Status Asthmaticus in Adults/Acute Severe Asthma

- Kenneth Miller MSRT, RRT-ACCS, AE-C, FAARC

Learning Objectives

- Review what is Asthma
- Define what is Status Asthmaticus/Acute Severe Asthma
- Describe conventional asthma treatments
- Describe the utilized of Ventilator Graphics in the treatment and recognition of severe Asthma
- Review alternative therapies utilization to manage severe Asthma

What is Asthma

- Chronic inflammatory disease of the airways- hyperresponsive airways
- Acute and chronic airway inflammation
- Airway remodeling – permanent airway changes
- Up to 10% of people in the U.S. are affected
- Increased by 60% in the past 20 years
- ~10% of patients with asthma will require corticosteroid tx, and ED visit or hospitalization once/yr.

Causes of Asthma Exacerbations

- Respiratory infection
- Exposure to allergens
- Air pollutants
- Exposure to tobacco smoke
- Exercise
- Changes in weather/cold-air exposure
- Non-compliance with control medications

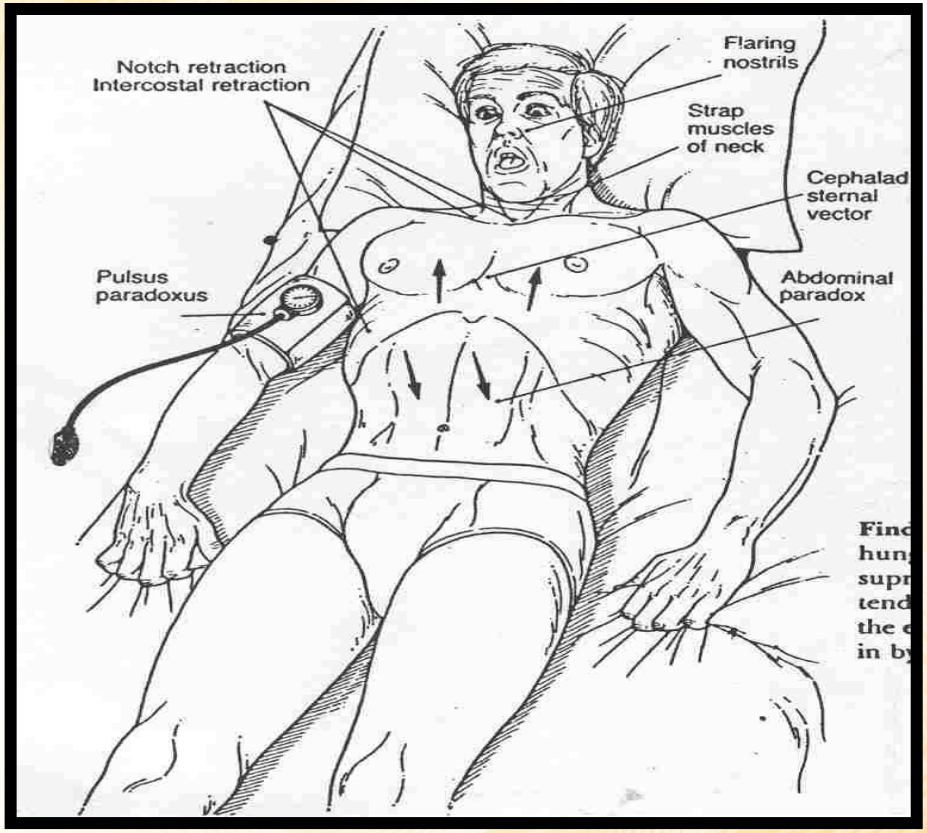
Clinical Presentation of Asthma

- Inspiratory and expiratory wheezes or diminished breath sounds(ominous sign)
- Tachypnea
- Cough
- Chest tightness
- Increased secretions
- Accessory muscle use
- Increased anxiety

What is different in Acute Severe Asthma?

- Doesn't respond to initial bronchodilator treatment
- RR > 30
- Significant accessory muscle use/retractions
- Confusion/fatigue
- Absent breath sounds/minimal air movement
- PEF 25-50% predicted
- Paradoxical breathing pattern
- Refractory hypercapnia
- Worsening hypoxemia
- Can progress to respiratory failure and cardiac arrest

Patient Presentation



Differential Diagnosis

- COPD
- CHF
- Pneumonia
- Pulmonary embolism
- Pneumothorax
- Allergic response

Acute Severe Asthma

Bronchospasm

Airway Inflammation

Increased secretions/ mucus plugging

Hyperinflation, V/Q Mismatch

Respiratory Failure

Can gradually worsen or can be an acute severe attack

Hyperinflation on CXR

(Respiratory Care Library, Lehigh Valley Health Network)

Risk Factors for Death from Asthma

- History of severe exacerbation
- 2 or more asthma-related hospitalizations in 1 year
- More than 3 visits to the ED for asthma
- Use of more than 2 rescue inhaler canisters in 1 month
- Resident of inner city or low socioeconomic class
- Illegal drug use
- Medical or psychiatric comorbidities

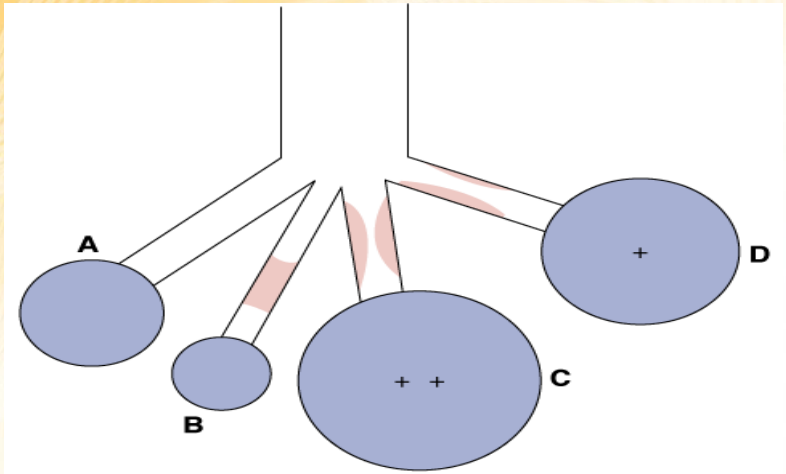
Standard Treatments

- Nebulized bronchodilators – β_2 agonists, muscarinic antagonists
- Systemic Corticosteroids
- Hydration – hyperventilation-related dehydration
- Oxygen therapy
- Heliox
- Mechanical ventilation

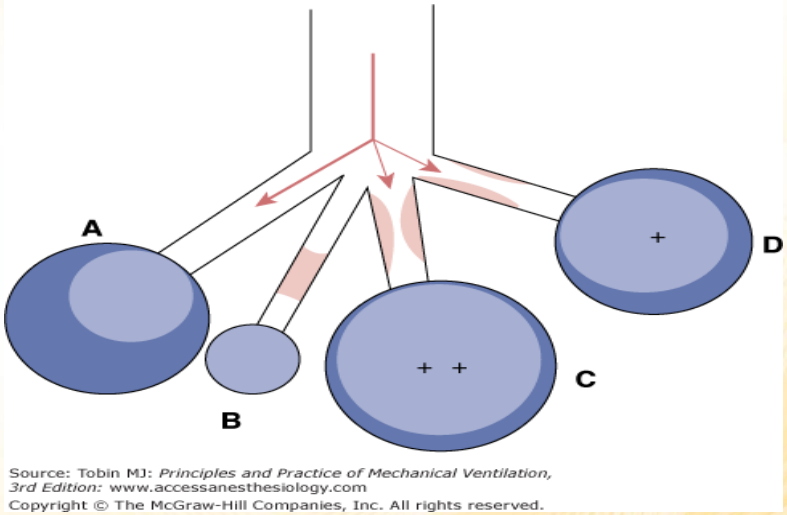
Goals with Mechanical Ventilation

- Volume control modes preferred - PIPs will be high due to elevated resistance
- Keep plateau pressures < 30 cmH_20
- Set appropriate high-pressure limit to deliver adequate tidal volume
- Low RR 6 to 10
- I:E Ratio 1:4 or 1:5
- Adequate sedation for vent synchrony – may need paralytic

