Use of Driving Pressure and Transpulmonary Pressure for Morbidly Obese and ARDS Patients!

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Lecture Objectives

- Define and describe the terms "driving pressure" and "transpulmonary pressure“
- Discuss how driving and transpulmonary pressures are affected in patients with morbid obesity and ARDS
- Discuss how driving and transpulmonary pressures can be utilized to assist in the care of patients with morbid obesity and ARDS

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Road Map

Background

ARDS

- Driving Pressure
- Esophageal Balloon / Transpulmonary Pressure

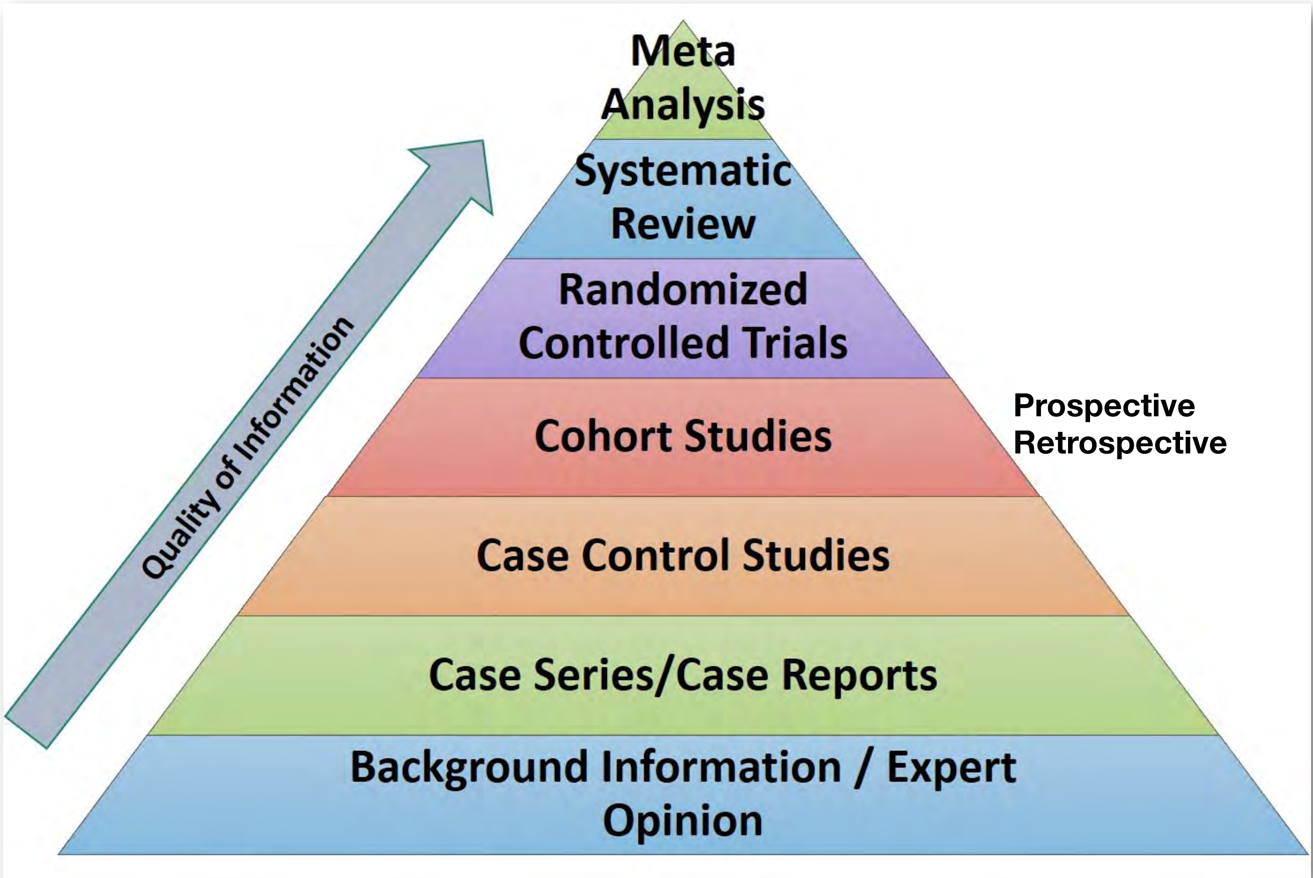
Obesity

- Driving Pressure
- Esophageal Balloon / Transpulmonary Pressure

Quick Demonstration

Summary / Key Take Home Points

Background


Meta
Analysis
Systematic
Review
Randomized
Controlled Trials
Cohort Studies
Case Control Studies
Case Series/Case Reports
Background Information / Expert
Opinion
Quality of Information
Prospective
Retrospective

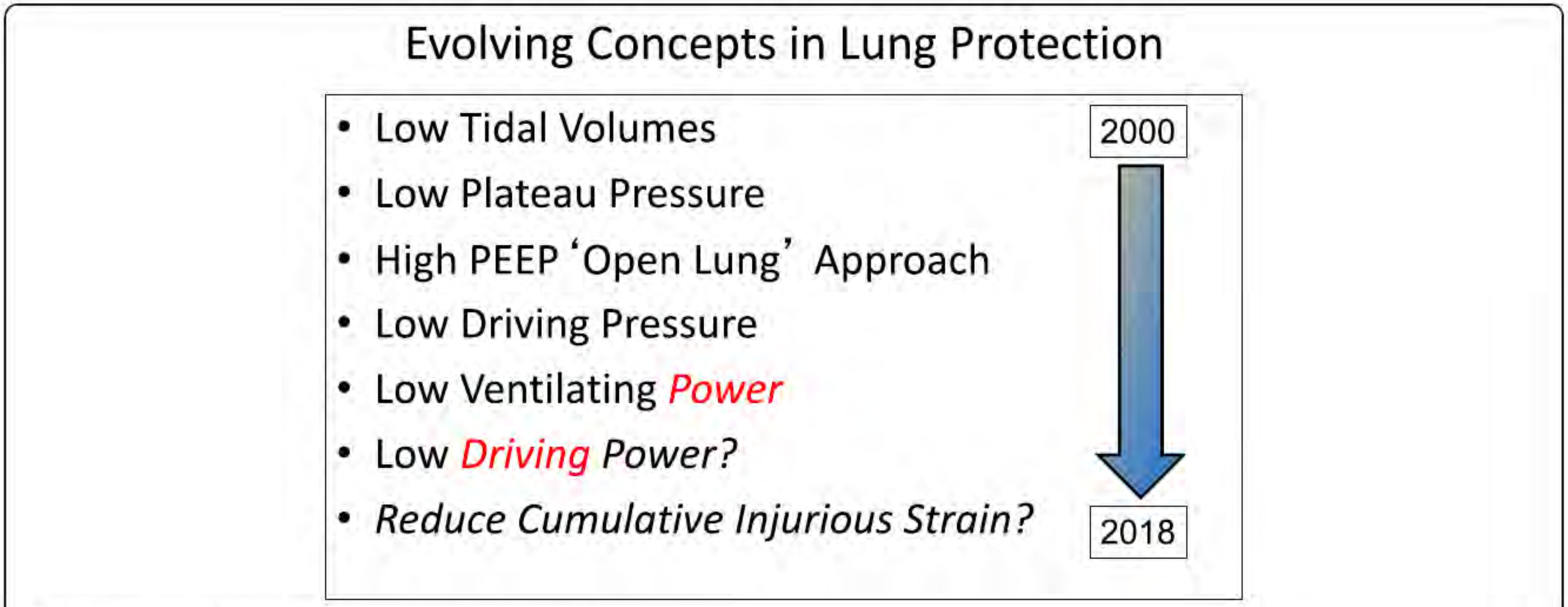


Fig. 1 Timeline of advancing knowledge regarding VILI causation

Stress – force per unit area

Strain – change in length vs original length

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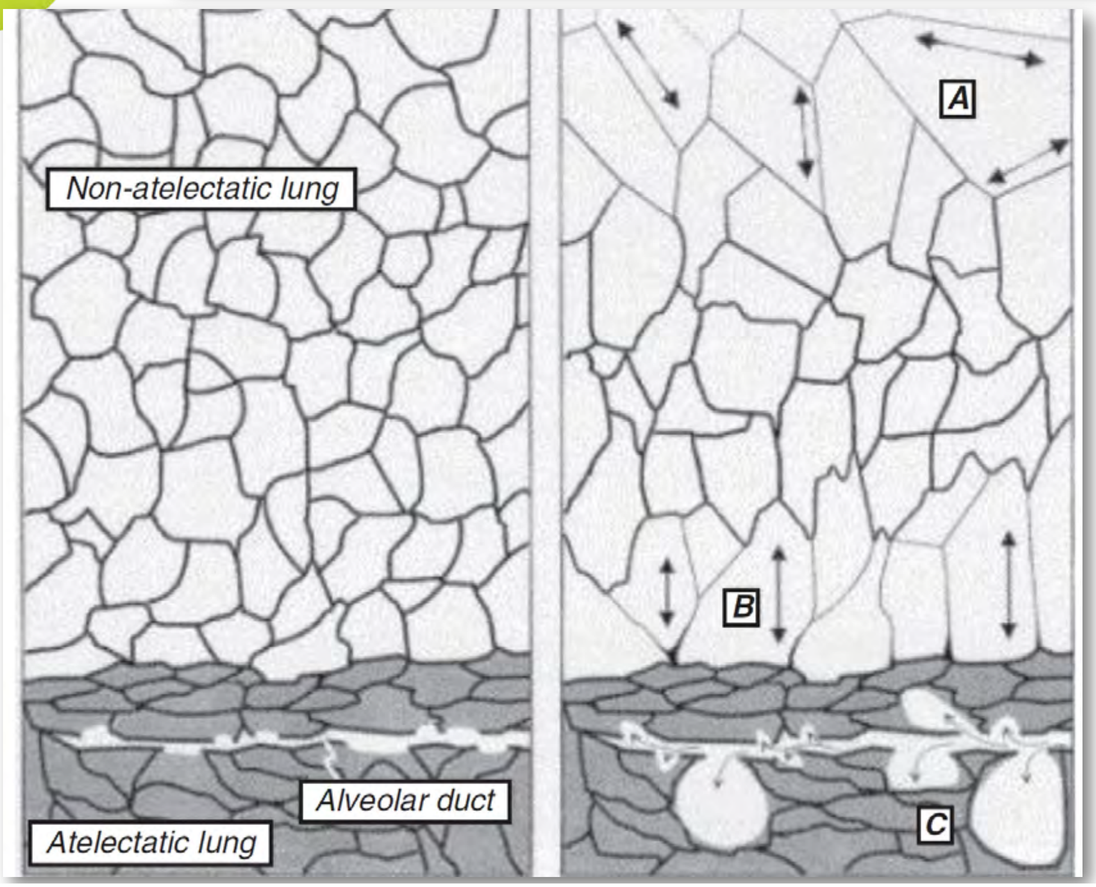
Fifty Years of Research in ARDS

Setting Positive End-Expiratory Pressure in Acute Respiratory Distress Syndrome

Am J Respir Crit Care Med Vol 195, Iss 11, pp 1429–1438, Jun 1, 2017

Sarina K. Sahetya[1], Ewan C. Goligher[2,3], and Roy G. Brower[1]



"No single method of PEEP titration has been shown to improve clinical outcomes compared with other approaches of setting PEEP"

Figure 1. Mechanisms of ventilator-induced lung injury. *Left panel* shows lung regions at end-expiration. *Right panel* shows the same lung regions at end-inspiration. (*A*) Patent alveoli are overdistended or stretched to injurious volumes. (*B*) Some tissue may be injured by excessive stress at the margins between atelectatic and aerated alveoli. (*C*) Small bronchioles and alveoli may be injured by mechanical forces involved in repeated opening and closing. Reprinted with permission from Reference 80.

