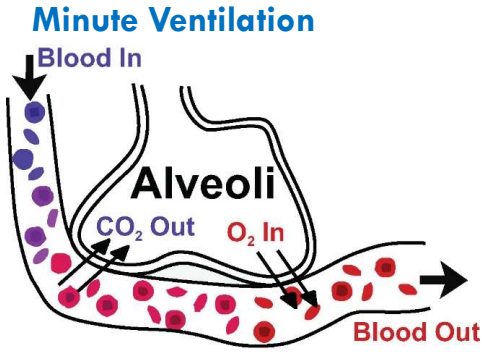
Setting	Range	Considerations
PEEP	**Min 5cmH_2O- Max (patient dependent)**	**SpO_2 target** **Effect on Blood Pressure**
FIO2	**Min .21- Max 1.0**	**SpO_2 target** **PaO_2 target** **Oxygen Toxicity** **Reabsorption atelectasis @ 1.0 FIO_2**

$PaCO_2$

VENTILATION SETTINGS

Respiratory Rate x Tidal Volume= Minute Ventilation





Mechanics of Breathing | Boundless Anatomy and Physiology | | Course Hero

Initial Settings

Determine appropriate tidal volume
- 6-8 ml/kg ideal body weight

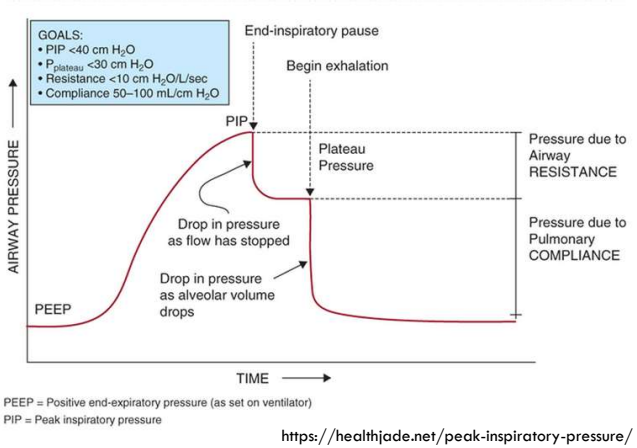
Set respiratory rate to achieve > 5-7 lpm

Adjust for optimal ventilation ($PaCO_2$)

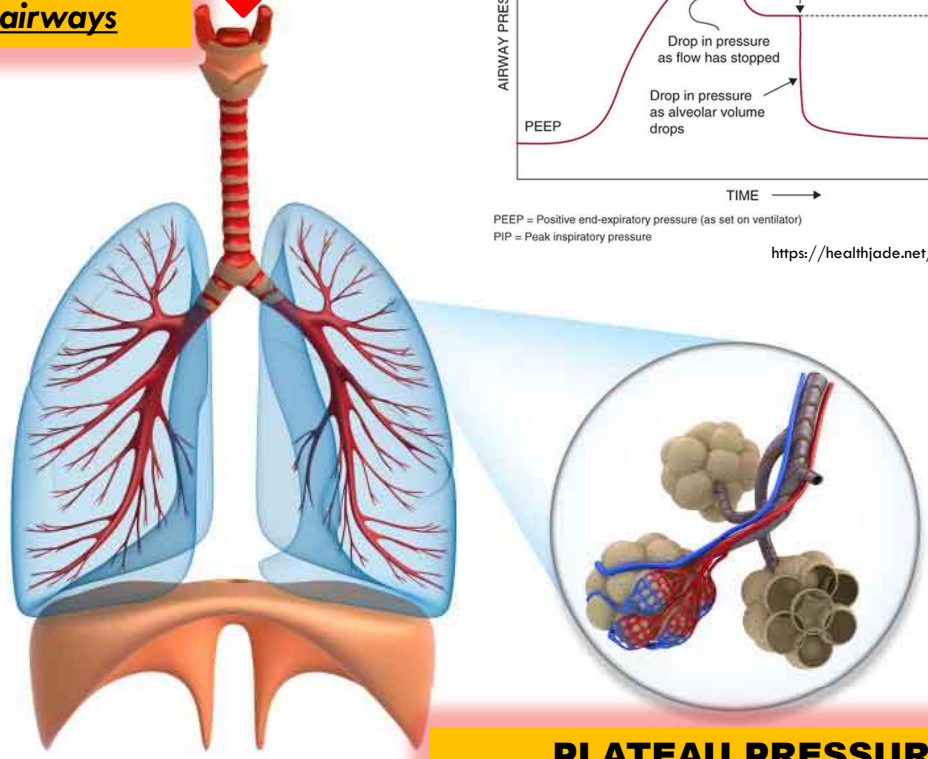
LUNG PRESSURE MONITORING

PEAK INSPIRATORY PRESSURE

Pressure it takes to get air from the machine through the ***big airways***



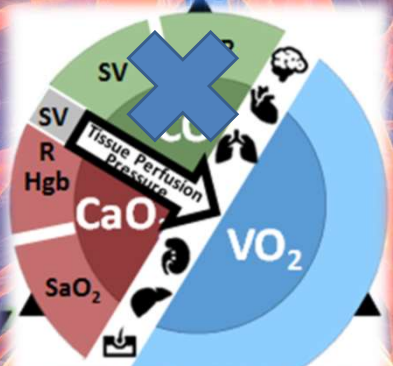
https://healthjade.net/peak-inspiratory-pressure/



PLATEAU PRESSURE

Pressure it takes to hold the ***alveoli*** open

CARDIAC EFFECTS OF LUNG PRESSURE



Autopeep (Intrinsic PEEP)

Can't fully exhale → Lungs overfill → ↑ Thoracic Pressure → Squeezes the heart → ↓ Cardiac output

CONCLUSIONS

Early recognition and accurate identification of the type of respiratory failure is key to treatment

The type of failure, the patient's symptoms and incorporating evidence-based practices will help determine the appropriate intervention

Settings selection and adjustments should be targeted to improve ventilation, oxygenation, patient comfort and balanced with hemodynamic considerations

REFERENCES (NOT REFERENCED IN TEXT)

1. Rochwerg B, Brochard L, Elliott MW, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. *Eur Respir J*. Aug 2017;50(2)doi:10.1183/13993003.02426-2016

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2. Amato MB, Meade MO, Slutsky AS, et al. Driving pressure and survival in the acute respiratory distress syndrome. *N Engl J Med*. Feb 19 2015;372(8):747-55. doi:10.1056/NEJMsa1410639