Gas Distribution in Alveoli



End exhalation



Positive-pressure breath

Leatherman, 2013, Mechanical Ventilation for Severe Asthma

Auto-PEEP Measurements

Average P_{ALV} = +15

AutoPEEP (Static) = +10

AutoPEEP (Dynamic) =+5

Auto-PEEP Measurements

- **Advantages**
  - trend values
  - est. of airway obstruction
  - easily performed
- **Disadvantages**
  - under-estimate
  - can lead to more air-trapping
  - ventilator limitations
  - incorrect interpretation

Potential Complications

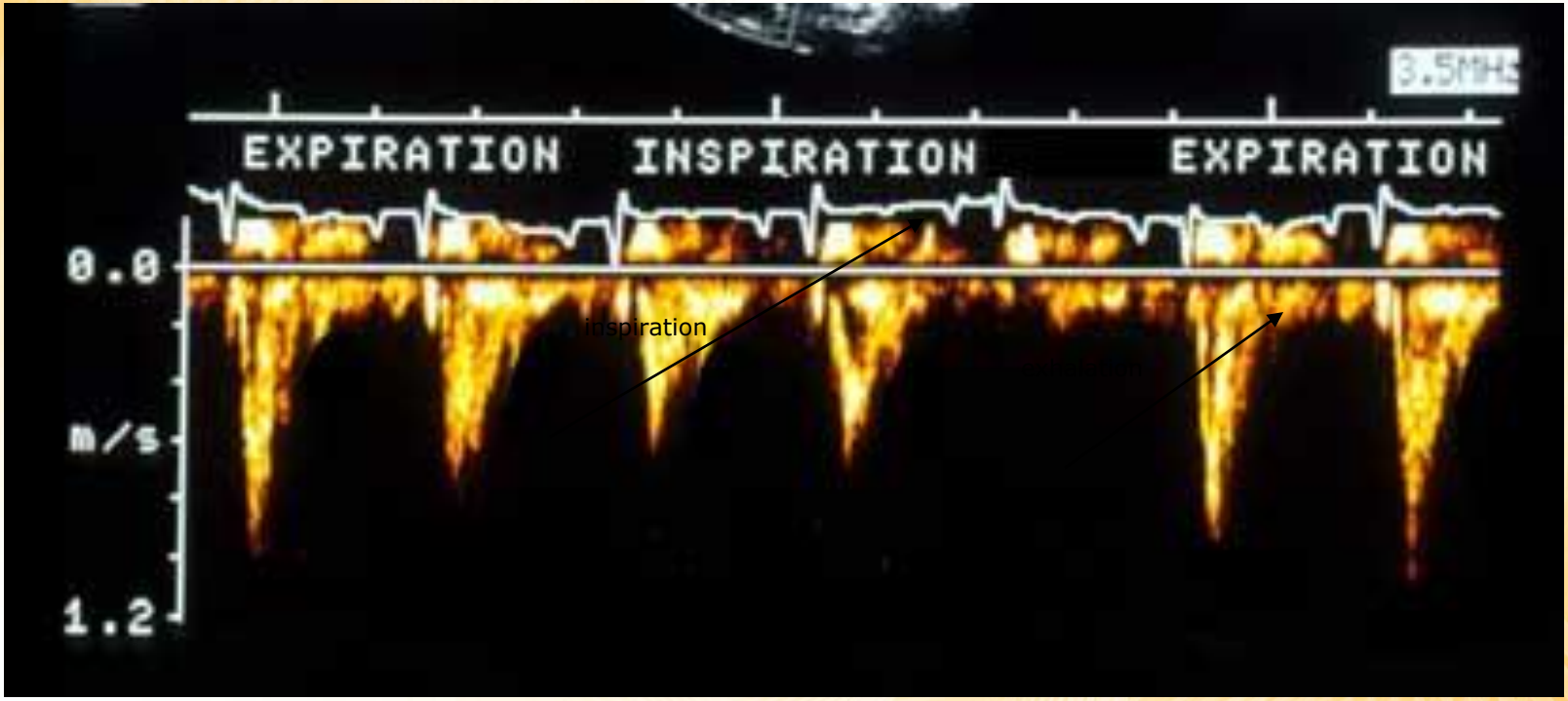
- Pneumothorax
- Pneumomediastum
- Mucus plugging
- Cardiac – stress cardiomyopathy
- Hypotension – hyperinflation can decrease venous return
- Lactic acidosis
  - Production of lactate from accessory muscle use
  - High doses of albuterol
- Anoxia – cerebral anoxia =most common cause of death in status asthmaticus patients

Hemodynamic Instability

- Air Trapping
- Increased pulmonary vascular resistance
- Decreased venous return
- Reduced cardiac output
- Hemodynamic Instability

Pulse Paradoxes

BP varies more than 10 mm/hg between inspiration and exhalation
Reflective of airway obstruction and air trapping



Life Threatening Asthma

Classification of Life-threatening Asthma

- Gradual deterioration over an extended period
  - often associated with an infection
- A mild attack that turns into a severe attack **(asphyxia asthma)**
  - often associated with an event or reaction
  - **can occur with any asthmatic!!!!!**

MILD/MODERATE

- SpO_2 >92%
- RR:
  <30 (over 5's)
  <40 (under 5's)
- No or minimal accessory muscle use
- Feeding well or talking in full sentences
- Wheeze (may only be audible with stethoscope)

SEVERE

- SpO_2 <92%
- PEFR 33-50% predicted
- RR:
  >30 (over 5's)
  >40 (under 5's)
- Too breathless to feed or talk
- HR:
  >125 (over 5's)
  >140 (under 5's)
- Use of accessory muscles
- Audible wheeze