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Meta-analysis

Cochrane Library

Cochrane Database of Systematic Reviews

High versus low positive end-expiratory pressure (PEEP) levels for mechanically ventilated adult patients with acute lung injury and acute respiratory distress syndrome (Review)

Santa Cruz R, Rojas JI, Nervi R, Heredia R, Ciapponi A

Meta-analysis revealed <u>no statistically significant differences</u> between the two groups nor was any statistically significant difference seen in the risk of barotrauma - Oxygenation was improved in the high-PEEP group

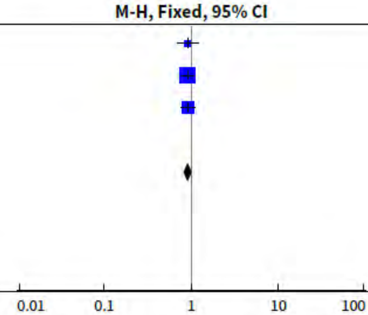
Analysis 1.1. Comparison 1 High versus low levels of PEEP, Outcome 1 Mortality before hospital discharge.

Study or subgroup	High PEEP n/N	Low PEEP n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Brower 2004	69/276	75/273		17.82%	0.91[0.69,1.21]
Meade 2008	173/475	205/508		46.82%	0.9[0.77,1.06]
Mercat 2008	136/385	149/382		35.35%	0.91[0.75,1.09]
Total (95% CI)	**1136**	**1163**		**100%**	**0.9[0.81,1.01]**

Total events: 378 (High PEEP), 429 (Low PEEP)

Heterogeneity: $Tau^2=0$; $Chi^2=0$, df=2(P=1); $I^2=0\%$

Test for overall effect: Z=1.76(P=0.08)



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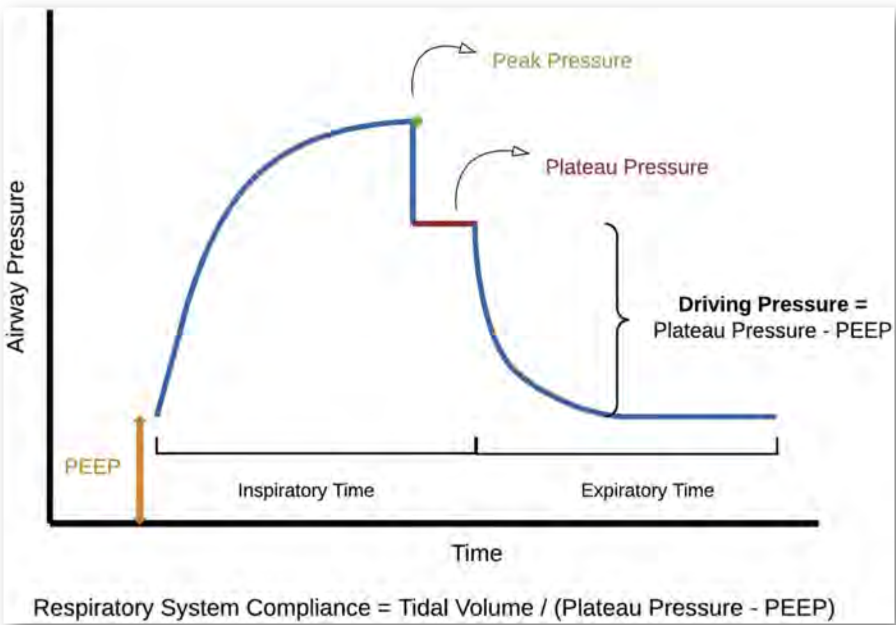
Defining Terms: Driving Pressure

1. **Plat (cmH2O) – PEEP (cmH2O), generally want < 15**
2. Inspiratory Pressure with zero flow (cmH2O) – PEEP (cmH2O)
3. Tidal Volume (ml) ÷ Respiratory System Compliance (ml / cmH2O)



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Defining Terms: Transpulmonary Pressure

Transpulmonary pressure (TPP) = airway pressure - pleural pressure
Generally, want (+) end expiratory and < 10 to 15 end inspiratory

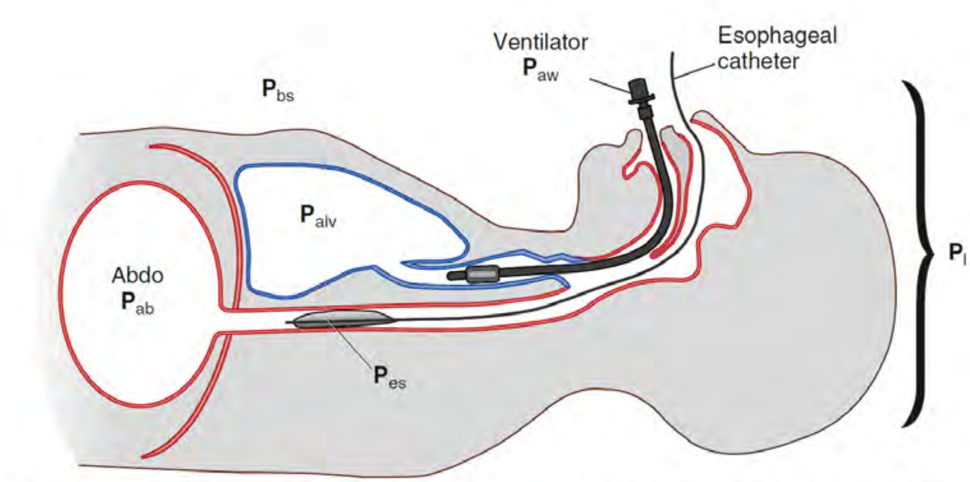
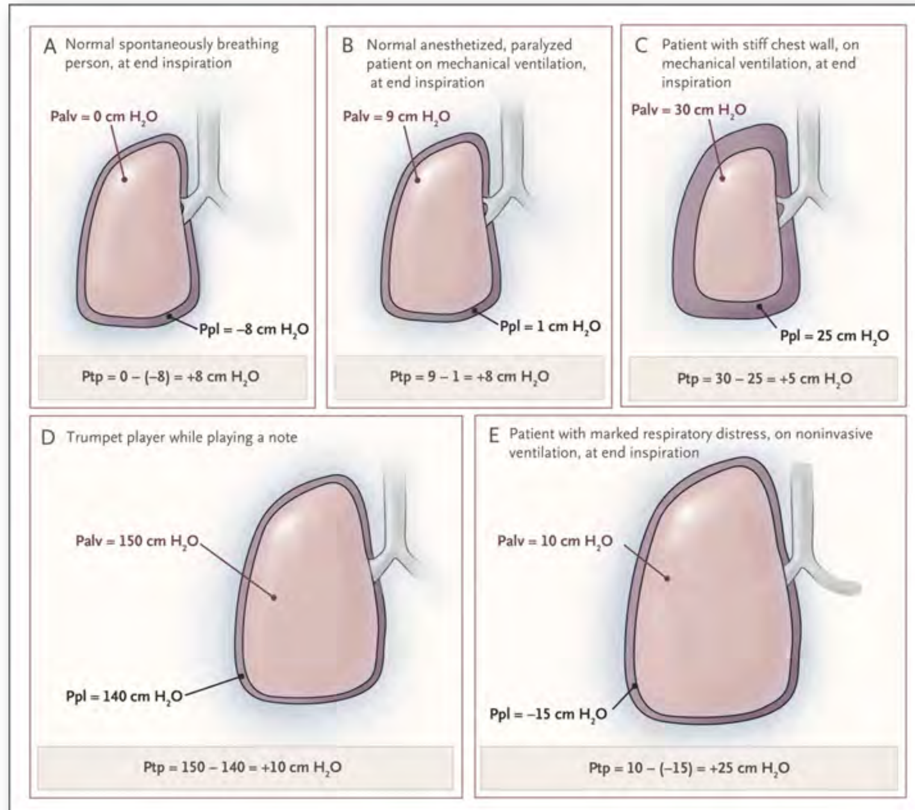


Figure 2. The clinician can directly measure the pressure from the ventilator at the airway opening (airway pressure [Paw]) and reference it to body surface pressure (Pbs). Esophageal pressure (Pes) may also be directly measured with a balloon manometer. Transpulmonary pressure (P_L) = Paw − Pes. The alveolar pressure (Palv) can be measured from Paw during end-inspiratory (plateau) and end-expiratory (total positive end-expiratory pressure) holds. Abdominal pressure (Pab) can be measured in the stomach or the bladder. Abdo = abdomen. Artwork by Vicky Earle.



TPP & Driving Pressure: ARDS

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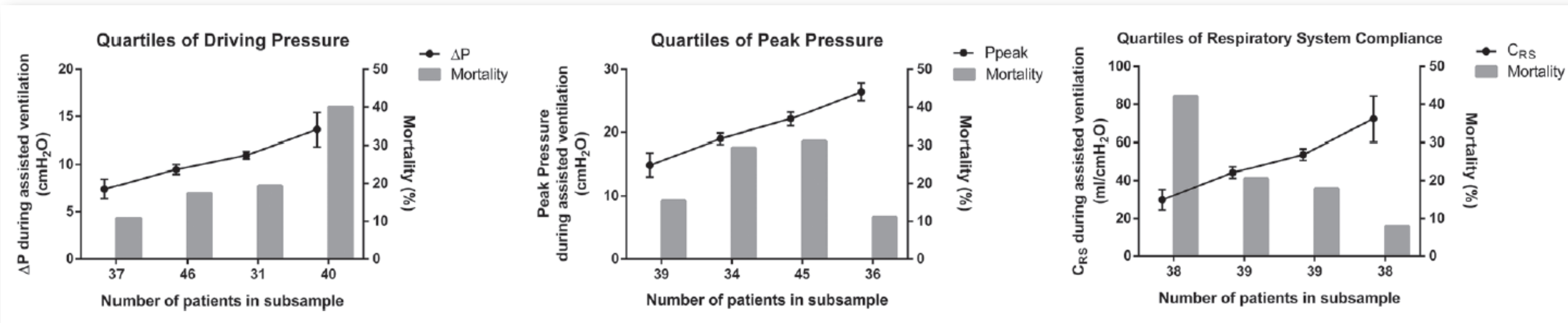
Retrospective

ANESTHESIOLOGY

Driving Pressure Is Associated with Outcome during Assisted Ventilation in Acute Respiratory Distress Syndrome

Anesthesiology 2019; 131:594–604
retrospective study of 154 ARDS patients



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Retrospective

Dynamic Airway Driving Pressure and Outcomes in Children With Acute Hypoxemic Respiratory Failure

Respir Care 2021;66(3):403–409, n=161 pediatrics 1 to 15 years old

Abdul Rauf, Anil Sachdev, Shekhar T Venkataraman, and Veronique Dinand

Table 2. Comparison of Outcome Parameters in Both Driving Pressure Groups

Low DP < 15 High DP ≥ 15

Outcome	Low ΔP ($n = 47$)	High ΔP ($n = 54$)	P
ARDS, *n*	29	36	
Duration of ventilation, d			
Total	5 (4–6)	8 (6–11)	< .001
ARDS	6 (4–7)	9 (6–12)	< .001
Ventilator-free days at day 28, d			
Total	23 (20–24)	17 (0–22)	< .001
ARDS	22 (19–23)	16 (0–21)	< .001
ICU length of stay, d			
Total	6 (5–8)	12 (7–15)	< .001
ARDS	7 (6–9)	14 (7–15)	< .001
Hospital length of stay, d			
Total	11 (7–14)	18 (13–25)	< .001
ARDS	12 (8–15)	19 (13–25)	< .001
In-hospital mortality, %			
Total	17	24	.38
ARDS	18	25	.33

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Am J Respir Crit Care Med. 2021 Mar 30. doi: 10.1164/rccm.202009-3467OC. Online ahead of print.

