Respiratory Management for the Patient with COVID-19

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Overview of Talk

- Goals of Oxygen Supplementation
- Respiratory Management of the non-intubated patient
- Ventilator Management of Acute Respiratory Distress Syndrome
  - Lung-protective Ventilation
  - Prone position ventilation
  - Management for refractory hypoxemia
  - When to consider ECMO

A Case:

54 y/o woman with DM, HTN presents with fever, malaise and dyspnea for the past 10 days.

HR 110, BP 105/65, RR 32, 80% RA

WBC 4.0 (ALC 0.7)

Ferritin 708

CRP 72

Fibrinogen 491

COVID +

What are your next steps?

Poll #1

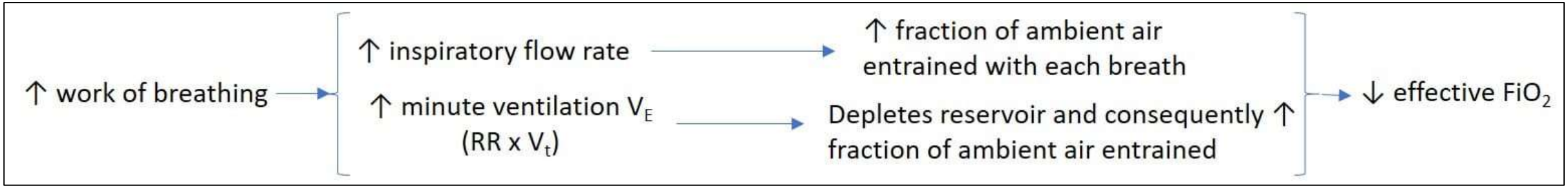
- What are your next steps?
  1. Oxygen via nasal cannula, goal O2 sat >94%
  2. Oxygen via nasal cannula, goal O2 sat >90%
  3. Oxygen via nasal cannula, goal O2 sat >88%

Goals of Oxygen Therapy- Demystifying "Happy Hypoxia"

$$\text{Oxygen Extraction Ratio} = \frac{\text{VO2 (oxygen consumption)}}{\text{DO2 (systemic oxygen delivery)}}$$

Adequacy of Oxygenation?
- *Mental status*
- *Work of breathing*
- *Lactate*
- *End-organ damage*

WHO Guidelines:
≥94% initial resuscitation
≥90% maintenance



To improve external oxygen delivery: 1.) increase flow rate, 2.) increase concentration (FiO2)

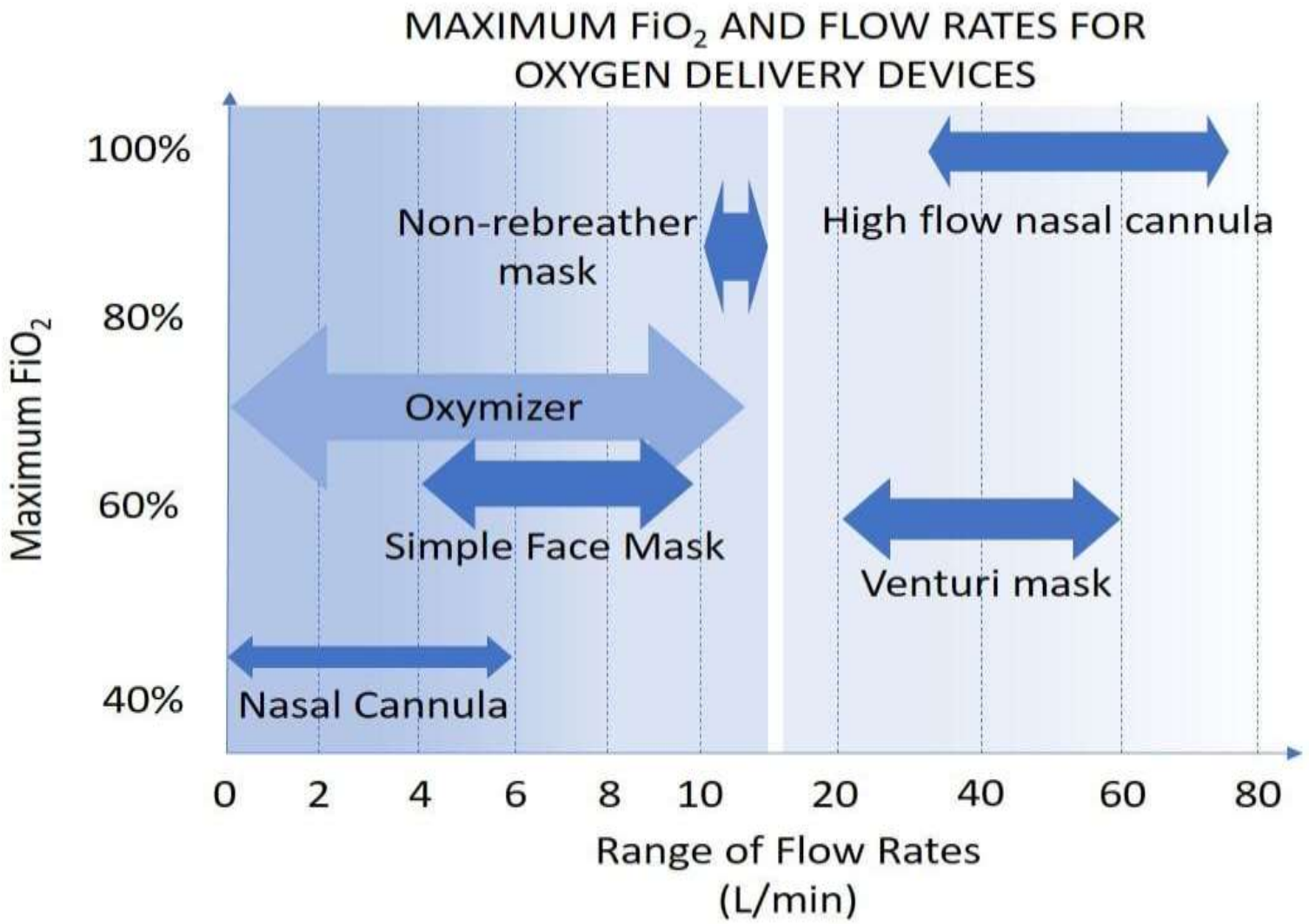
Oxygen Delivery- What are the options

Standard Oxygen

High-flow oxygen

Non-invasive ventilation

Invasive Mechanical Ventilation



Aerosolization Risk???

DEVICE	FLOW RATE (LPM)	DISPERSION DISTANCE (cm)
HHFNC	60	17
	30	13
	10	6.5
Simple Mask	15	11.2
	10	9.5
NRB	10	24.6
Venturi	6	39.7

Li et al. Eur Respir J. 2020 May; 55(5): 2000892.