LIFE THREATENING

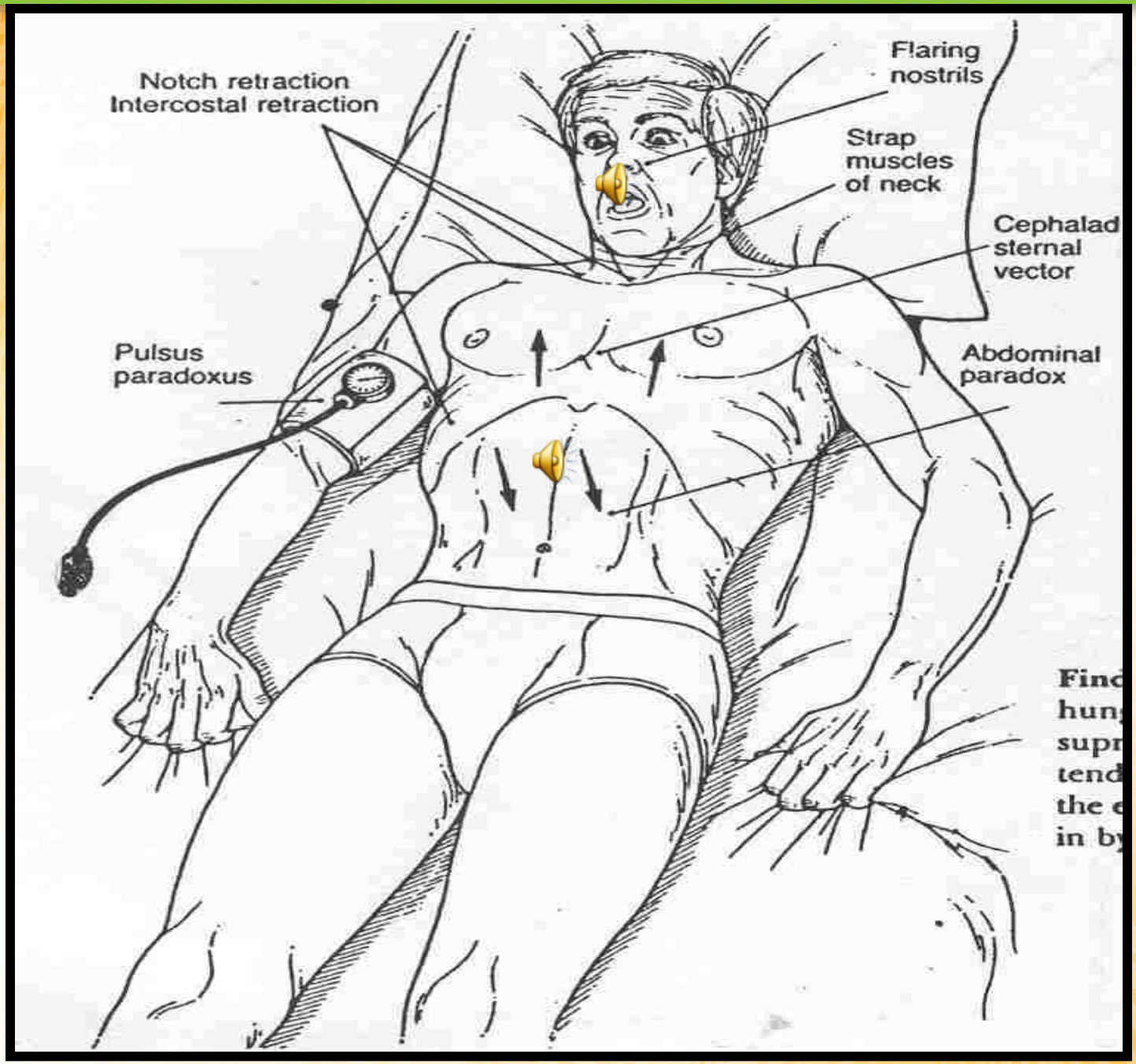
- SpO_2 <92%
- PEFR <33% predicted
- Silent chest
- Poor respiratory effort
- Altered consciousness
- Agitation/confusion
- Exhaustion
- Cyanosis

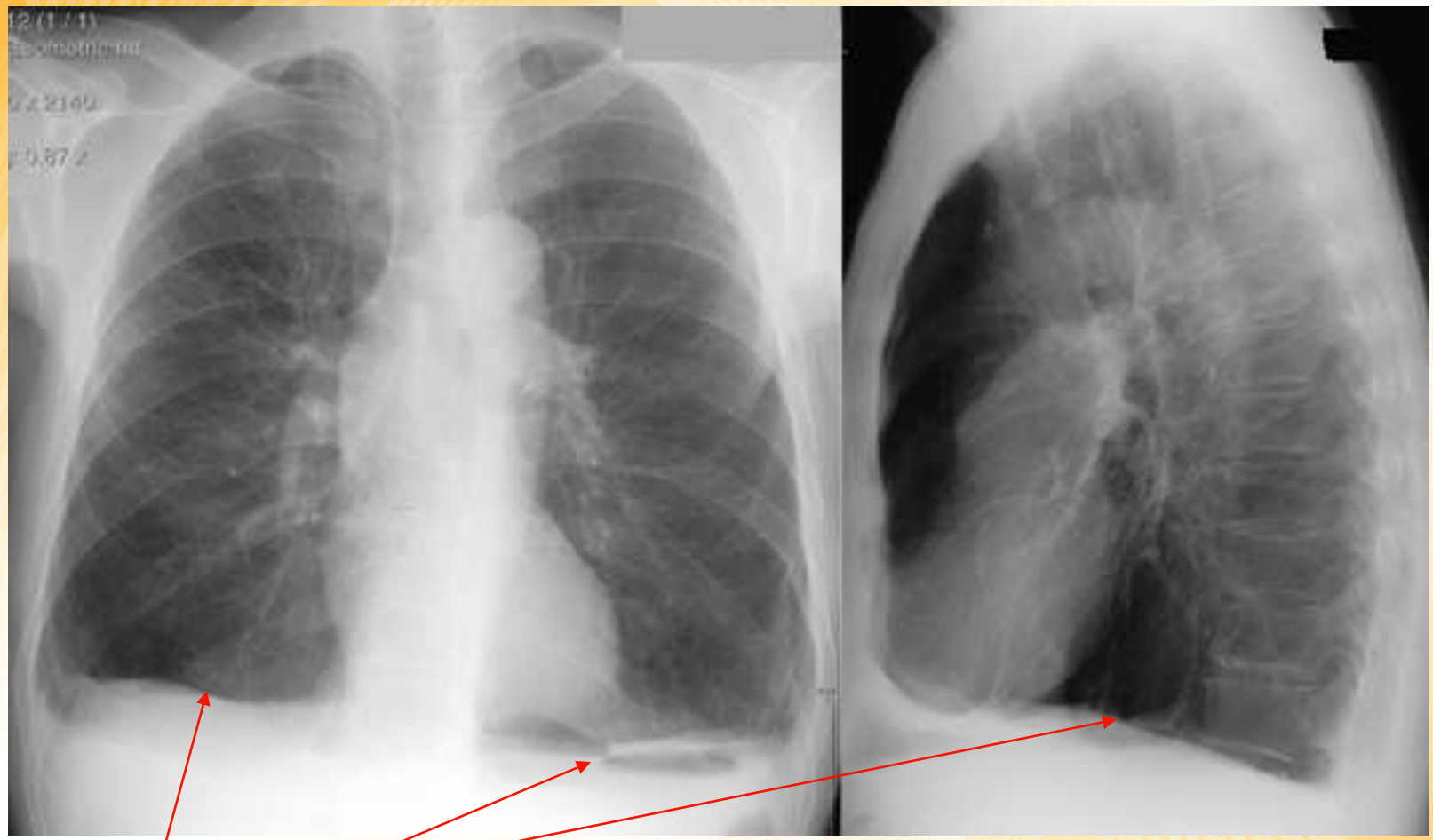
Phenotypes of Acute Severe Asthma

	Gradual Onset	Sudden Onset
Course	Days	Hours-asphyxic
Incidence	10-33%	45-88%
Airway pathology	Mucus plugging	None
Inflammatory cell	Eosinophil	Neutrophil
Response to treatment	Slow	Quicker
Hospitalization course	Long	Short
Prevention	Possible	Underdetermined?