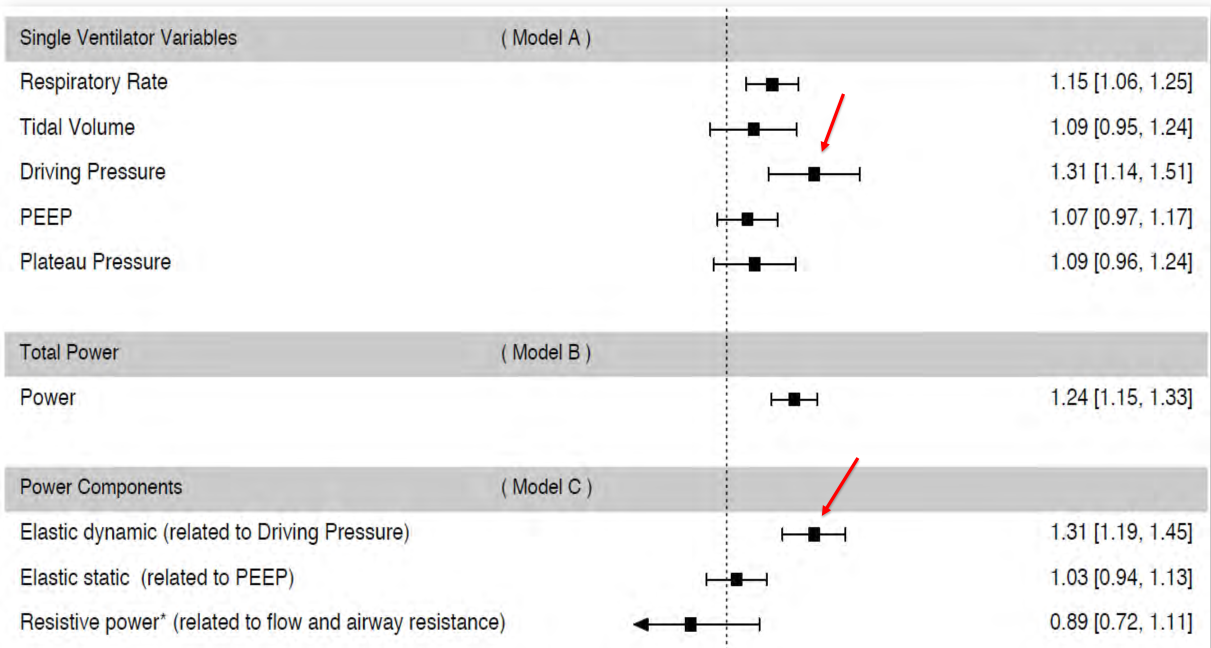
Ventilatory Variables and Mechanical Power in Patients with Acute Respiratory Distress Syndrome

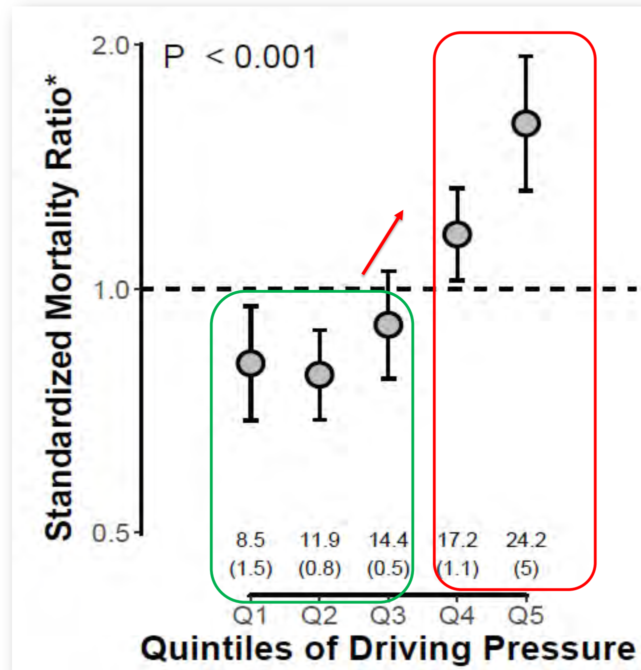
4,549 ARDS patients in a pooled database

Eduardo L V Costa [1 2], Arthur Slutsky [3 4], Laurent J Brochard [4 3], Roy Brower [5], Ary Serpa-Neto [6], Alexandre B Cavalcanti [7], Alain Mercat [8], Maureen Meade [9], Caio C A Morais [10], Ewan Goligher [11 3], Carlos R R Carvalho [12], Marcelo B P Amato [1]

Pooled data from Retrospective and Prospective RCT's

Driving Pressure and RR = significantly associated with mortality



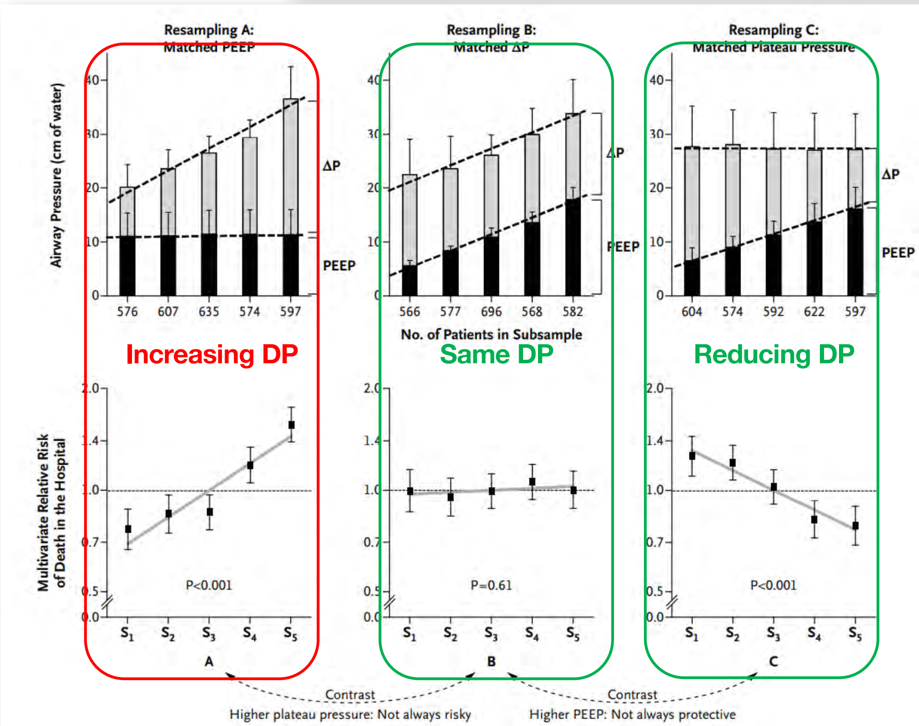


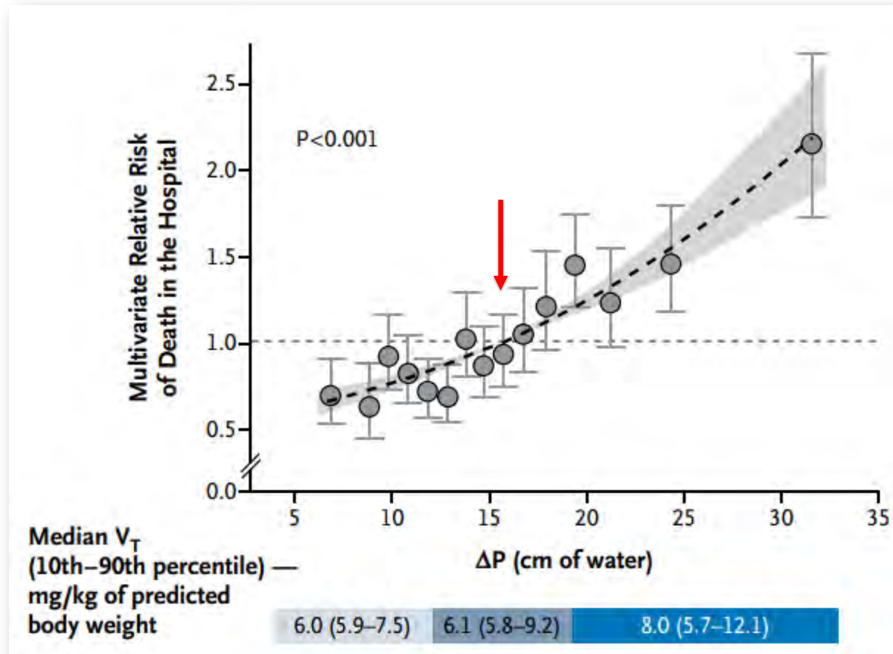
Driving Pressure and Survival in the Acute Respiratory Distress Syndrome

N Engl J Med 2015;372:747-55, 3562 patients from previous studies

Marcelo B.P. Amato, M.D., Maureen O. Meade, M.D., Arthur S. Slutsky, M.D., Laurent Brochard, M.D., Eduardo L.V. Costa, M.D., David A. Schoenfeld, Ph.D.,

Pooled data from Previous RCT's





Decreasing DP with changed vent settings was associated with increased survival

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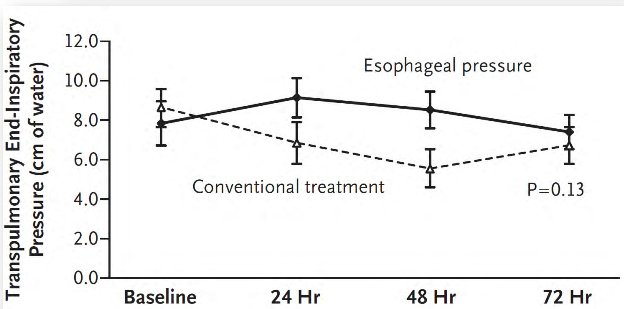
Prospective RCT

ESTABLISHED IN 1812 NOVEMBER 13, 2008 VOL. 359 NO. 20

N Engl J Med 2008;359:2095-104. n=61 "EPVent 1"

Mechanical Ventilation Guided by Esophageal Pressure in Acute Lung Injury

Daniel Talmor, M.D., M.P.H., Todd Sarge, M.D., Atul Malhotra, M.D., Carl R. O'Donnell, Sc.D., M.P.H., Ray Ritz, R.R.T., Alan Lisbon, M.D., Victor Novack, M.D., Ph.D., and Stephen H. Loring, M.D.