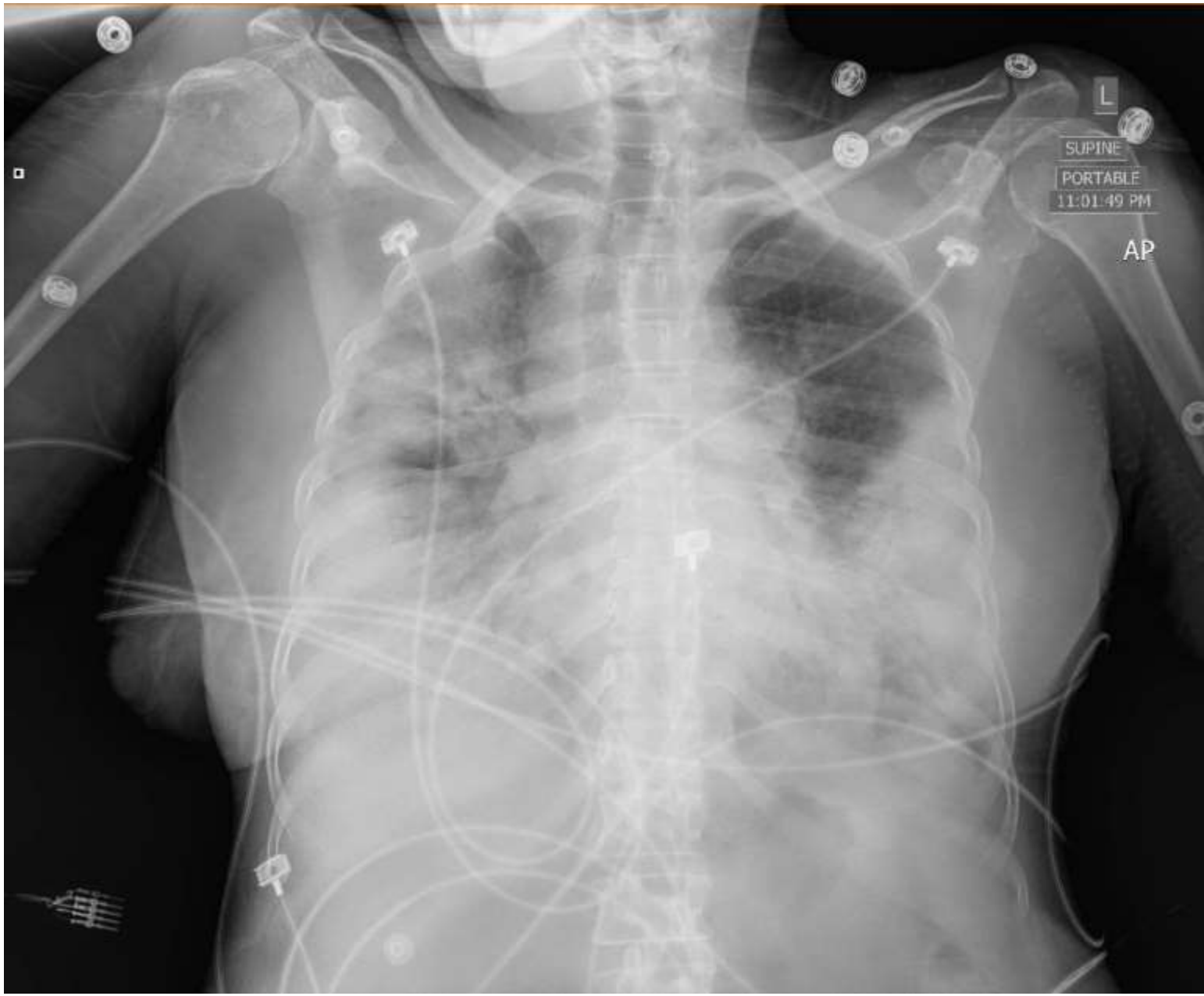
Case continued

The patient is managed with oxygen via nasal cannula.

On HD#3, due to ongoing desaturation, she is started on HHFNO with increasing oxygen requirements.

By HD#5, she is saturating 88% on HHFNO 100% FiO2 at 60LPM

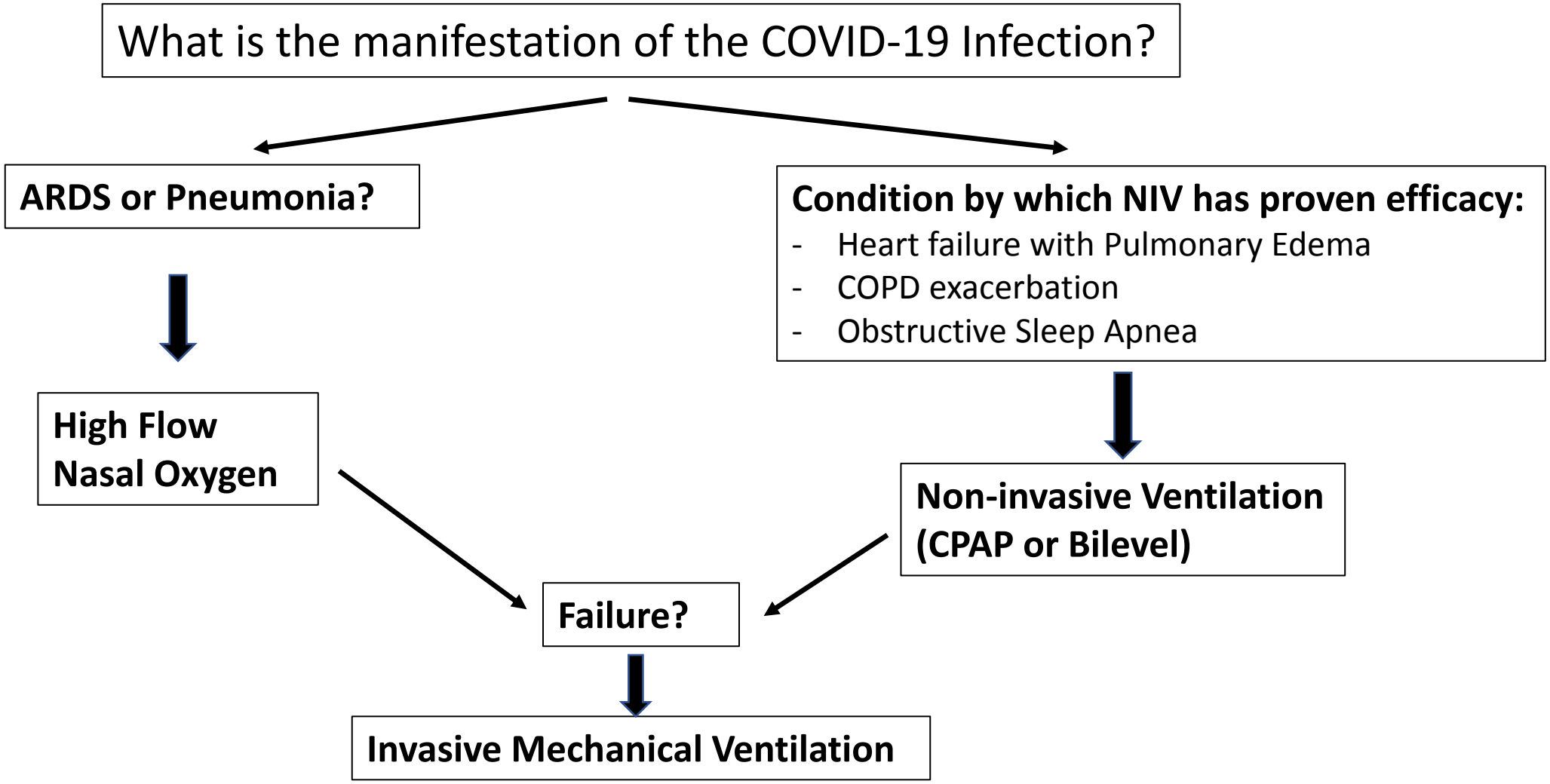
What next?



Poll #2

- What are your next steps?
  1. Proceed with intubation for invasive mechanical ventilation
  2. Trial non-invasive ventilation (CPAP or bilevel)
  3. Add non-rebreather mask to the heated high flow nasal oxygen