Important Considerations of Hospitalization vs. ICU Admission

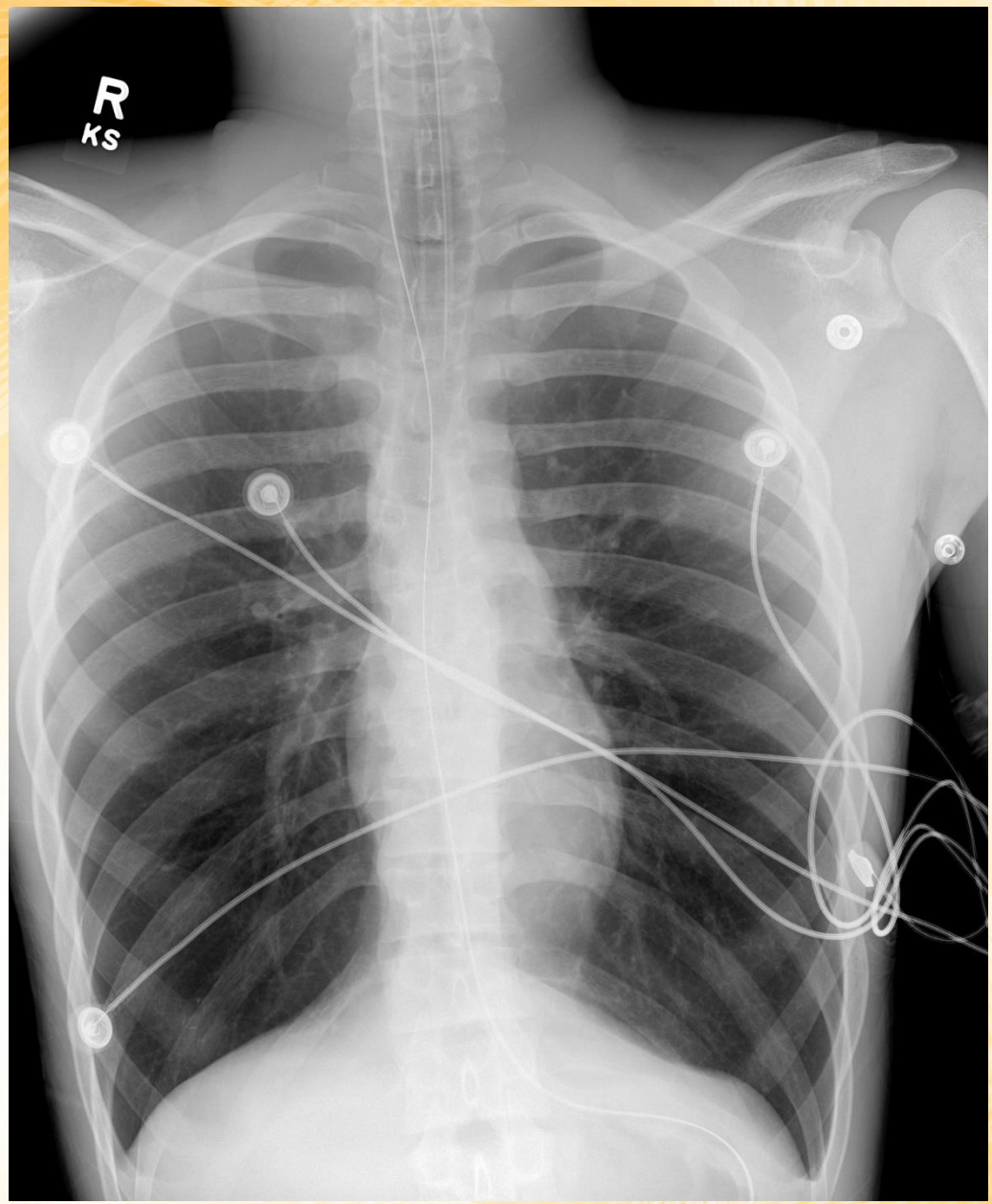
Hospitalization	ICU Admission
Duration and severity of symptoms	Drowsy or confused
Severity of airflow	Paradoxical thoraco-abdominial movement
Severity of prior exacerbations	Absence of wheezing
Medication utilization at time of exacerbation	Bradycardia
Access to medical care and medications	PEPR<25%
Presence of psychiatric illness	SpO2<90%
Home support and conditions	Pulsus paradoxus


Notch retraction
Intercostal retraction
Flaring nostrils
Strap muscles of neck
Cephalad sternal vector
Pulsus paradoxus
Abdominal paradox