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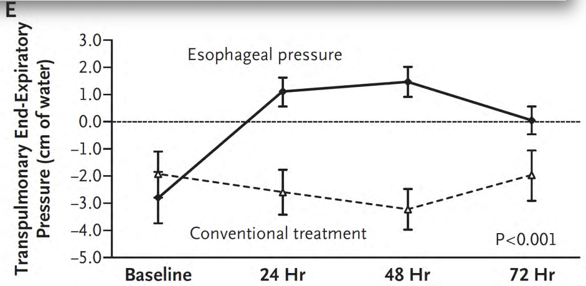

Table 4. Clinical Outcomes.*

Outcome	Esophageal-Pressure–Guided (N=30)	Conventional Treatment (N=31)	P Value
28-Day mortality — no. (%)	5 (17)	12 (39)	0.055
180-Day mortality — no. (%)	8 (27)	14 (45)	0.13
Length of ICU stay — days			0.16
Median	15.5	13.0	
Interquartile range	10.8–28.5	7.0–22.0	

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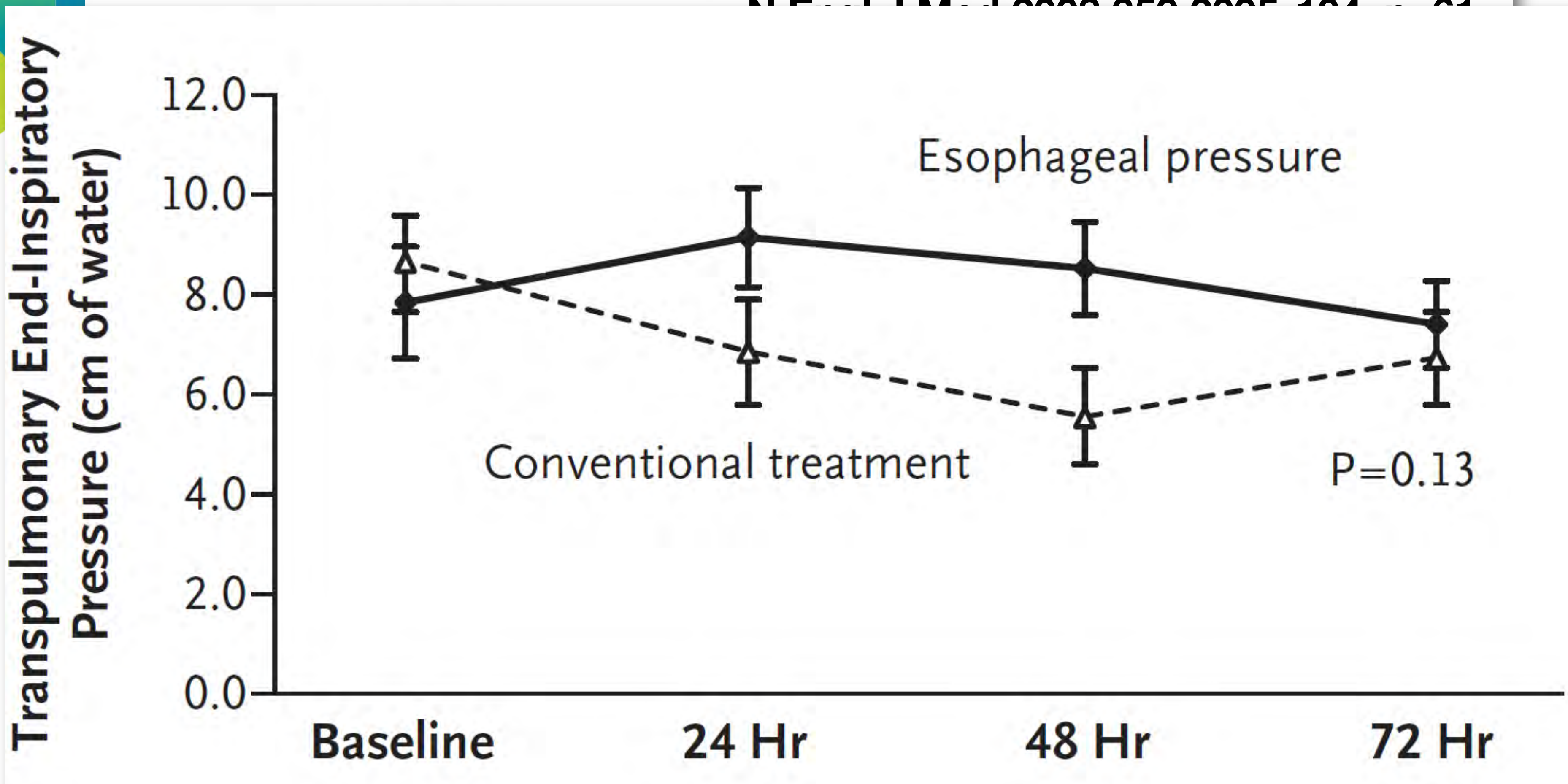

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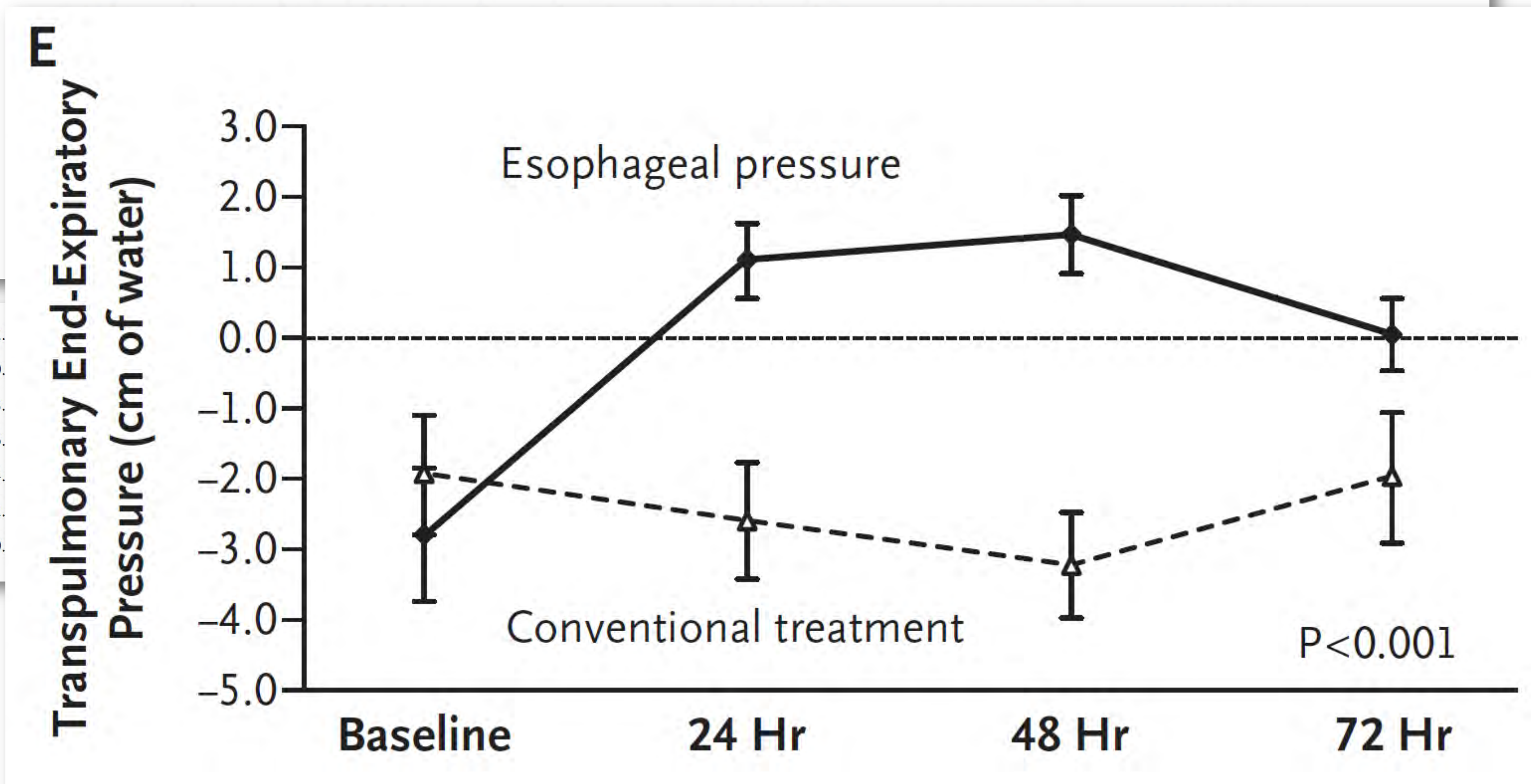
N Engl J Med 2008;359:2095-104. n=61



Value
).055
).13
).16

ESTABLISHED IN 1812 NOVEMBER 13, 2008 VOL. 359 NO. 20

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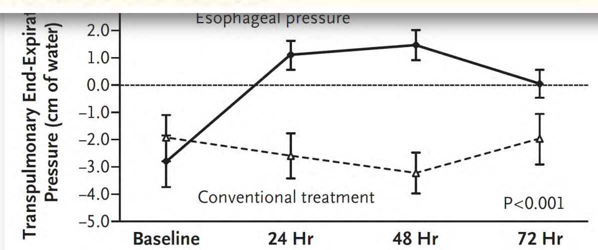


JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Titrating Positive End-Expiratory Pressure (PEEP) With an Esophageal Pressure–Guided Strategy vs an Empirical High PEEP-FIO_2 Strategy on Death and Days Free From Mechanical Ventilation Among Patients With Acute Respiratory Distress Syndrome

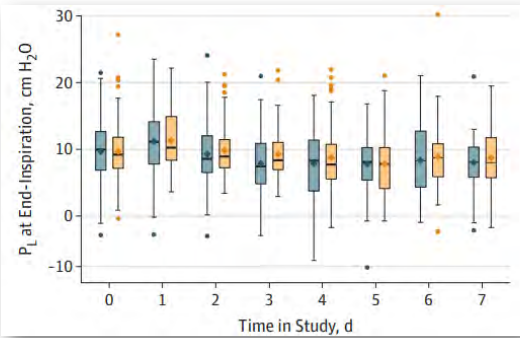
A Randomized Clinical Trial

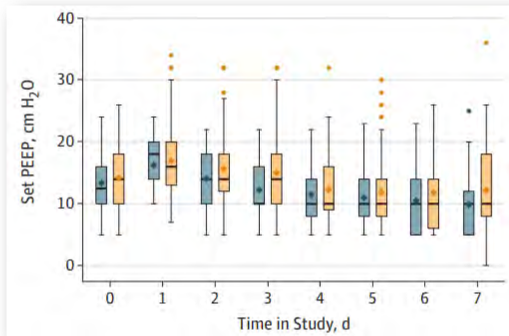
Prospective RCT

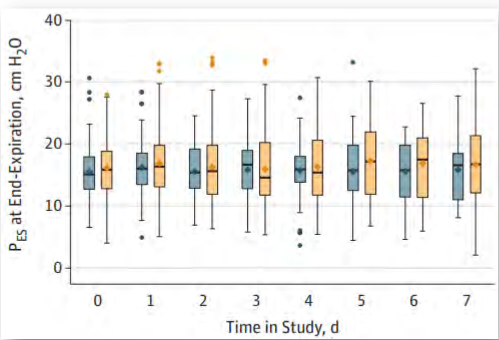
"EPVent 2"