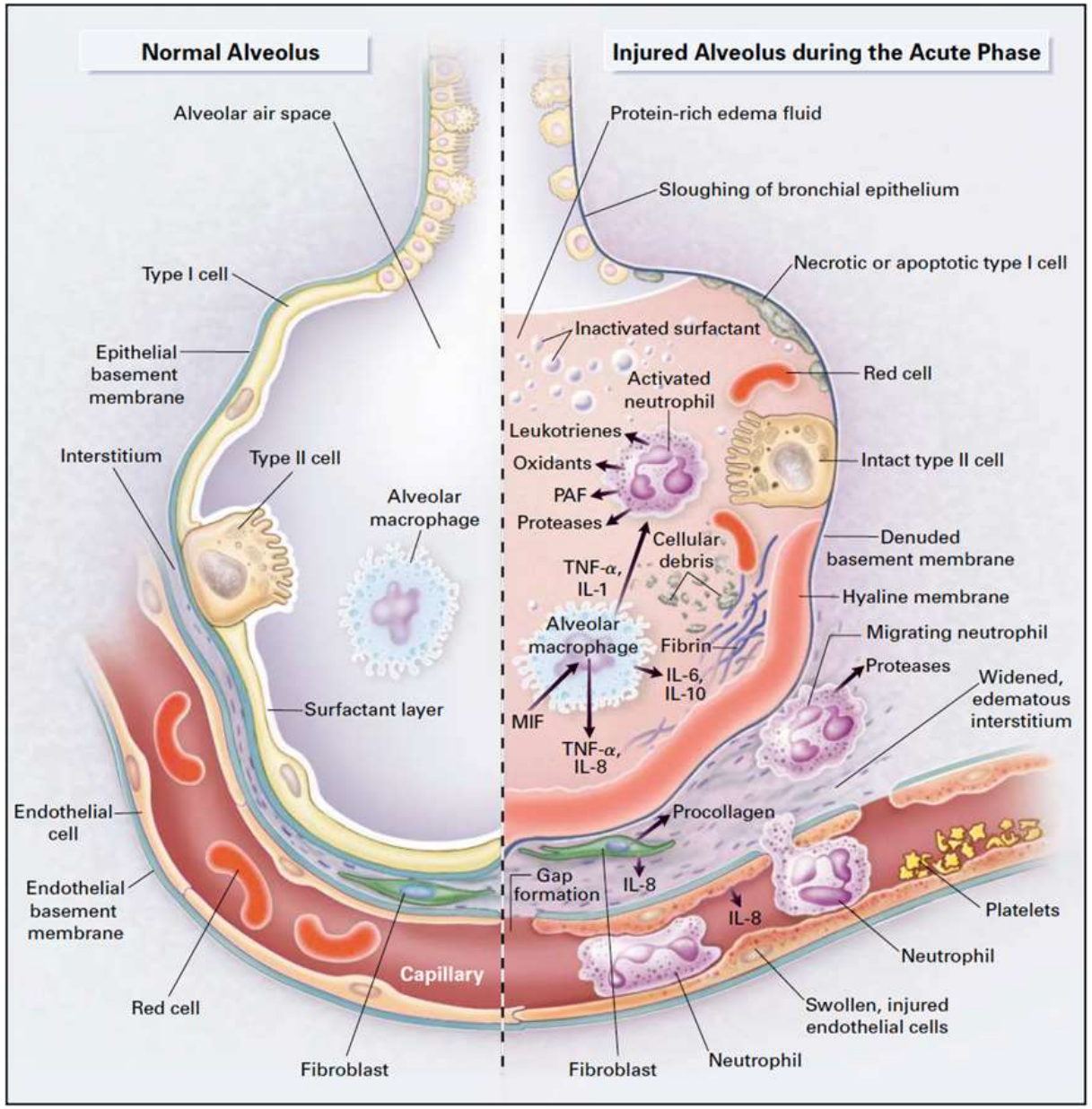
Non-invasive Ventilation versus High-flow oxygen?



COVID and Acute Respiratory Distress Syndrome

Diagnostic Criteria:

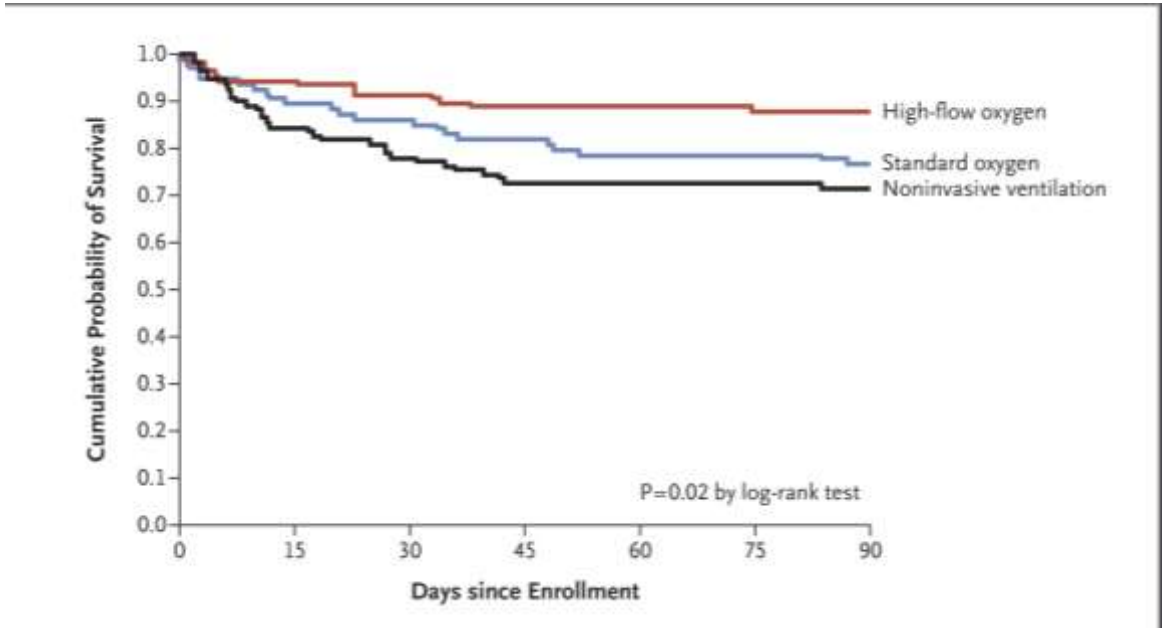
- Bilateral alveolar infiltrates
- Hypoxia
  - Mild: P/F: > 200 but ≤300
  - Moderate: P/F: > 100 but ≤200
  - Severe: P/F: ≤100
- On PEEP ≥5
- Unlikely cardiogenic



Ware et al. NEJM 2000; 342:1334

For ARDS, avoid non-invasive ventilation

High **FL**ow Nasal **O**xygen in the **R**esuscitation of patients with **A**cute **L**ung **I**njury) (NEJM 2015)



Hazard Ratio:
Standard Oxygen vs. HHFNC 1.85 (0.84-4.09)
NIV vs. HHFNC 2.55 (1.21-5.35)

ORIGINAL ARTICLE

Noninvasive Ventilation of Patients with Acute Respiratory Distress Syndrome
Insights from the LUNG SAFE Study

NIV failure occurred in:
Mild ARDS (22%)
Moderate ARDS (42%)
Severe ARDS (47%)

Hospital mortality: NIV success: 16% vs. NIV failure: 45%

ICU mortality was higher in NIV than invasively ventilated patients with P:F <150

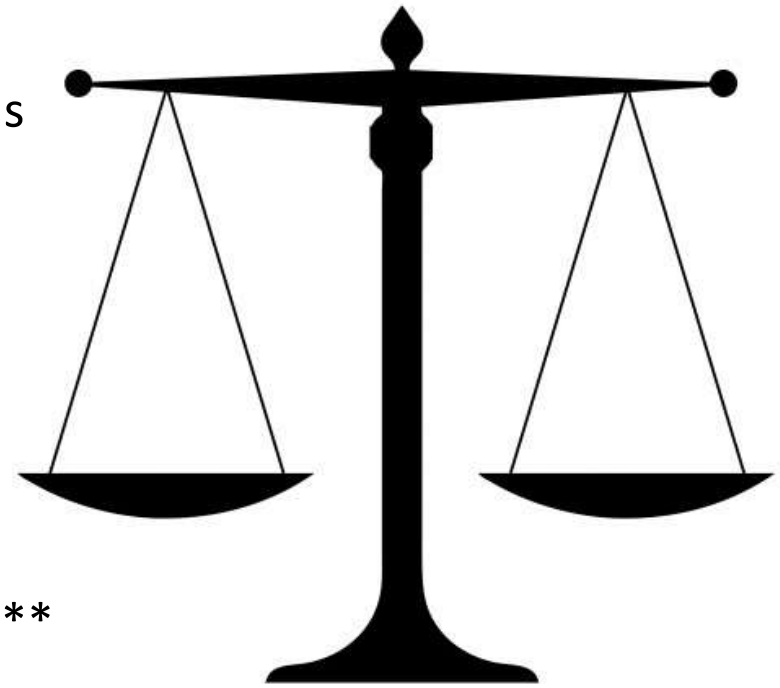
Bellani et al. AJRCCM. 2016

Timing of Intubation

Low threshold for intubation

- Rapid progression of oxygen needs
- Lack of improvement on HFNO (>50LPM, >0.6)
- Evolving hypercapnia
- Encephalopathy
- Hemodynamic instability/ multiorgan failure

- ** availability of airway support ***



Ongoing monitoring

- Minimal work of breathing (RR, accessory muscles)
- Stabilize oxygen needs with HHFNO