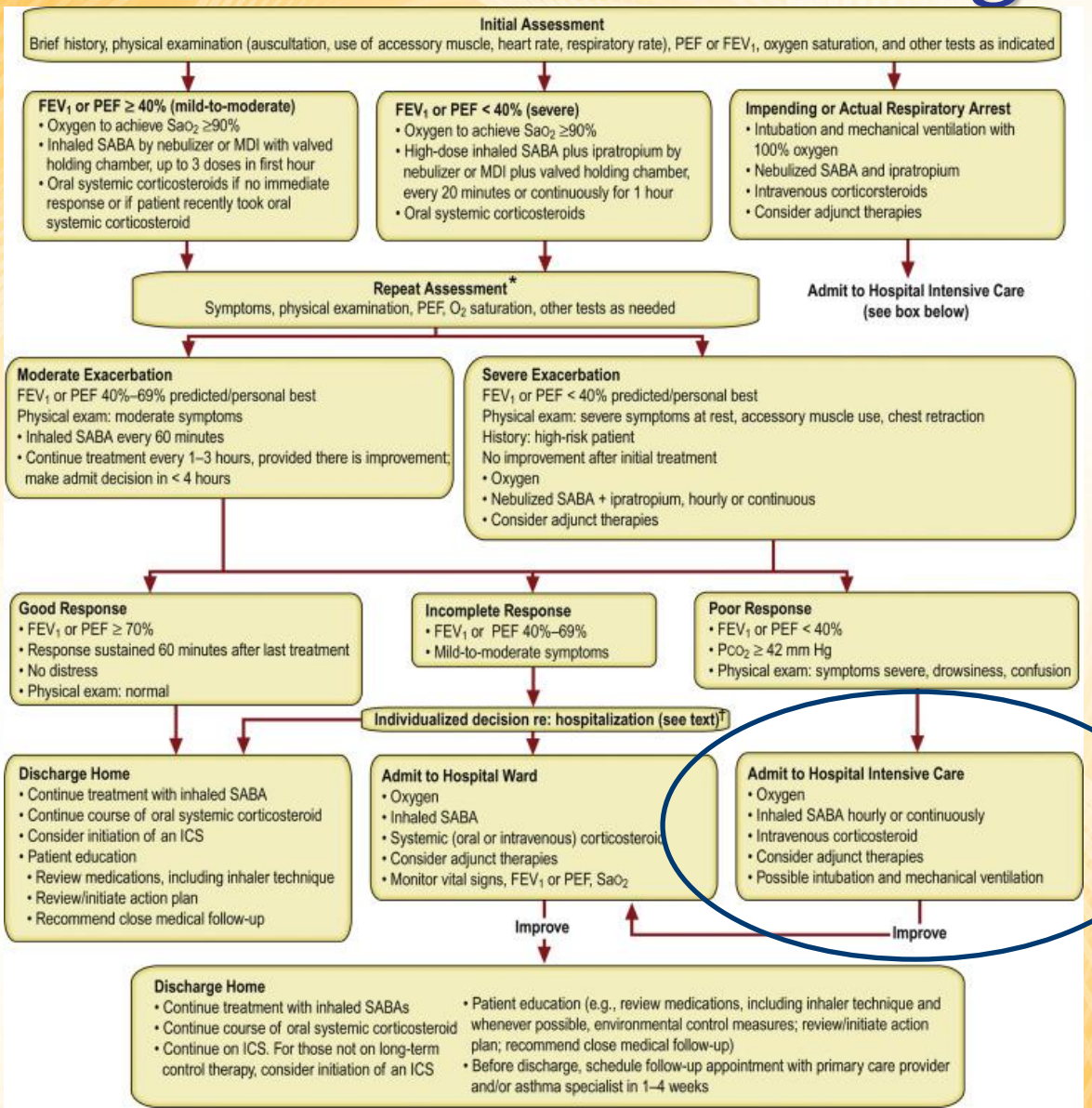


Flatten Diagrams

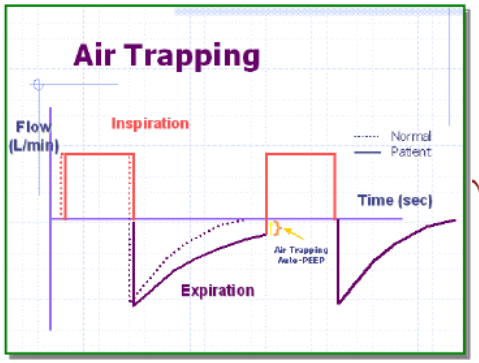
22 yr. old
Status

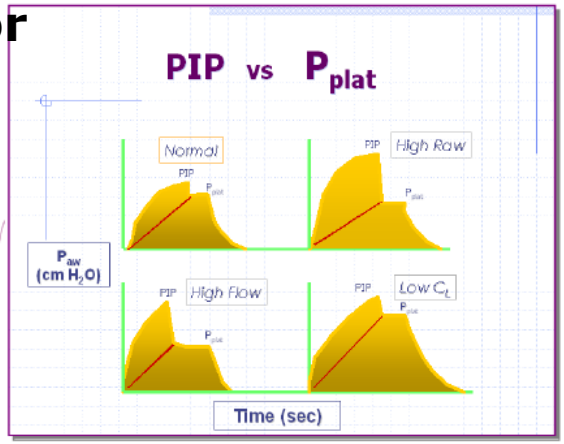


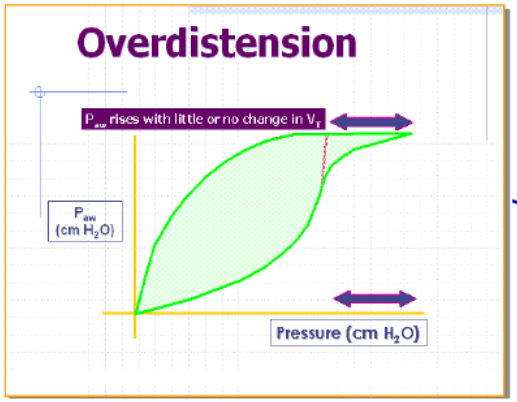
Treatment of Life-Threatening Asthma

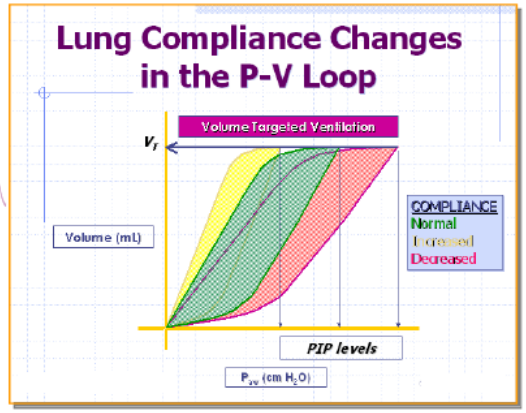


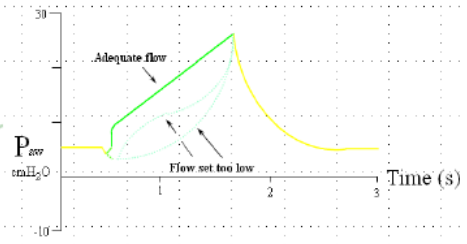
Using Ventilator Graphics











Continuous Beta-agonist Therapy

Continuous nebulization with SABA, albuterol 10–25 mg per hour or 0.5–1 mg per kg per hour

Side Effects

- Tachycardia
- Hyperkalemia
- Tachyphylaxis
- Tremor (may be difficult to see in patient who is on a paralytic)

Alternative Treatments

- Permissive hypercapnia – pH > 7.2
- HFNC/NPPV – limited number of small trials
- Magnesium sulfate
- Methylxanthines – theophylline, aminophylline
- V-V ECMO – minimize MV adverse effects
- Sevoflurane therapy

Alternative Interventions

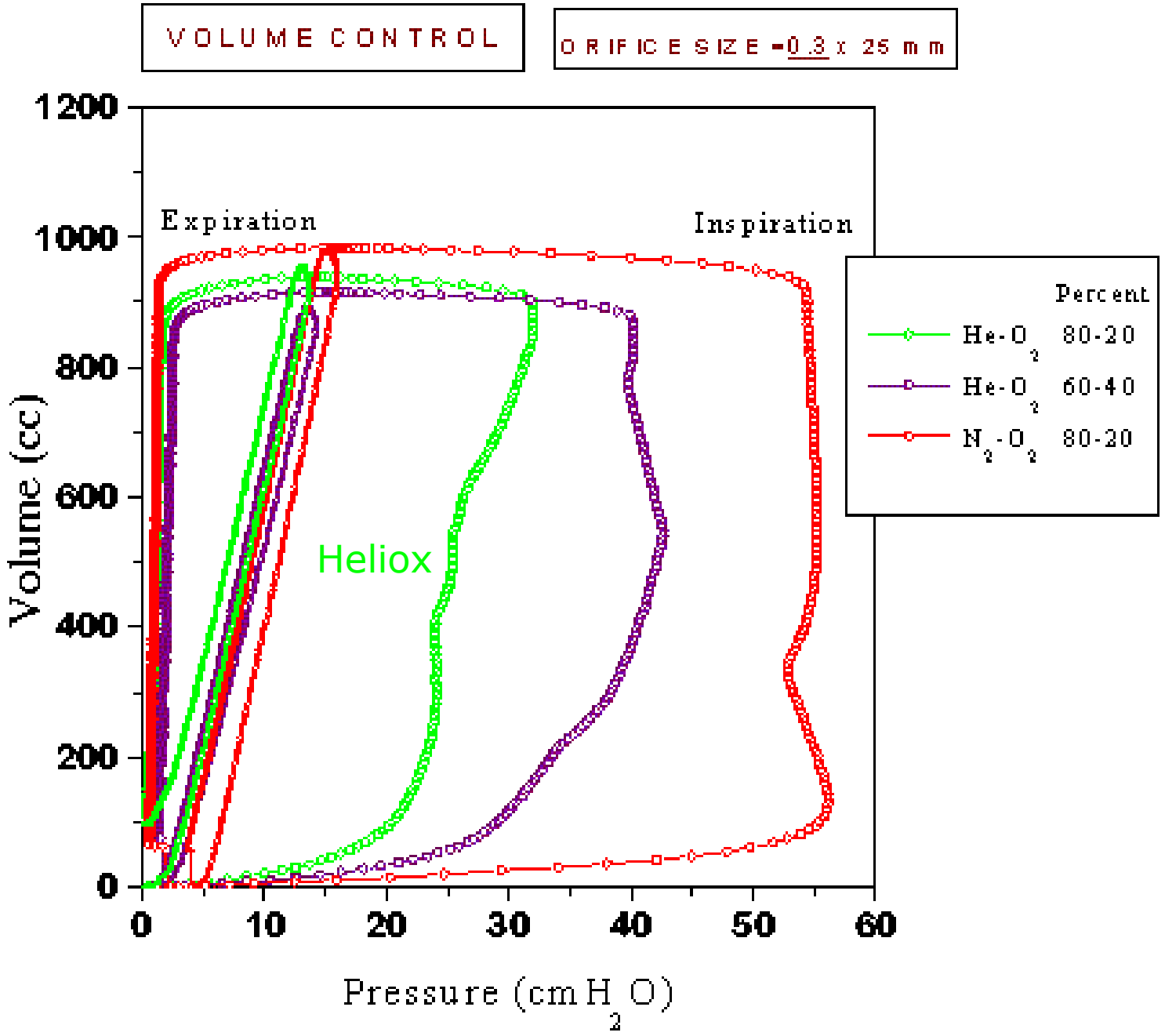
- Permissive hypercarbia
- Heliox
- V-V ECMO
- Magnesium Sulfate