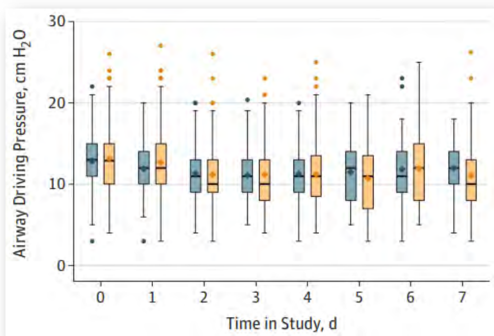
JAMA. 2019;321(9):846-857, n=200

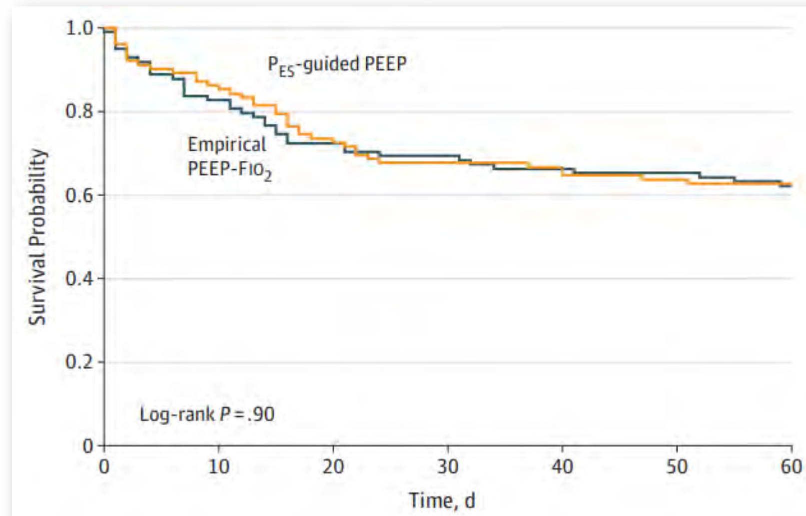
Balloon vs high PEEP table







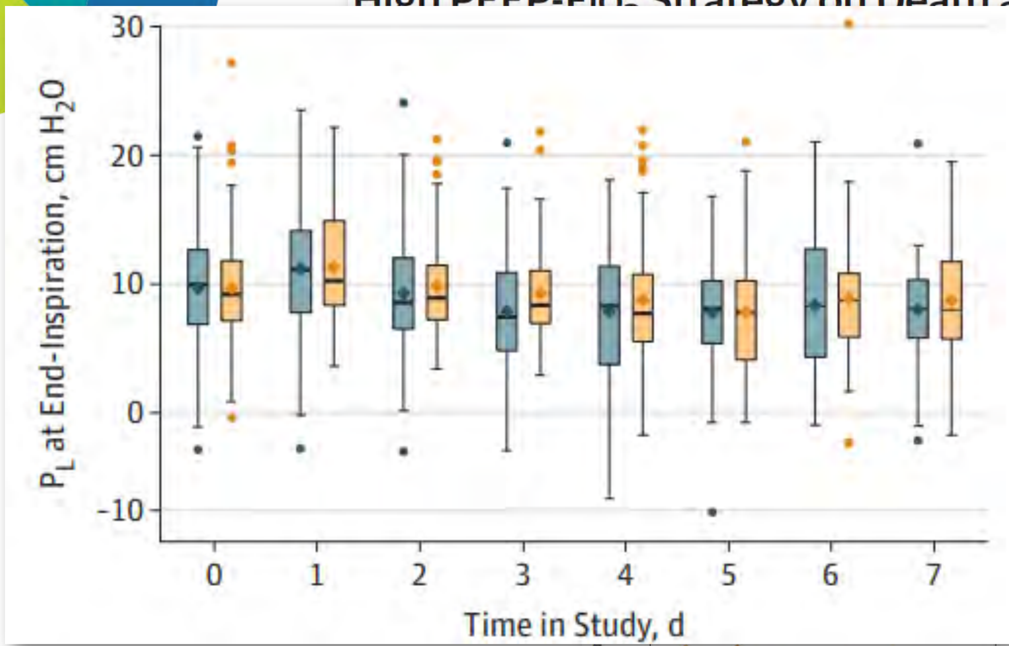


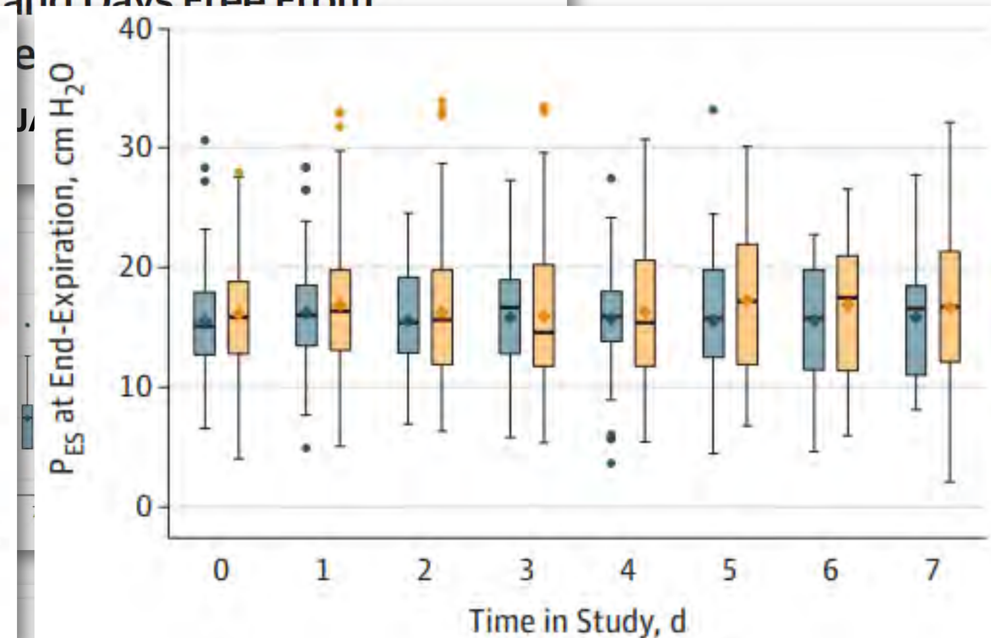


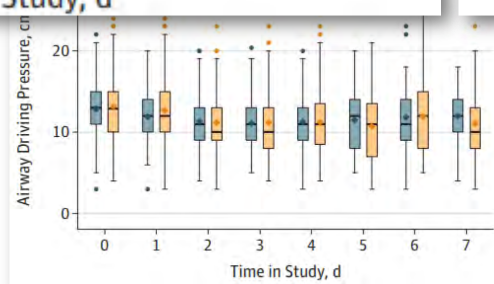
"Among patients with moderate to severe ARDS, PES-guided PEEP, compared with empirical high PEEP-FIO2, resulted in no significant difference in death and days free from mechanical ventilation. These findings do not support PES-guided PEEP titration in ARDS"

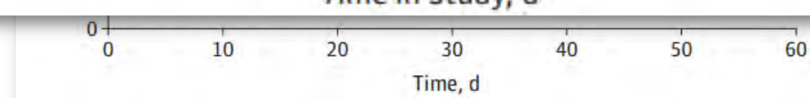
JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Titrating Positive End-Expiratory Pressure (PEEP) With an Esophageal Pressure–Guided Strategy vs an Empirical High PEEP-FIO_2 Strategy on Death and Days Free From









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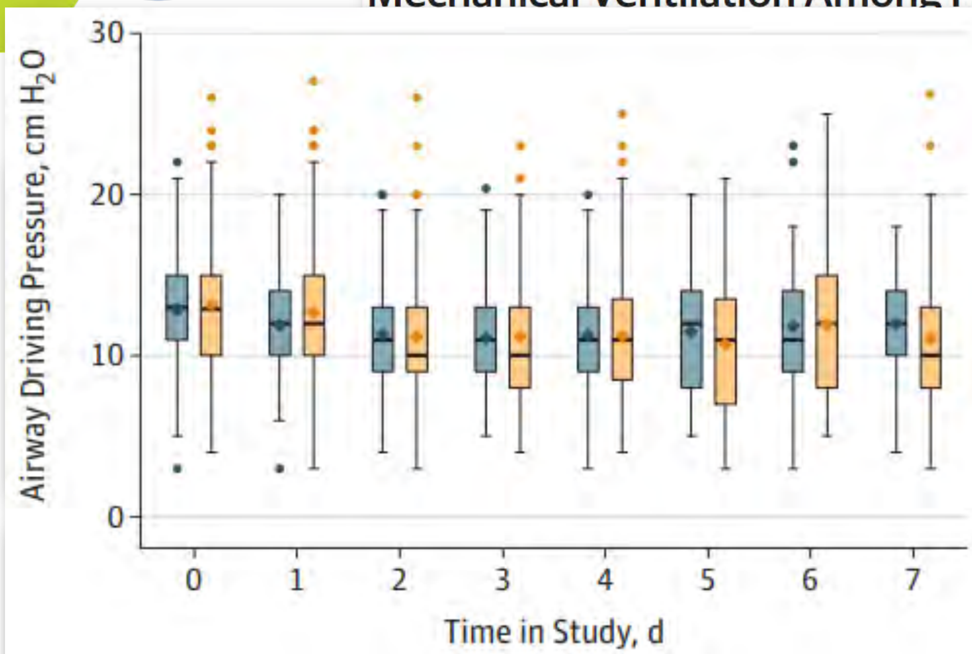
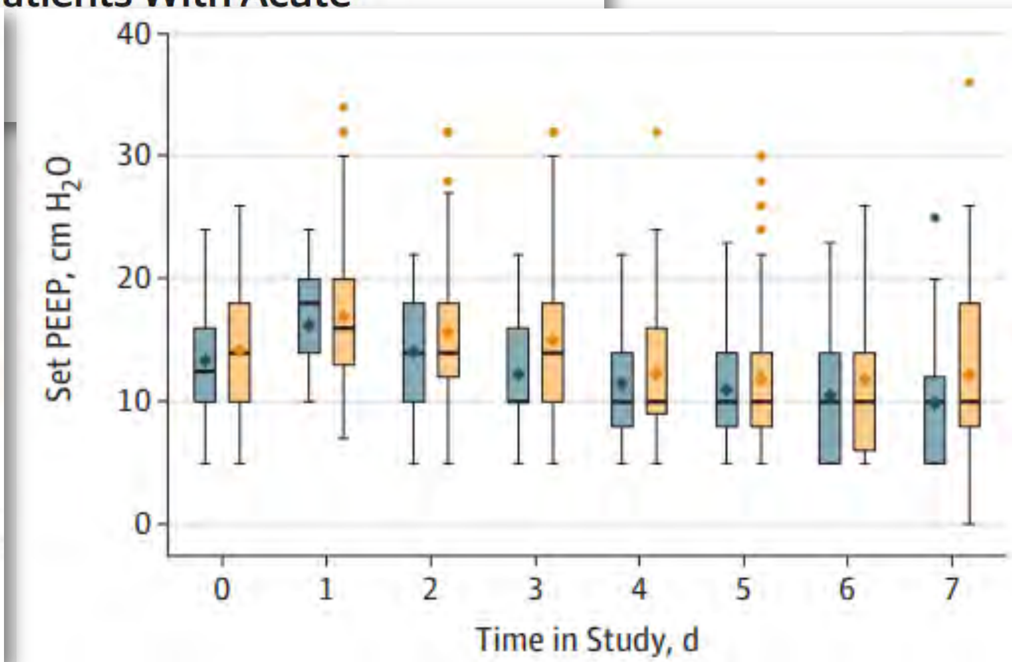
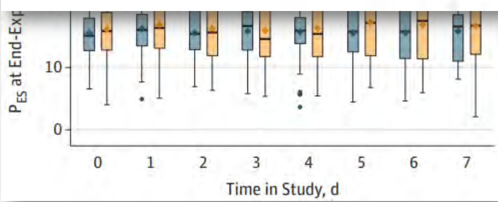
JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Titrating Positive End-Expiratory Pressure (PEEP) With an Esophageal Pressure–Guided Strategy vs an Empirical High PEEP-FIO_2 Strategy on Death and Days Free From Mechanical Ventilation Among Patients With Acute