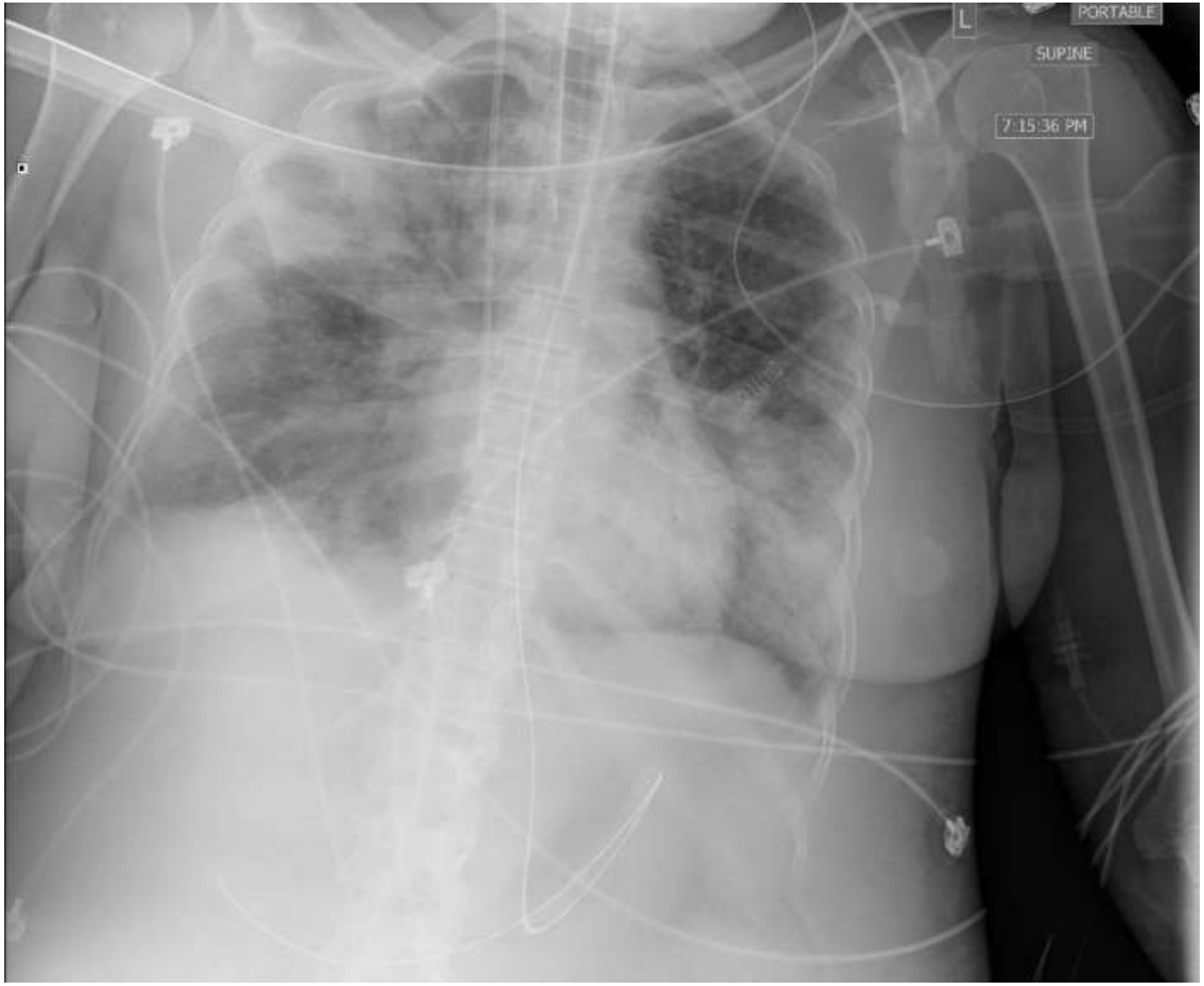
Case Cont.

The patient is intubated. She is placed on ACVC, TV 500, RR 20, PEEP 10, FiO2 60%

ABG 7.30/50/50

Plateau pressure is 34

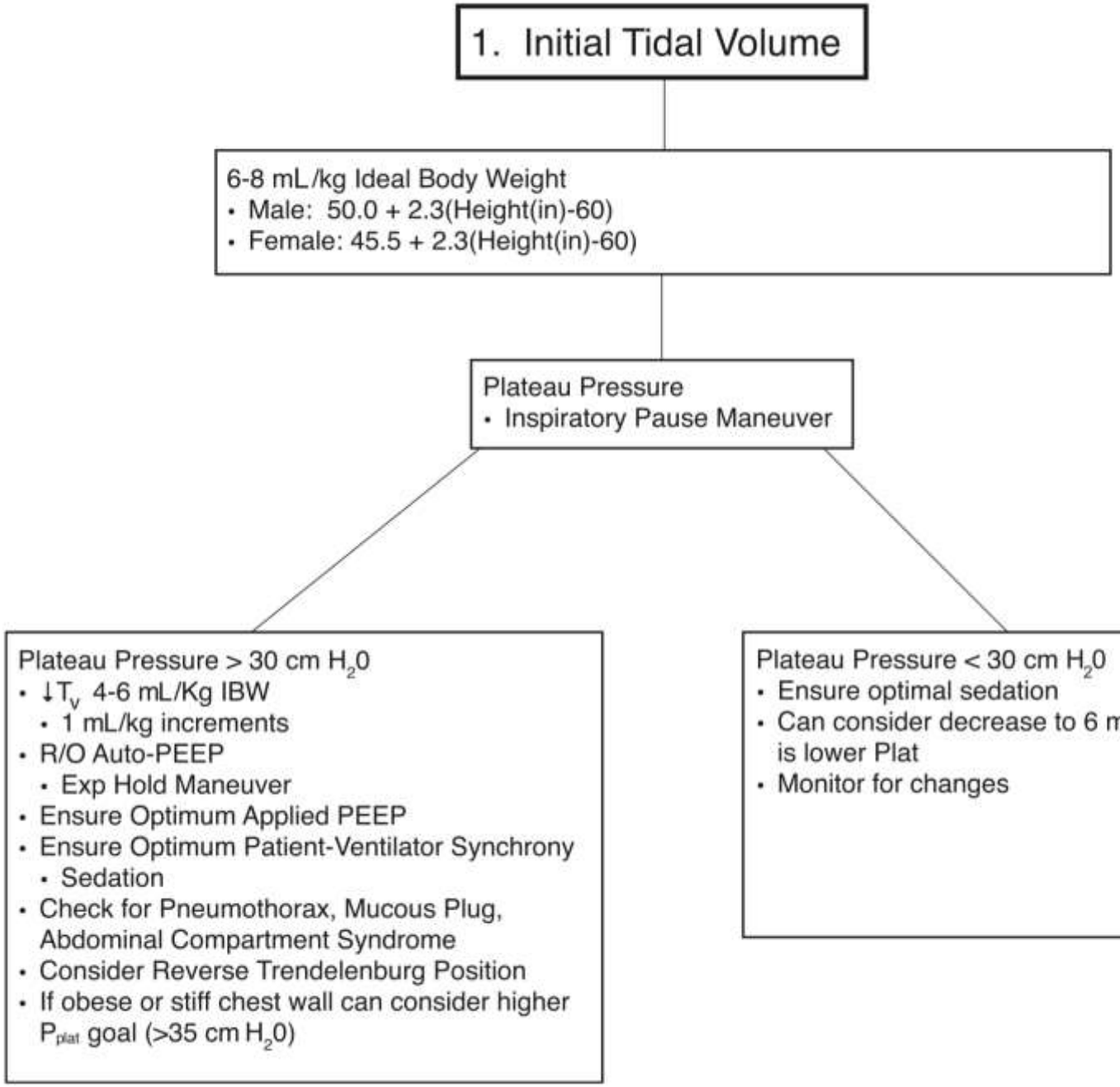
Now what?



Poll #3

Do you want to make any adjustments to the ventilator?

1. yes, reduce the tidal volume, goal is 6cc/kg predicted body weight
2. Yes, increase the oxygen
3. Yes, increase the PEEP
4. No changes
5. All of the above



Ventilator Waveform from Santanilla JI, Daniel B, Yeow ME. Mechanical ventilation. Emerg Med Clin N Am 2008; 26:849–62.