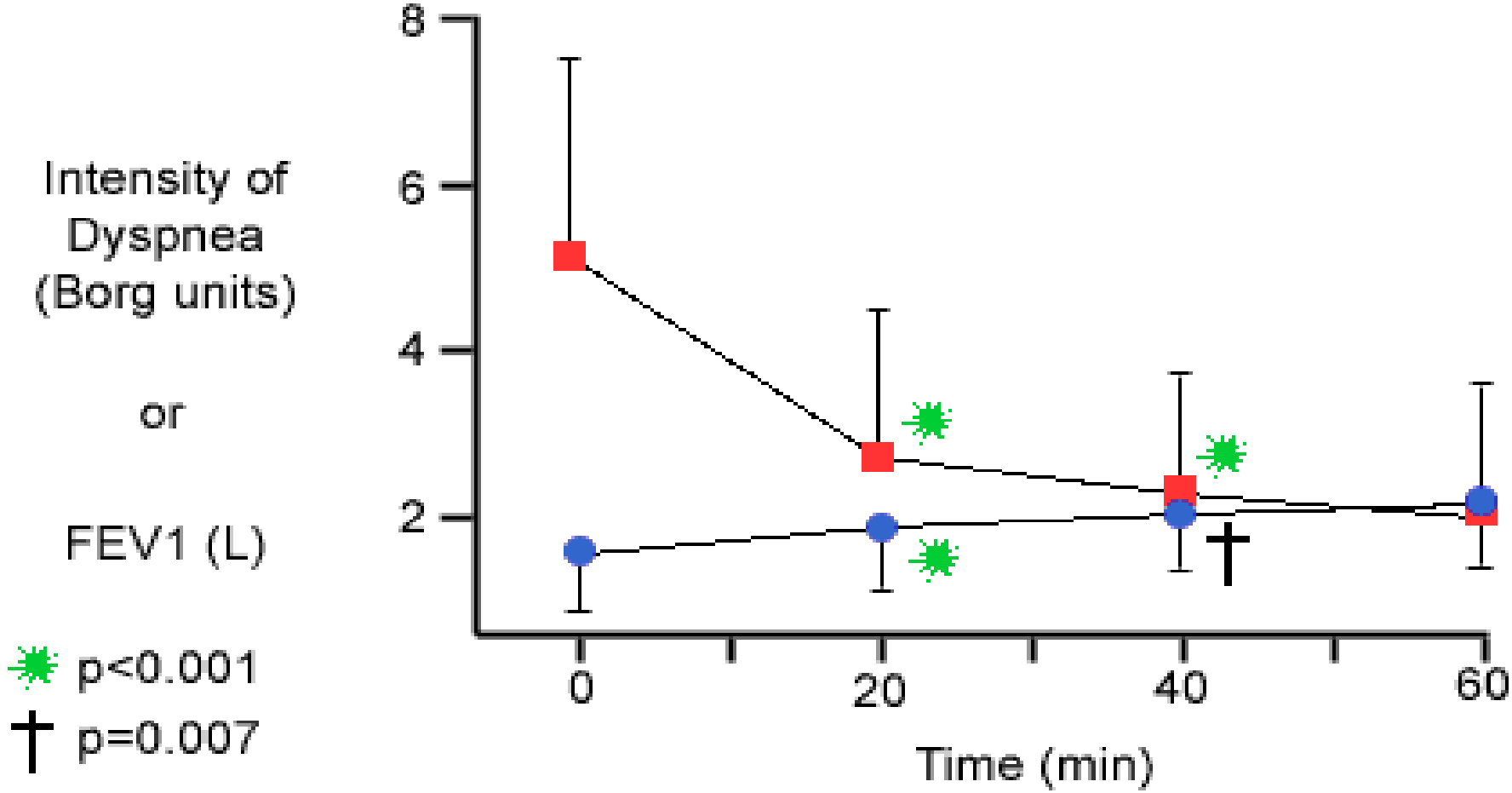
Permissive Hypercarbia

- Allow $PaCO_2$ to rise in order protect the lung for injury from high PIP/P_{LT}
- Maintain pH > 7.25
- Buffer pH with THAM or HCO_3
- May cause cardiac ischemia
- Not to be used in head injured patients

Heliox

- Lower density than oxygen
- Produces a lower Reynolds Number
- Clinical studies have demonstrated a reduced of WOB by 35%
- Decreases pulses paradoxes
- Reduction in $PaCO_2$
- ?reliable ventilator monitoring


VOLUME CONTROL
ORIFICE SIZE = 0.3 x 25 mm
Expiration
Inspiration
Heliox
Percent
He-O2 80-20
He-O2 60-40
N2-O2 80-20
Volume (cc)
Pressure (cm H2O)
0
200
400
600
800
1000
1200
0
10
20
30
40
50
60


Intensity of Dyspnea (Borg units)
or
FEV1 (L)
p<0.001
p=0.007
8
6
4
2
0
20
40
60
Time (min)