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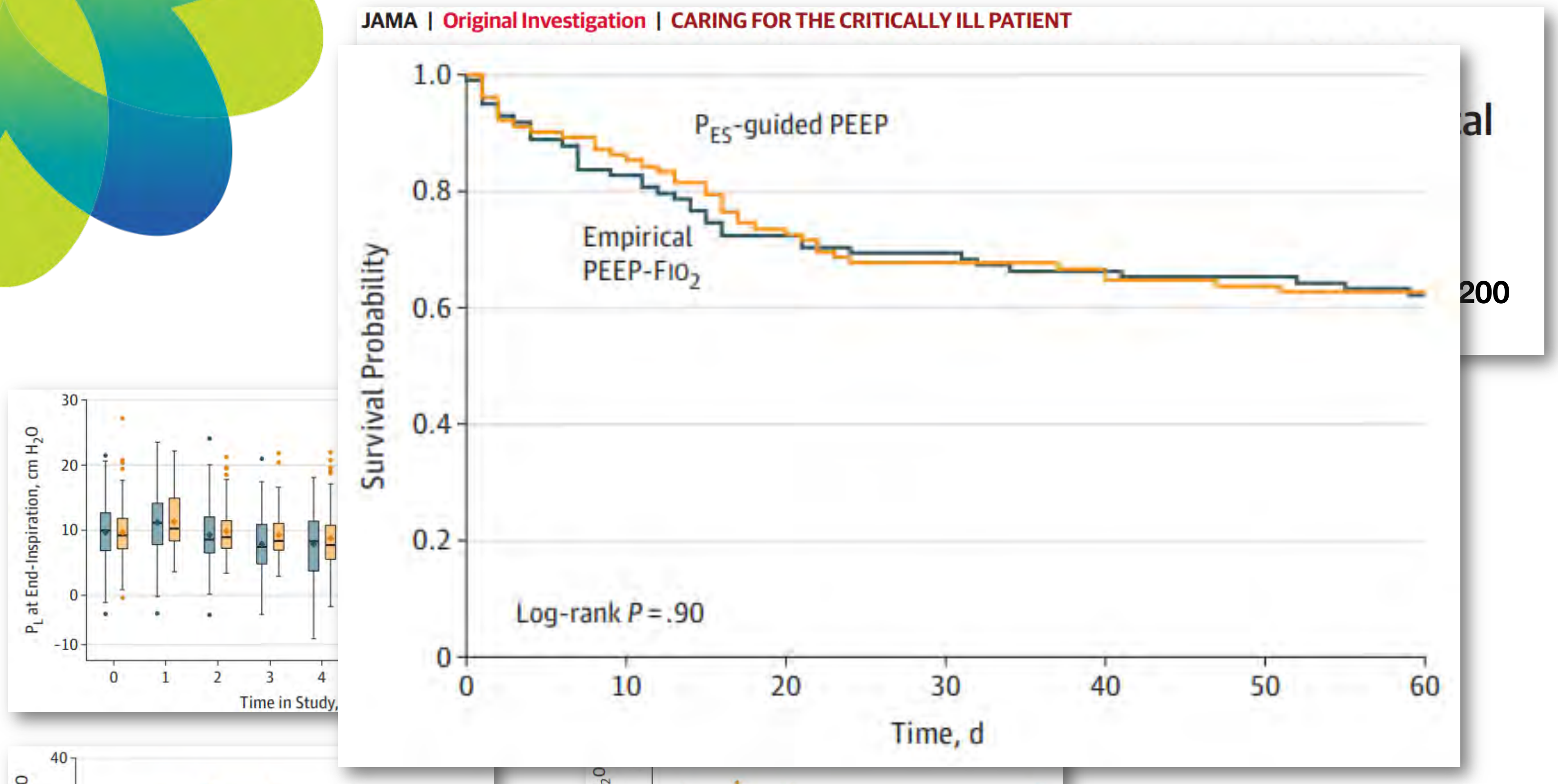

"Among patients with moderate to severe ARDS, PES-guided PEEP, compared with empirical high PEEP-FIO2, resulted in no significant difference in death and days free from mechanical ventilation. ***These findings do not support PES-guided PEEP titration in ARDS"***

Cochrane Library

Cochrane Database of Systematic Reviews

No difference between high PEEP and low PEEP

High versus low positive end-expiratory pressure (PEEP) levels for mechanically ventilated adult patients with acute lung injury and acute respiratory distress syndrome (Review)

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 NOVEMBER 13, 2008 VOL. 359 NO. 20

EPVent 1 - Balloon vs low PEEP – Balloon Better???

Mechanical Ventilation Guided by Esophageal Pressure in Acute Lung Injury

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Titrating Positive End-Expiratory Pressure (PEEP) With an Esophageal Pressure–Guided Strategy vs an Empirical High PEEP-FIO_2 Strategy on Death and Days Free From Mechanical Ventilation Among Patients With Acute Respiratory Distress Syndrome

A Randomized Clinical Trial

EPVent 2 - Balloon vs high PEEP – No Difference

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Driving pressure and long-term outcomes in moderate/severe acute respiratory distress syndrome

Ann Intensive Care (2018) 8:119, n=33 ARDS pts @ 6 months

Prospective not an RCT

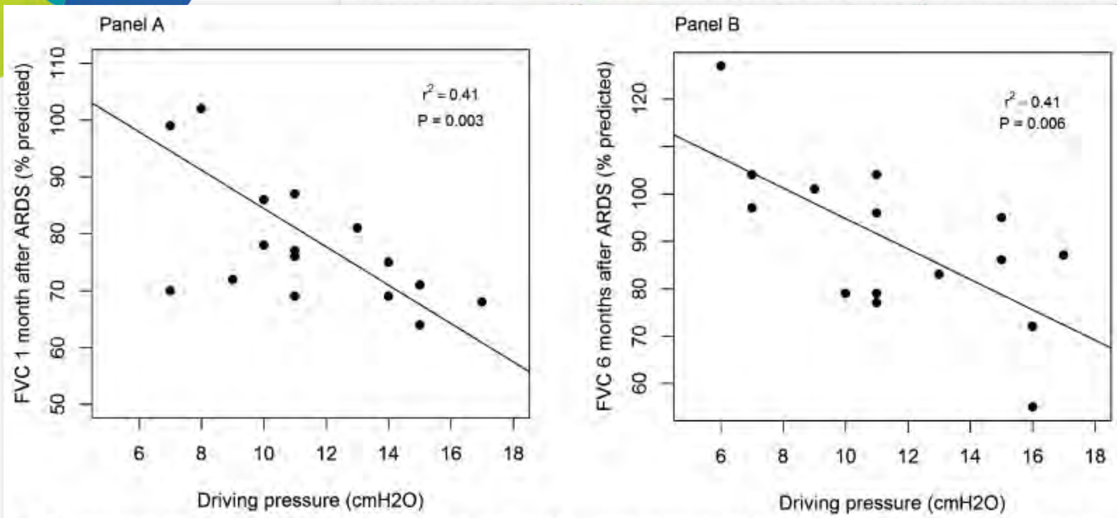

Fig. 2 Relationship between driving pressure and forced vital capacity after 1 month (panel A) and 6 months (panel B) of acute respiratory distress syndrome

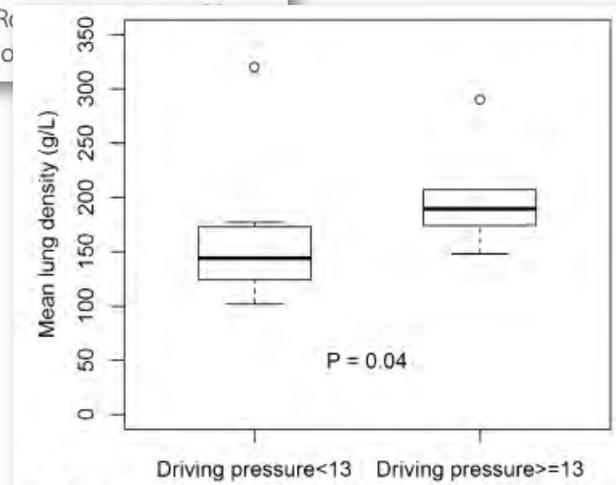

Fig. 3 Mean pulmonary parenchyma density in the whole-lung CT scan in 17 ARDS patients after 6 months of follow-up split based on driving pressure median

We already know ARDS long term outcomes include: cognitive, psychiatric & physical issues

Higher driving pressure = worse long-term pulmonary function and structure even with "protective ventilation"

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TPP & Driving Pressure: Obesity

Anesthesiology
1999; 91:1221-31

Positive End-expiratory Pressure Improves Respiratory Function in Obese but not in Normal Subjects during Anesthesia and Paralysis