LUNG PROTECTIVE VENTILATION GOALS:

PaO2 55-80

Plateau Pressure <30 cmH2O

Tidal Volume 6ml/kg predicted body weight

pH>7.15

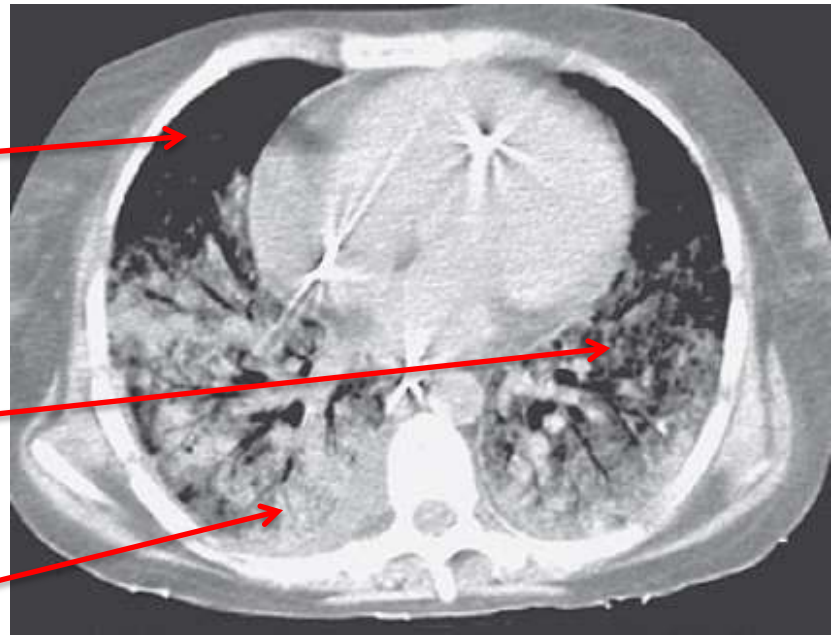
FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Why does Low Tidal Volume Ventilation reduce mortality?

ARDS affects the lung in a heterogeneous fashion

- Normal alveoli
- Injured alveoli can potentially participate in gas exchange, susceptible to damage from opening and closing
- Damaged alveoli filled with fluid, do not participate in gas exchange



3 TYPES OF LUNG INJURY:

- Volutrauma
- Barotrauma
- atelectotrauma

Low tidal volumes prevent over distention of normal alveoli and PEEP maintains alveolar recruitment to prevent atelectotrauma (opening/closing)

Case Cont.

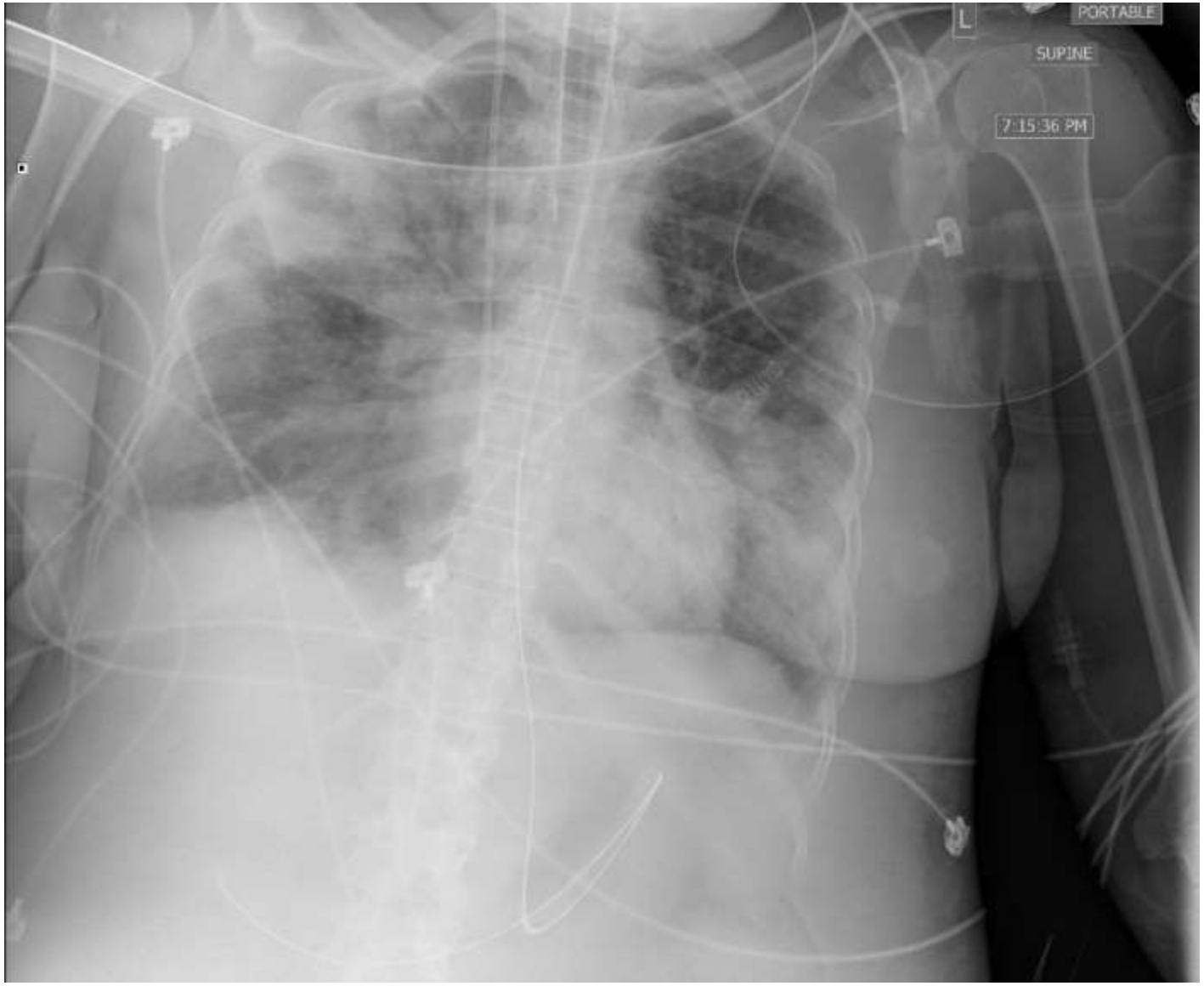
The patient is 5’ tall. The vent settings are changed to:

TV 270ml, RR 32, PEEP 12, FiO2 70%

Pplat 29

ABG 7.20/60/65

Anything else you want to do?



Poll #4

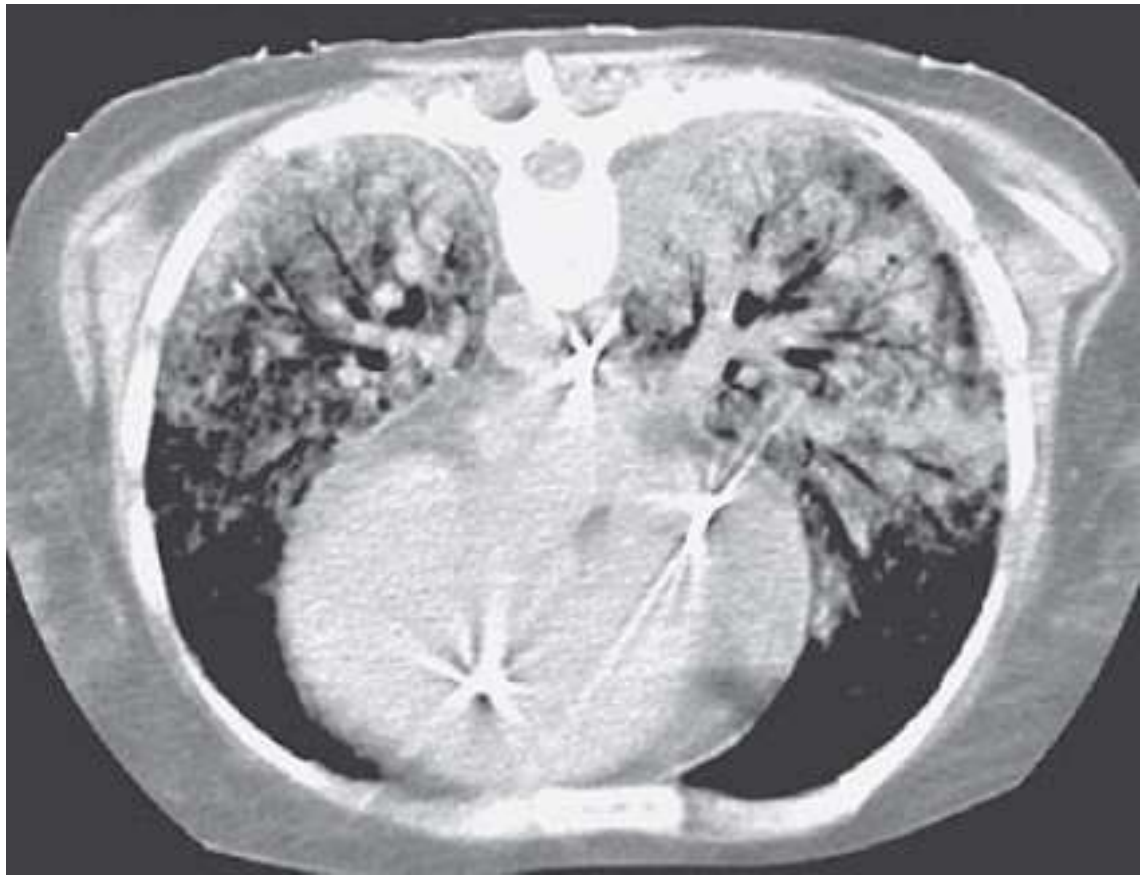
Anything else you want to do?