Pre Heliox

Raw

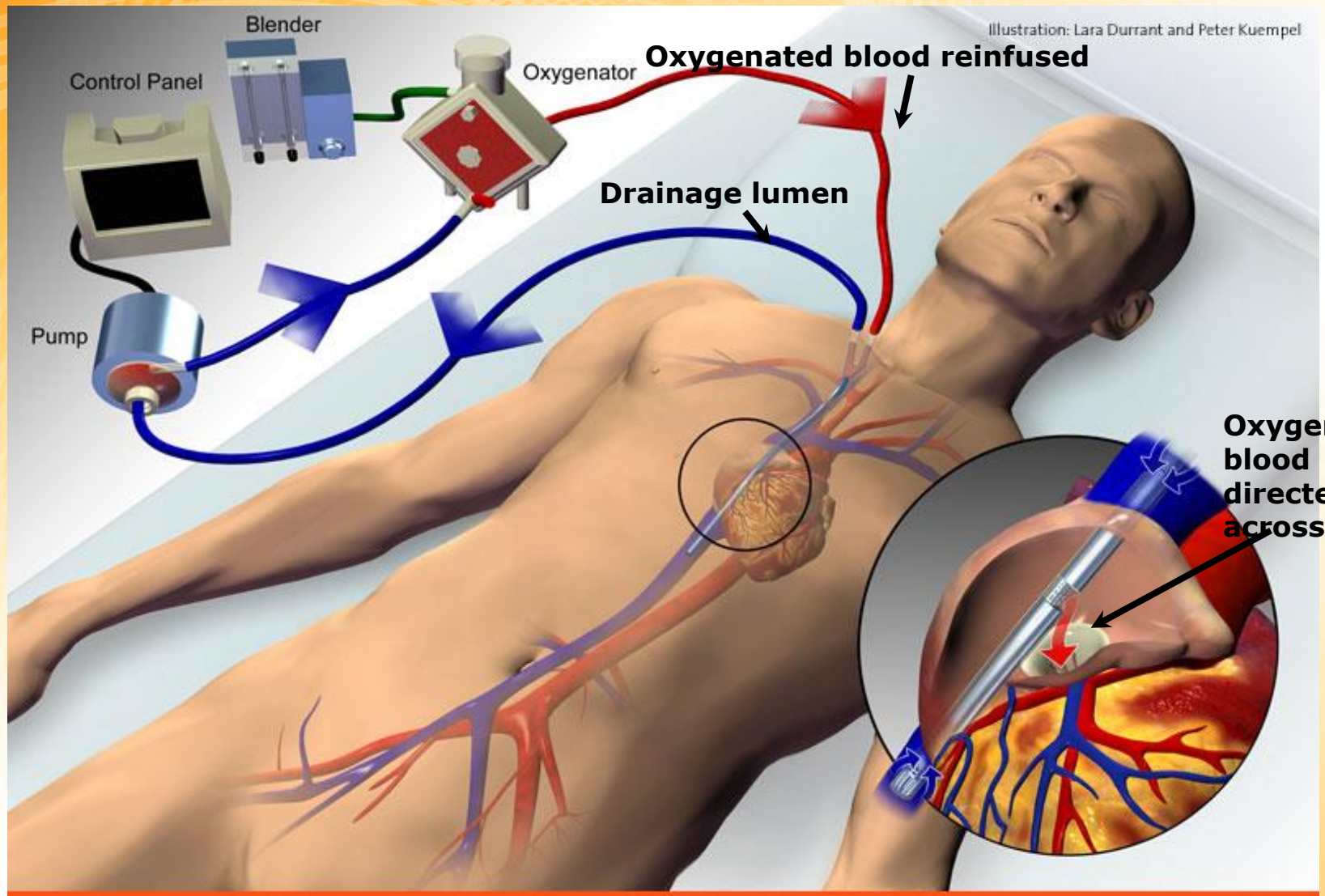
Settings P-CMV 38/12 I/E 1:3.3

Post heliox administration 70/30

V-V ECMO

- Utilized in severe situations often associated with mucus plugging
- Plt>35cm
- $PaCO_2$>90 and pH<7.20
- FIO_2>60%
- Ability to allow the lung to rest until bronchodilator/steroids/etc. reverse bronchospasm and inflammation

Dual Lumen Cannula for VV ECMO



Single-site approach to venovenous ECMO cannulation:
A dual-lumen cannula is inserted in the internal jugular vein (extending through the right atrium and into the inferior vena cava). Venous blood is withdrawn through one "drainage" lumen with ports in both the superior and inferior vena cava. Reinfusion of oxygenated blood occurs through the second lumen, with a port situated in the right atrium. Inset: The two ports of the "drainage" lumen are situated in the superior and inferior vena cavae, distant from the reinfusion port. The reinfusion port is positioned so that oxygenated blood is directed across the tricuspid valve and directly into the right ventricle. This arrangement significantly reduces recirculation of blood when the cannula is properly positioned.

ECMO Cannula

ECMO

- Allows the sweep to remove CO2
- Allows for oxygenation
- Allows for Heliox administration in hypoxemic patients
- Minimizes VILI

ECMO

- Associated with many hazards
- Typical duration: 3-5 days
- Quick ECMO and ventilator wean

THE UTILIZATION OF VENOUS-VENOUS EXTRACORPOREAL OXYGENATION MEMBRANE FOR THE MANAGEMENT OF STATUS ASTHMATICUS

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JENNIFER STOWE DO
ALISON BEDEKOVICH MSN, RN

Introduction

- **Life threatening refractory asthma:**
  - Requires intubation and mechanical ventilation
  - Often presents with high level of arterial $PaCO_2$ which require both a high minute ventilation and airway pressures despite lung protective ventilation and the administration of Heliox gas mixture
  - Ventilator induced trauma (VILI) is common
  - Has a mortality rate of around eight percent

Intervention

- Another approach to meet gas exchange goals and to provide maximum lung protective is to place these patients on venous-venous extracorporeal oxygenation membrane (ECMO) support.
- The clinical rational for this management would be to protect the lung from any additional VILI and provide a stable level of ventilation and acid-base balance.
- Allows for other clinical interventions to be administered in a more systematic manner.

Methods

- During a two year time frame we placed six status asthmaticus patients with refractory gas exchange on V-V ECMO.
- Five of the six patients were management on V-V ECMO until the asthma exacerbation was stabilized and progressed to both ECMO and ventilator liberation.
- One patient expired secondary to multi-system organ failure unrelated to asthma.