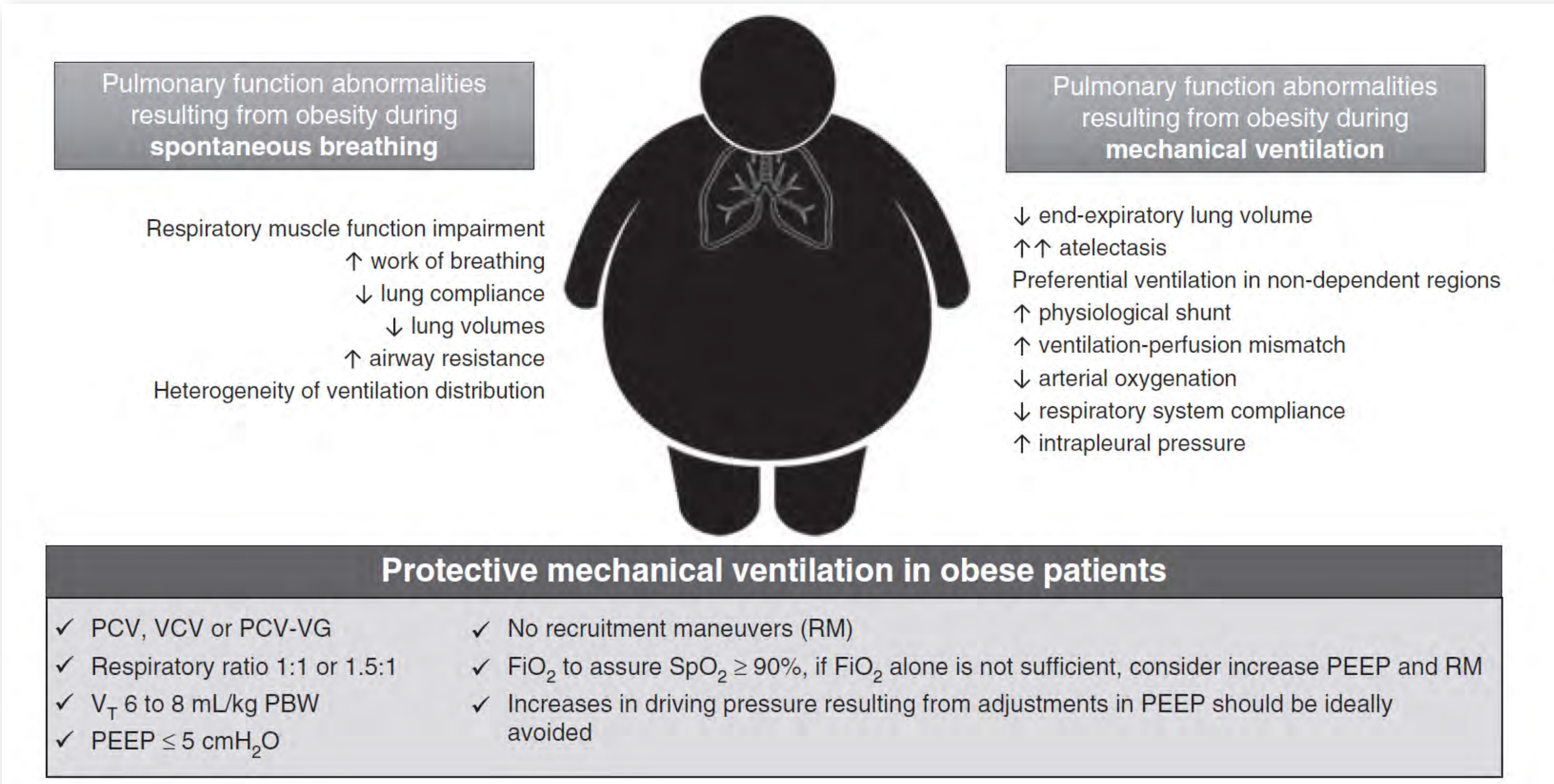
Paolo Pelosi, M.D.,* Irene Ravagnan, M.D.,† Gabriella Giurati, M.D.,† Mauro Panigada, M.D.,‡ Nicola Bottino, M.D.,‡ Stefano Tredici, M.D.,‡ Giuditta Eccher, M.D.,‡ Luciano Gattinoni, M.D.§

"PEEP improves respiratory function in morbidly obese patients but not in normal subjects"

Protective mechanical ventilation in the obese patient

Falcão et al. International Anesthesiology Clinics (2020) 58:3

Luiz F.d.R. Falcão, MD, MBA, PhD, TSA[a], Paolo Pelosi, MD, FERS[b,c], Marcelo Gama de Abreu, MD, MSc, PhD, DESA[d]



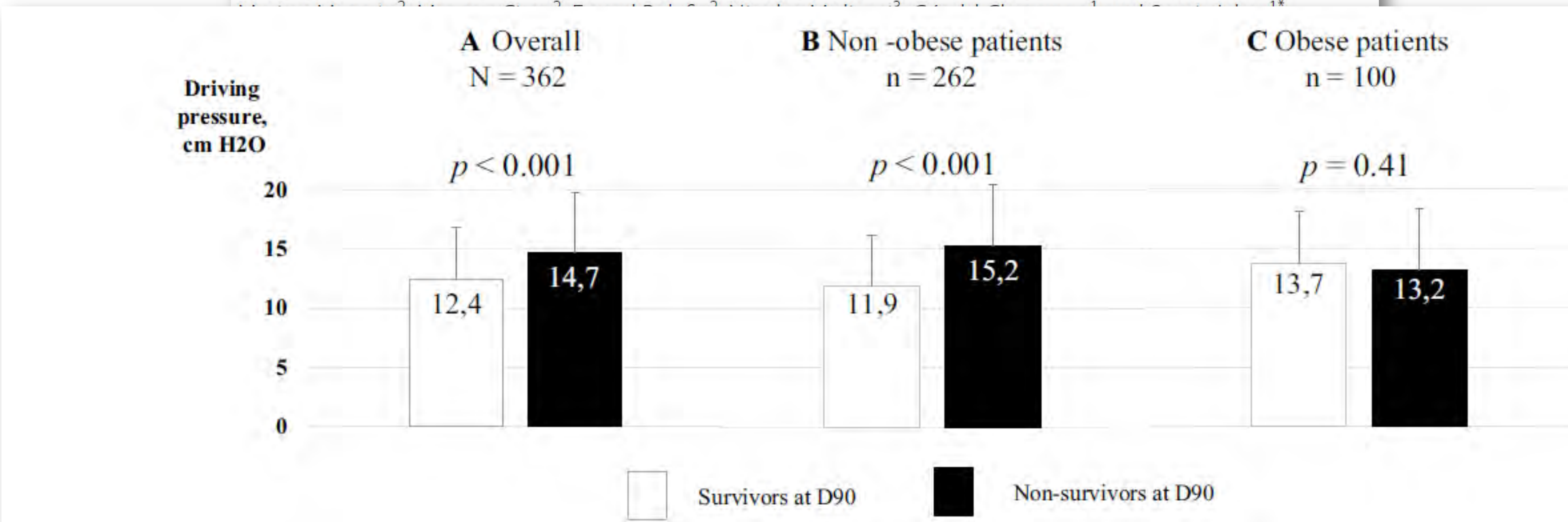
Retrospective

ORIGINAL

Impact of the driving pressure on mortality in obese and non-obese ARDS patients: a retrospective study of 362 cases

Intensive Care Med (2018) 44:1106–1114 – n=362

Audrey De Jong[1], Jeanne Cossic[2], Daniel Verzilli[2], Clément Monet[2], Julie Carr[2], Mathieu Conseil[2],



<u>Non-obese patients</u> – Increases in DP, Plat and Compliance are independently associated with mortality

<u>Obese patients</u> – increases in DP, Plat and Compliance are not associated mortality

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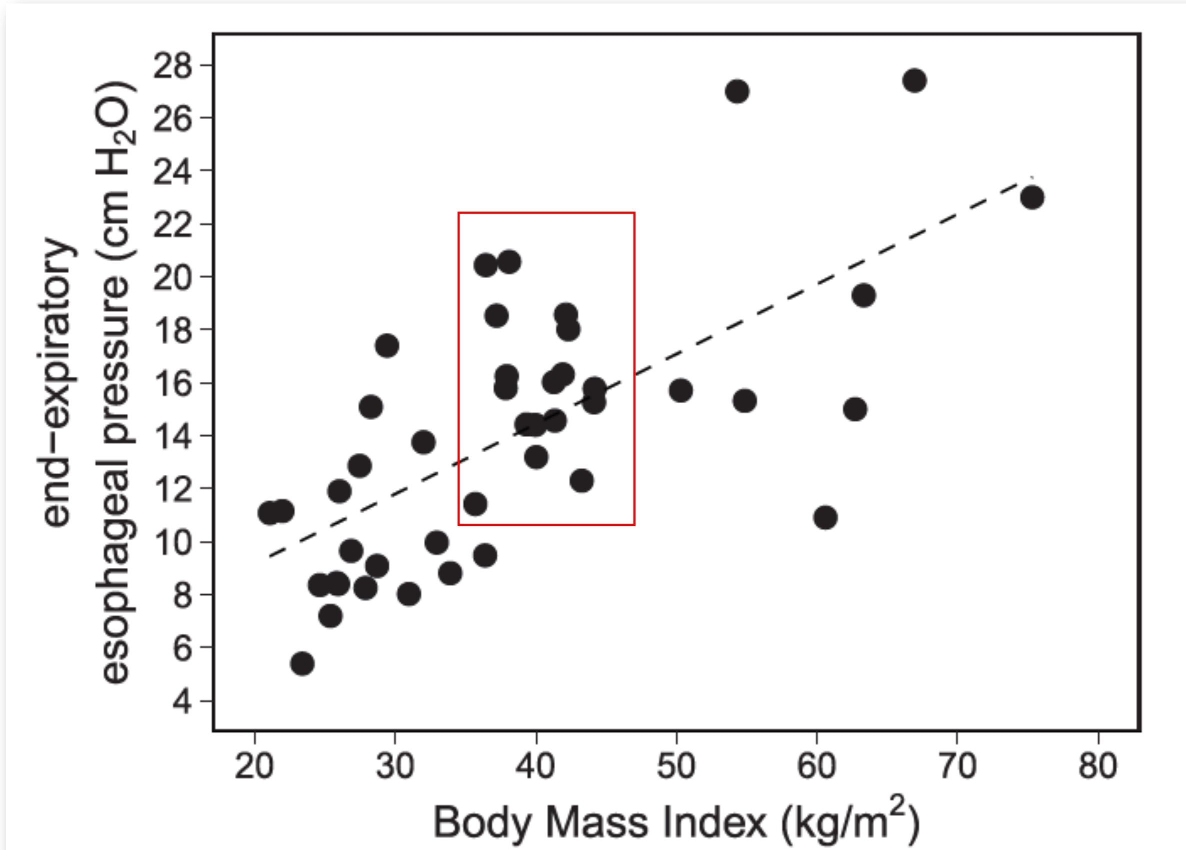
ANESTHESIOLOGY

Prevalence of Complete Airway Closure According to Body Mass Index in Acute Respiratory Distress Syndrome

Anesthesiology 2020; 133:867–78, n=51

Pooled Cohort Analysis

Pooled data from a prospective and retrospective study



- PEEP needed to keep airways open?
- PEEP needed to keep TPPee positive?