1. Prone positioning
2. Paralysis
3. Increase the PEEP
4. ECMO center referral

Physiologic Benefits of Prone Positioning

- Improves V/Q matching
  - Weight of heart is off posterior lung regions→ less alveolar collapse but dorsal lung perfusion is maintained

- Improves compliance of chest wall which improves distribution of tidal volume and PEEP



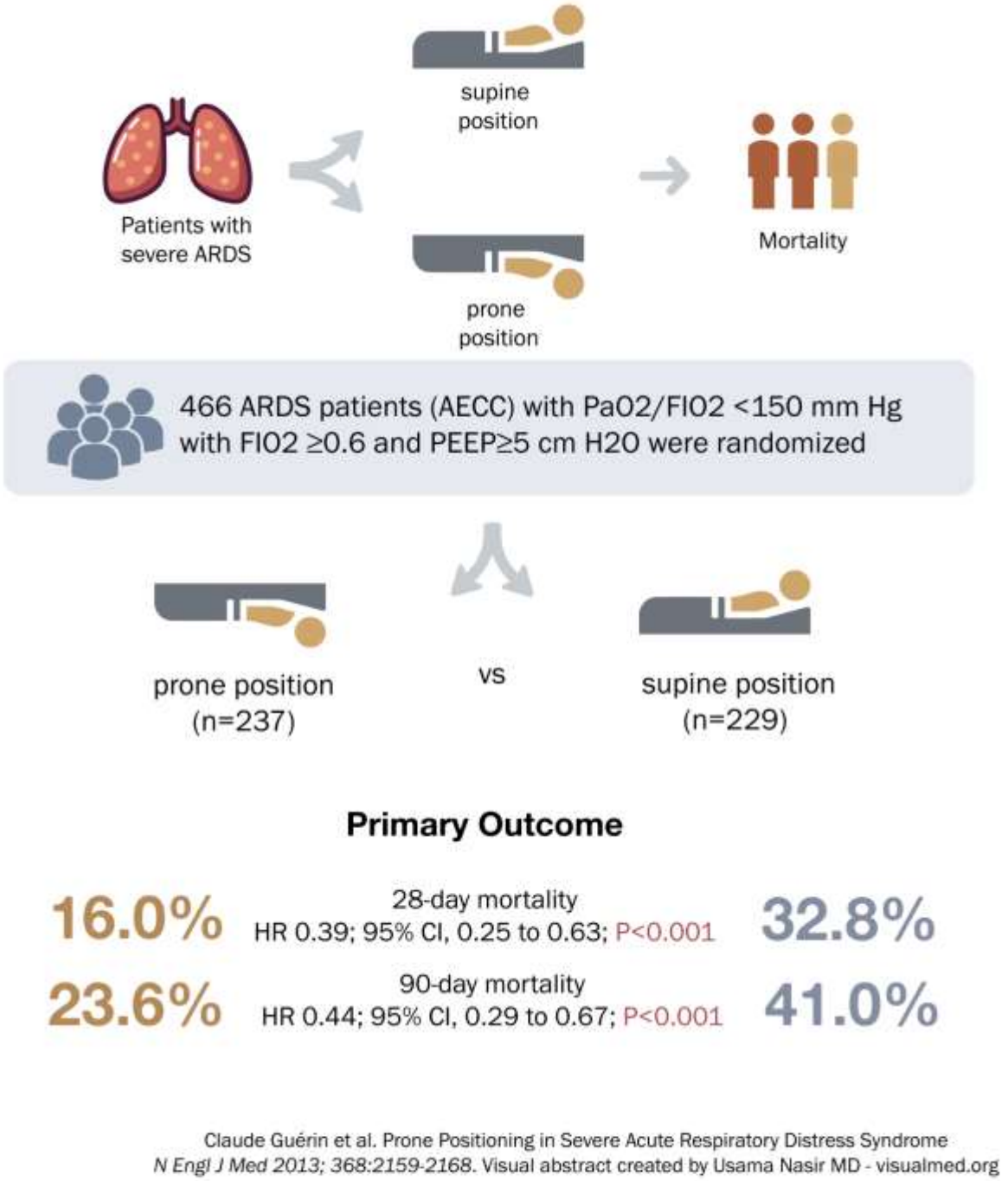
PROSEVA

- Prone for 16hrs/session

- Once P:F>150 on PEEP ≥ 10 and FiO2 ≥ 60%, maintained in supine position

NEJM Prone Positioning Video

https://www.youtube.com/watch?v=E_6jT9R7WJs



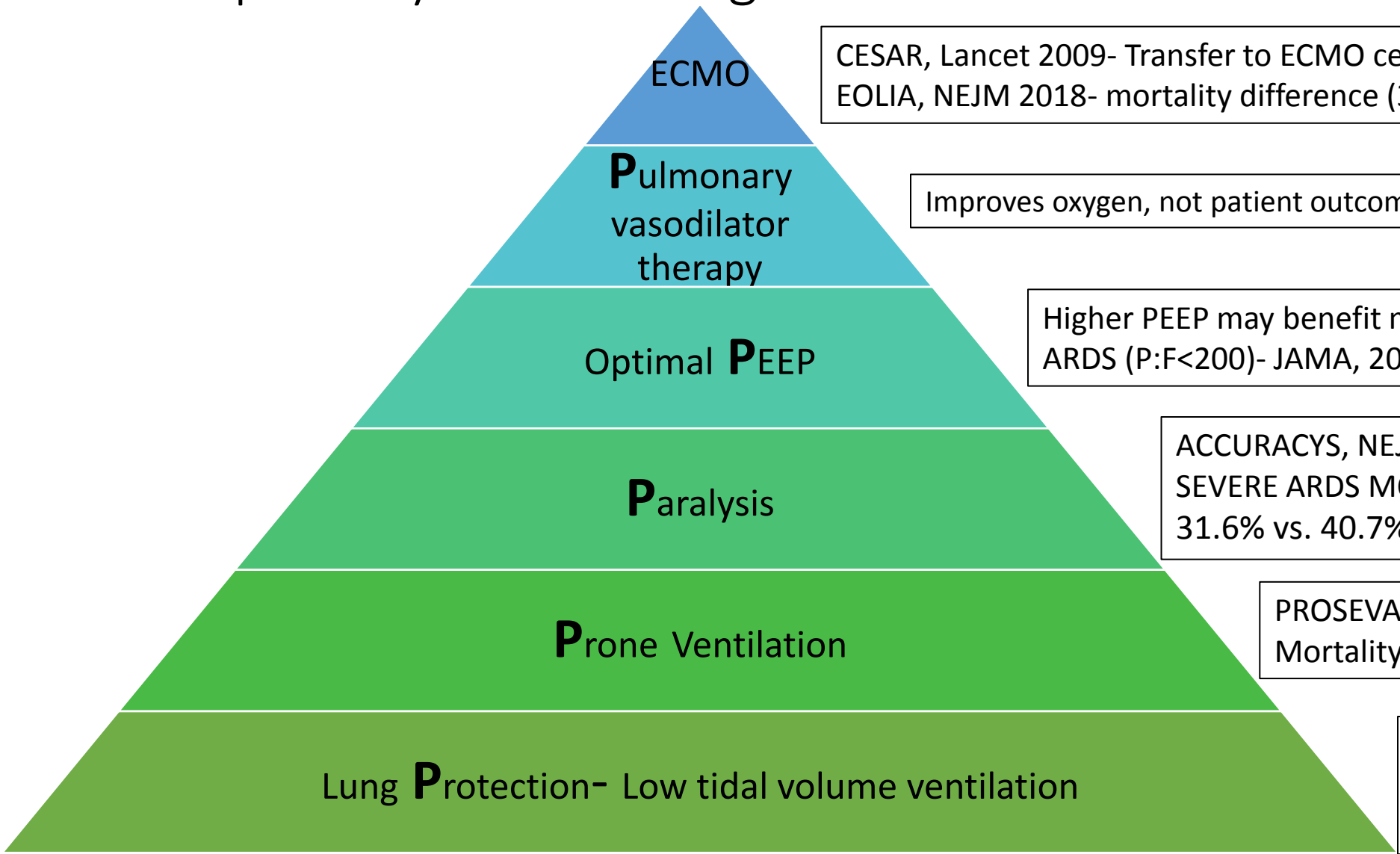
What about self- proning before patients require intubation?