ECMO Device

Transpulmonary Monitoring

Heliox Administration

P/V tool

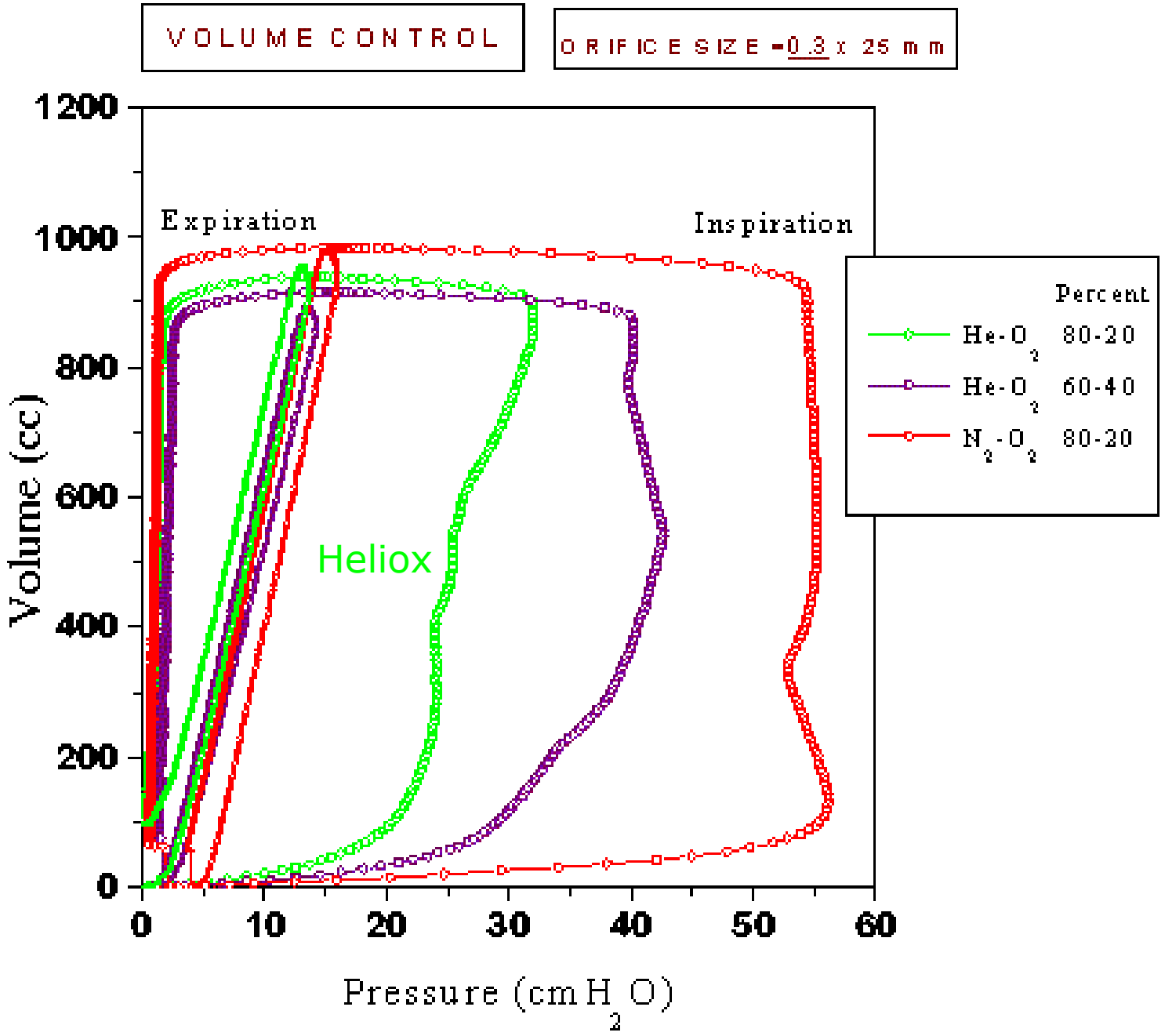
Results

Patient #	Age/G	S/E	Vent Mode/settings	V-V ECMO LOS	ECMO settings	Ext time from decannulation	Heliox
1	51/M	S	PCMV 4cc/kg	7	100/ 5lpm	120 hrs.	Y
2	28/M	S	CMV 4cc/kg	8	100/9lpm	70 hrs.	Y
3	49/M	S	PCMV 5cc/kg	5	100/4.5lpm	42 hrs.	Y
4	31/F	E	CMV 5cc/kg	15	80/3lpm	NA	Y
5	18/M	S	CMV 4cc/kg	8	80/4 lpm	209 hrs	Y
6	31/F	S	PCMV 4cc/kg/IBW	9	100/1.5lpm	42 hrs	Y

All received continuous Proventil
PEEP settings were guided by transpulmonaryE -2 to 2 cm
PEEP range 10-16cm
Patient 4 and 5 developed barotrauma prior to cannulation

Heliox

- Lower density than oxygen
- Produces a lower Reynolds Number
- Clinical studies have demonstrated a reduced of WOB by 35%
- Decreases pulses paradoxes
- Reduction in $PaCO_2$
- ?reliable ventilator monitoring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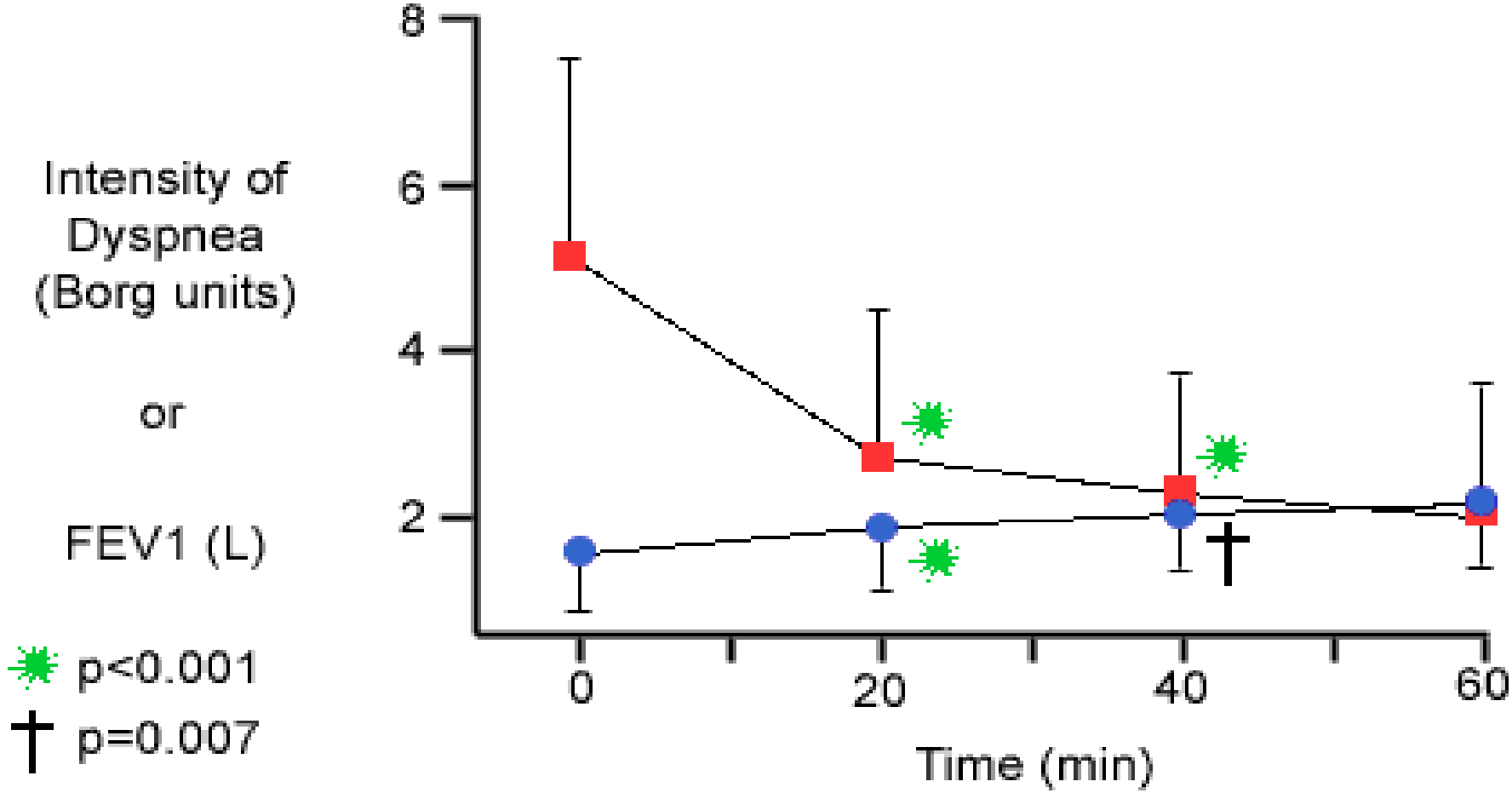
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FEV1 (L)
p<0.001
p=0.007
8
6
4
2
0
20
40
60
Time (min)

Heliox via MV

Before Heliox

With Heliox

Note improved resistance, lower PIP needed, increased TV improved flow waveform

What is Sevoflurane?

- Volatile anesthetic
  - General anesthesia
  - Rapid onset
  - Mild analgesic
- Liquid – vaporized for inhalation
- Clears primarily with pulmonary exhalation

Sevoflurane

Advantages

- Bronchodilator effects
- Alternative to benzodiazepines and opioids with risks of withdrawal/addiction, over sedation, hemodynamic effects
- Drug clears with exhalation & 5% via liver – rapid clearance time
- Decreased time to extubation
- Works for hard-to-sedate patients such as burns, drug abuse history

Disadvantages

- Requires specialized equipment – Anesthesia Conserving Device (AnaConDa or MIRUS – not in U.S.)
- “Off label” use in ICU
- Potential malignant hyperthemia in genetically predisposed patients – rare
- May increase ICPs in neuro patients
- Minimum vt 350ml

Respiratory Therapist Responsibility

- Patient Assessment
- Recognize severity
- Be familiar with treatment options & anticipate next steps
- Advocate for your patient
- Optimize mechanical ventilation settings, if intubated
- Lung protective/avoid barotrauma
- Monitor closely – use vent graphics, capnography, CXR

Become an Asthma Expert!

Summary

- Asthma can be life threatening
- Recognizing Status Asthmaticus/Acute Severe Asthma
- Have e an arsenal of non-conventional asthma interventions for the severe asthmatic

Questions?

References

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