FEASIBLE AND SAFE

IMPROVES OXYGENATION

Based on observational cohorts (lack of controls, short-follow up and small sizes of studies are limitations)

Management for ARDS due to COVID-19- Applying best principles of Respiratory Care Management



CESAR, Lancet 2009- Transfer to ECMO center improves mortality
EOLIA, NEJM 2018- mortality difference (35% with ECMO vs 46%, p=.09)

Improves oxygen, not patient outcomes

Higher PEEP may benefit mod/severe ARDS (P:F<200)- JAMA, 2010

ACCURACYS, NEJM 2010- SEVERE ARDS MORTALITY 31.6% vs. 40.7%; P=0.04

ROSE, NEJM 2019- MOD/SEVERE ARDS- no Δ

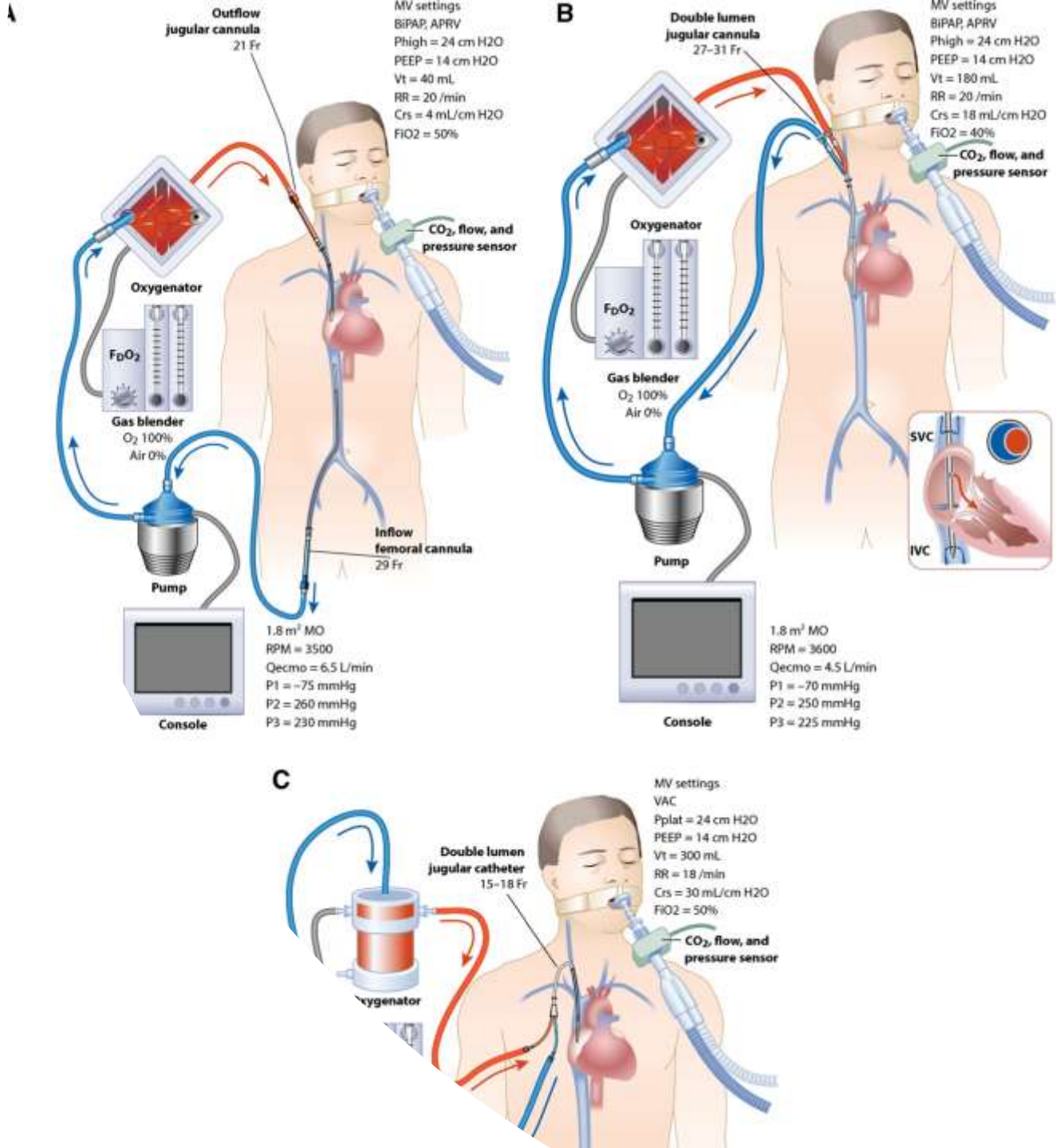
PROSEVA, NEJM 2013- Prone positioning
Mortality 23% versus 41%

ARMA, NEJM 2000
TV 6cc/kg vs 12cc/kg.
Mortality 31 vs 40%

When to Consider ECMO

Severe Hypoxemic Respiratory Failure

- **Consider**- P:F<150, FiO2>90%, Murray Score 2-3- **50% mortality risk**
- **Indicated**- P:F<100, FiO2 >90%, Murray Score 3-4, **80% mortality risk**



Murray Lung Injury Score- Mortality Risk

Parameter/ Score	0	1	2	3	4
P/F	≥300	225-299	175-224	100-174	<100
CXR	normal	1 point per quadrant infiltrated			
PEEP	≥5	6-8	9-11	12-14	≥15

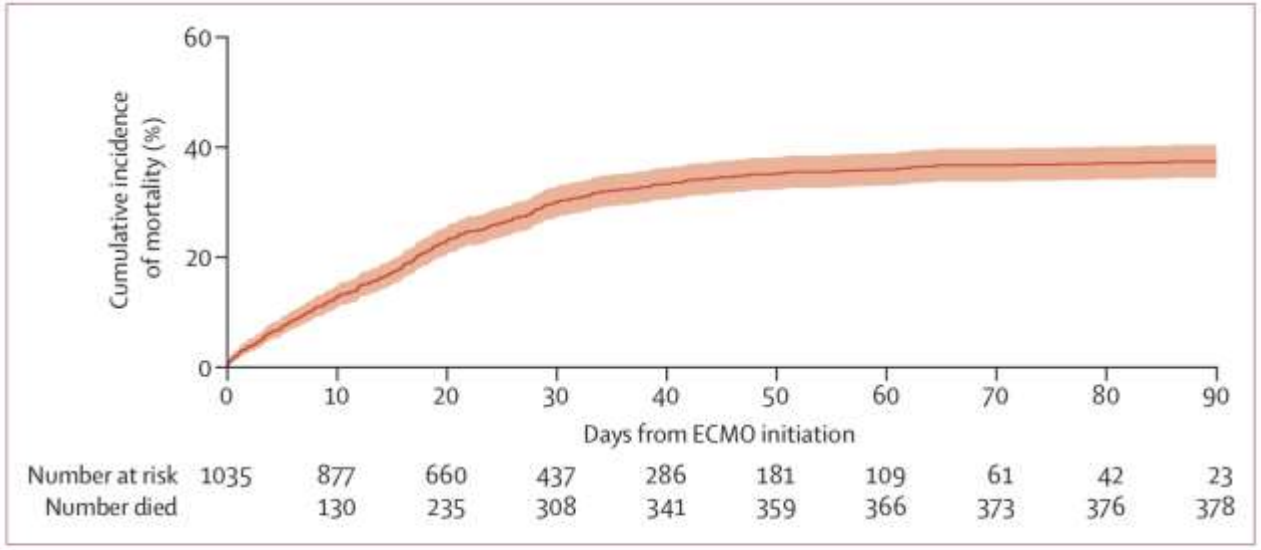


***Figure 2*: Cumulative incidence of mortality from time of ECMO initiation**
ECMO=extracorporeal membrane oxygenation. The solid line represents the estimated cumulative incidence of mortality and the shaded area represents the 95% CI.

RESP Score- Survival Possibility

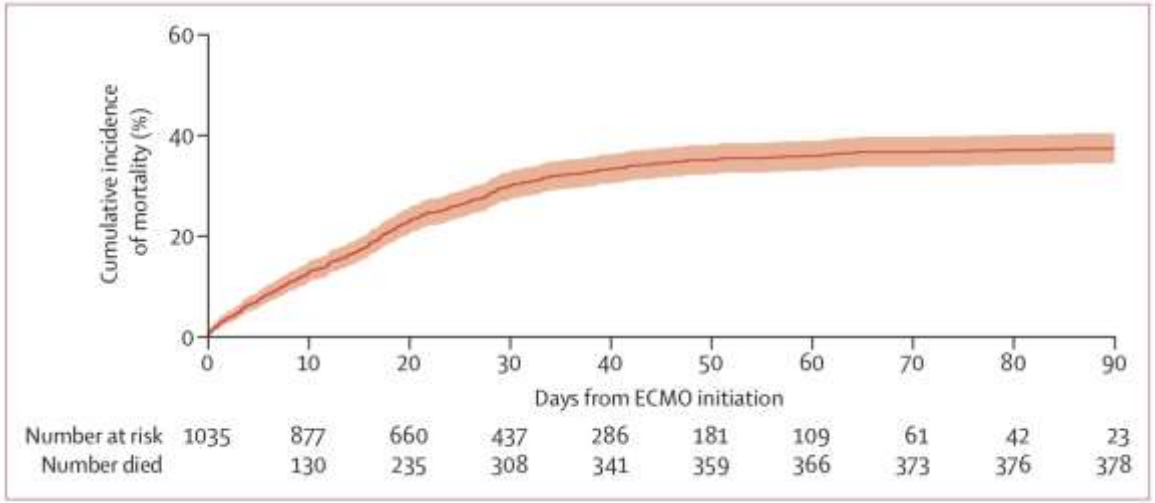
Parameter	Score
Age, yr	
18 to 49	0
50 to 59	−2
⩾60	−3
Immunocompromised status*	−2
Mechanical ventilation prior to initiation of ECMO	
<48 h	3
48 h to 7 d	1
>7 d	0
Acute respiratory diagnosis group (select only one)	
Viral pneumonia	3
Bacterial pneumonia	3
Asthma	11
Trauma and burn	3
Aspiration pneumonitis	5
Other acute respiratory diagnoses	1
Nonrespiratory and chronic respiratory diagnoses	0
Central nervous system dysfunction†	−7
Acute associated (nonpulmonary) infection‡	−3
Neuromuscular blockade agents before ECMO	1
Nitric oxide use before ECMO	−1
Bicarbonate infusion before ECMO	−2
Cardiac arrest before ECMO	−2
Pa_{CO_2}, mm Hg	
<75	0
⩾75	−1
Peak inspiratory pressure, cm H_2O	
<42	0
⩾42	−1
Total score	−22 to 15

Hospital Survival by Risk Class		
Total RESP Score	**Risk Class**	**Survival**
⩾6	I	92%
3 to 5	II	76%
−1 to 2	III	57%
−5 to −2	IV	33%
⩽−6	V	18%

Estimated 90-day mortality with ECMO for COVID is 37.4% based on ELSO registry

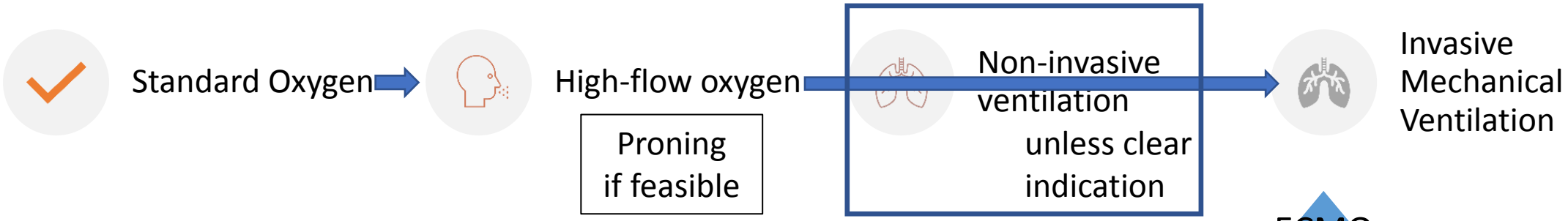
	Full cohort (n=1035)	ARDS cohort* (n=779)
Age (years)	49 (41–57)	50 (42–57)
BMI (kg/m²)†	31 (27–37)	32 (28–37)

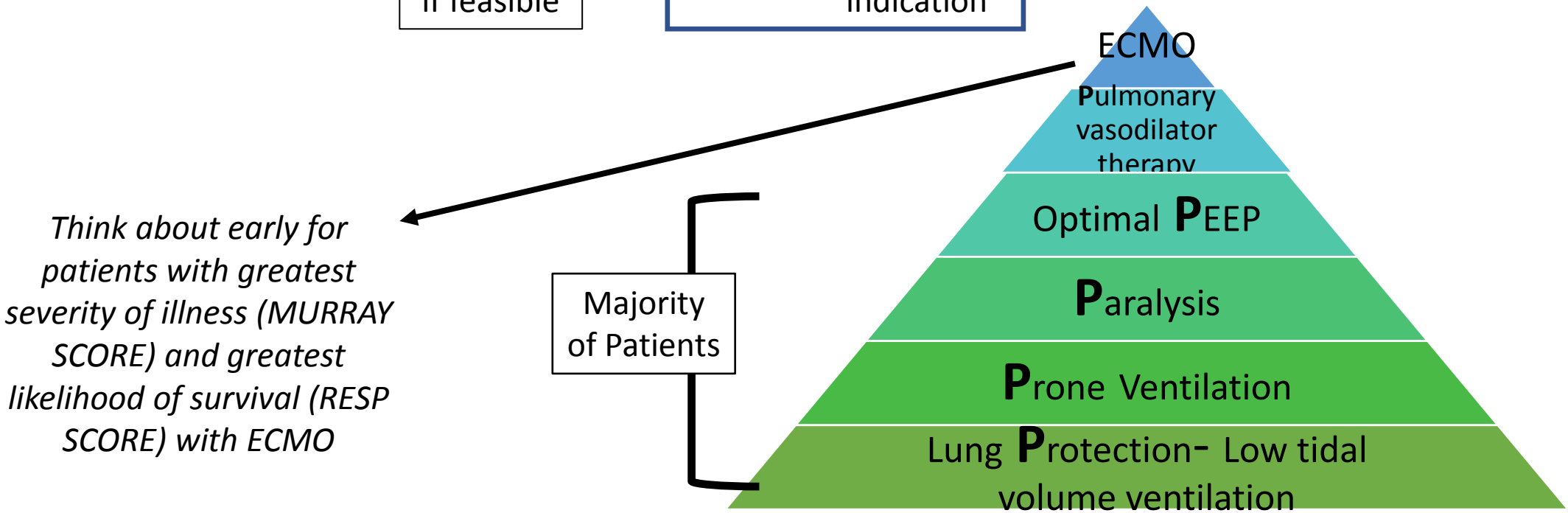
Pre-ECMO comorbidities		
No comorbidity	311 (30%)	243 (31%)
Cancer	11 (1%)	10 (1%)
Immunocompromised	24 (2%)	21 (3%)
Diabetes	245 (24%)	187 (24%)
Pre-existing cardiac disease	24 (2%)	13 (2%)
Pre-existing respiratory disease	29 (3%)	21 (3%)
Pre-existing renal insufficiency	21 (2%)	14 (2%)
Asthma	110 (11%)	91 (12%)
Pregnancy	22 (2%)	13 (2%)
Obesity (BMI >30 kg/m²)	487 (47%)	362 (47%)



Extracorporeal membrane oxygenation support in COVID-19: an international study of the Extracorporeal Life Support Organization registry. Lancet. Oct 10, 2020

Summary- Respiratory Management for the COVID patient





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