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Recruitment Maneuvers and Positive End-Expiratory Pressure Titration in Morbidly Obese ICU Patients

Prospective not an RCT

Crit Care Med 2016; 44:300–307

n=14, two methods of titrating positive end-expiratory pressure for BMI >35

Massimiliano Pirrone, MD[1,2]; Daniel Fisher, RRT[3]; Daniel Chipman, RRT[3]; David A. E. Imber, BA[1]; Javier Corona, MD[1,4]; Cristina Mietto, MD[1,2]; Robert M. Kacmarek, RRT, PhD[1,3]; Lorenzo Berra, MD[1]

TABLE 1. Characteristics of Study Patients

Total number of patients enrolled		14
Age, mean ± SD, yr		54.0 ± 15.7
Female, *n* (%)		6 (42.9)
Height, mean ± SD, cm	**5.5 ft**	170.9 ± 12.5
Weight, mean ± SD, kg	**321 lbs**	146.1 ± 40.8
Body mass index, mean ± SD, kg/m²		50.7 ± 16.0
Thoracic circumference, mean ± SD, cm	**57 in**	144.8 ± 23.3
Abdominal circumference, mean ± SD, cm	**59 in**	151.8 ± 23.8

TABLE 2. Respiratory Mechanics and Gas Exchange at Different Positive End-Expiratory Pressure Levels

	Baseline	Zero PEEP[a]	Lowest PEEP With Positive Ptpe	Lowest PEEP With Positive Ptpe After RM	Best Decremental PEEP After RM	Best Decremental PEEP–Head of Bed 30 Degree
PEEP cm H_2O	11.6 ± 2.9	0	20.7 ± 4.0[b]	20.7 ± 4.0[b]	21.3 ± 3.8[b]	21.5 ± 3.7[b]
End-expiratory lung volume, mL/kg ideal body weight **25+ ml/kg**	19.5 ± 8.3	14.6 ± 3.9	27.1 ± 9.2	30.1 ± 8.2[b,c]	30.6 ± 8.7[b]	38.5 ± 11.5[b]
Ppeak, cm H_2O	34.6 ± 5.8	22.4 ± 4.9	41.7 ± 6.0[b]	40.2 ± 6.1[b,c]	40.4 ± 5.2[b]	41.6 ± 5.5[b]
Pplat, cm H_2O	22.5 ± 4.1	11.7 ± 2.1	30.4 ± 4.2[b]	29.1 ± 4.1[b,c]	29.8 ± 3.8[b]	30.8 ± 3.2[b]
Pa_{O_2}/F_{IO_2}, torr	179 ± 60			270 ± 67[b]	266 ± 72[b]	
Ptpi, cm H_2O	1.6 ± 5.0	-3.2 ± 2.8	8.1 ± 2.5[b]	6.6 ± 3.3[b,c]	7.5 ± 2.6[b]	10.3 ± 3.8[b]
Ptpe, cm H_2O	-5.8 ± 5.8	-11.5 ± 1.7[b]	1.1 ± 1.5[b]	1.4 ± 2.4[b]	2.3 ± 2.3[b]	4.2 ± 3.8[b]

Commonly used PEEP levels for morbidly obese patients are too low, cause atelectasis and hypoxemia – TPP or decremental trails with RM's may benefit these patients

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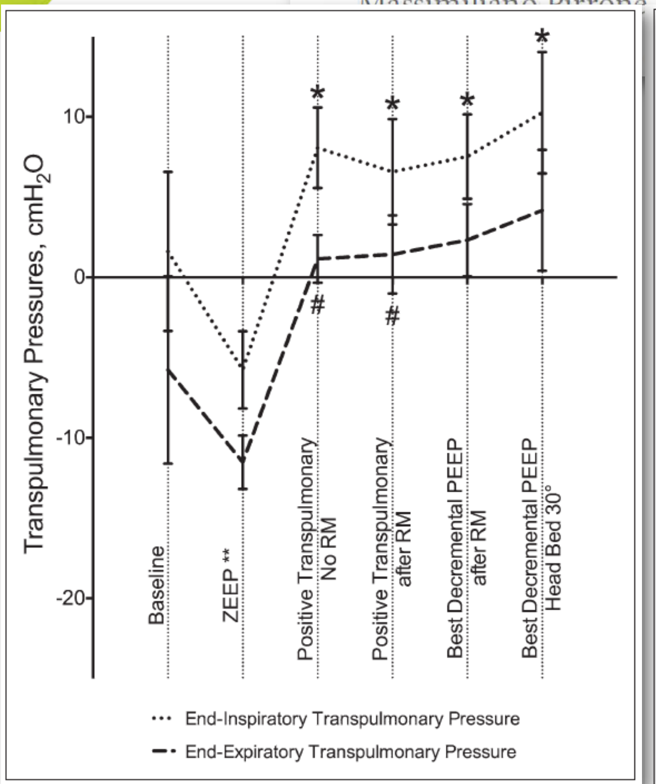
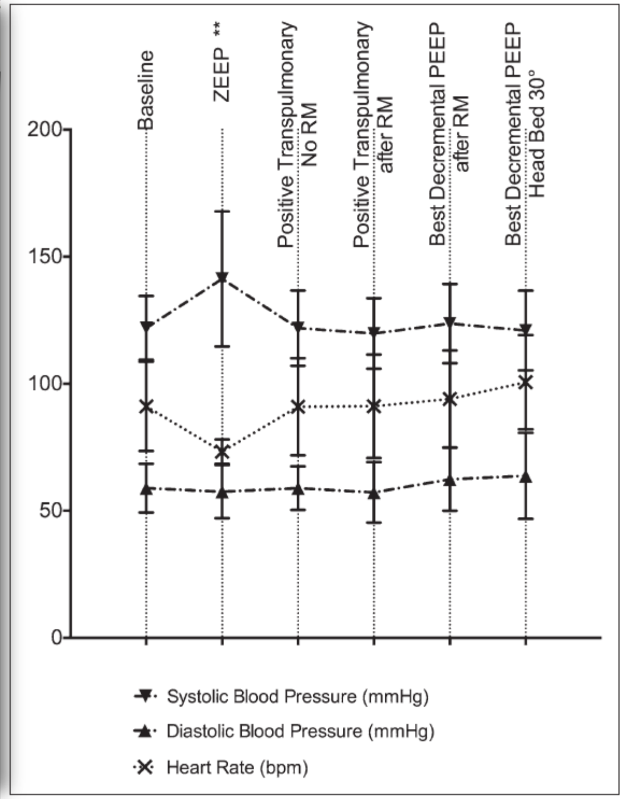
Recruitment Maneuvers and Positive End-Expiratory Pressure Titration in Morbidly Obese ICU Patients

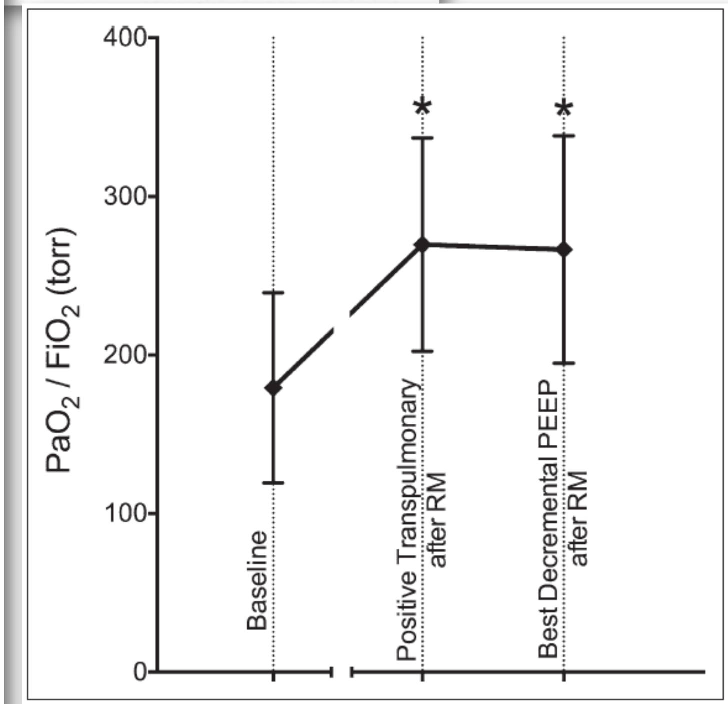
Crit Care Med 2016; 44:300–307

n=14, two methods of titrating positive end-expiratory pressure for BMI >35

Massimiliano Pirrone, MD[1,2]; Daniel Fisher, RRT[3]; Daniel Chipman, RRT[3]; David A. E. Imber, BA[1];
RT, PhD[1,3]; Lorenzo Berra, MD[1]







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Prospective
not an RCT

Transpulmonary Pressure Describes Lung Morphology During Decremental Positive End-Expiratory Pressure Trials in Obesity*

Crit Care Med 2017; 45:1374–1381, n=16 crit ill obese patients (most 300-400lbs)

Jacopo Fumagalli, MD[1,2]; Lorenzo Berra, MD[1]; Changsheng Zhang, MD, PhD[1]; Massimiliano Pirrone, MD[1,2];

TABLE 1. Patients' Respiratory Parameters

Respiratory Parameters, *n* = 16	Baseline	Optimal PEEP	*p*
PEEP (cm H_2O)	12.7 ± 2.9	21.7 ± 3.7	< 0.001
Plateau pressure (cm H_2O)	23.8 ± 3.4	28.3 ± 4.3	< 0.001
Peak pressure (cm H_2O)	33.3 ± 65.1	38.8 ± 4.9	< 0.001
End-inspiratory transpulmonary pressure (cm H_2O)	2.5 ± 5.1	6.1 ± 3.2	0.001
End-expiratory transpulmonary pressure (cm H_2O)	−4.4 ± 4.6	2.1 ± 2.0	< 0.001
End-expiratory lung volume (mL/kg ideal body weight)	19.6 ± 8.0	30.4 ± 9.1	< 0.001
Elastance of the respiratory system (cm H_2O/L)	23.9 ± 7.1	18.6 ± 6.1	< 0.001
Elastance of the lung (cm H_2O/L)	16.6 ± 5.1	10.8 ± 4.3	< 0.001
Elastance of the chest wall (cm H_2O/L)	7.2 ± 2.9	7.7 ± 3.5	0.547
Pao_2/Fio_2	163.4 ± 56.7	273.4 ± 72.1	< 0.001
$Paco_2$ (mm Hg)	47.9 ± 13.4	50.9 ± 11.6	0.140

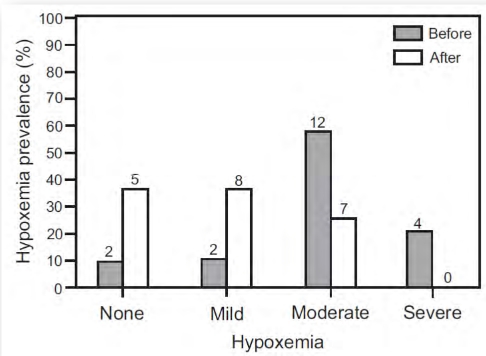
Optimizing the PEEP with TPP and/or decremental PEEP Trial

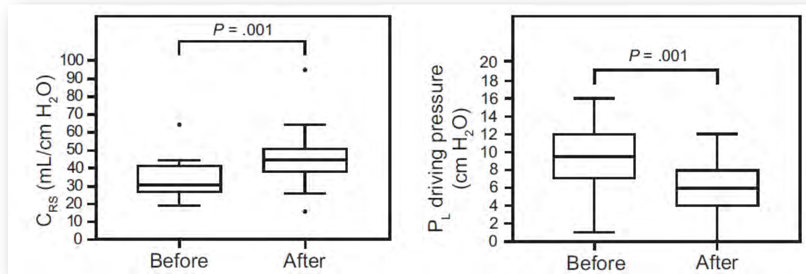
Retrospective

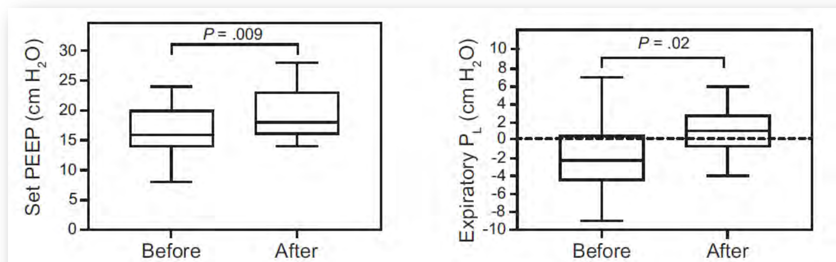
Transpulmonary Pressure-Guided Lung-Protective Ventilation Improves Pulmonary Mechanics and Oxygenation Among Obese Subjects on Mechanical Ventilation

RESPIRATORY CARE Paper in Press. Published on 20 April, 2021, n=20

Daniel D Rowley, Susan R Arrington, Kyle B Enfield, Keith D Lamb, Alexandra Kadl, John P Davis, and Danny J Theodore



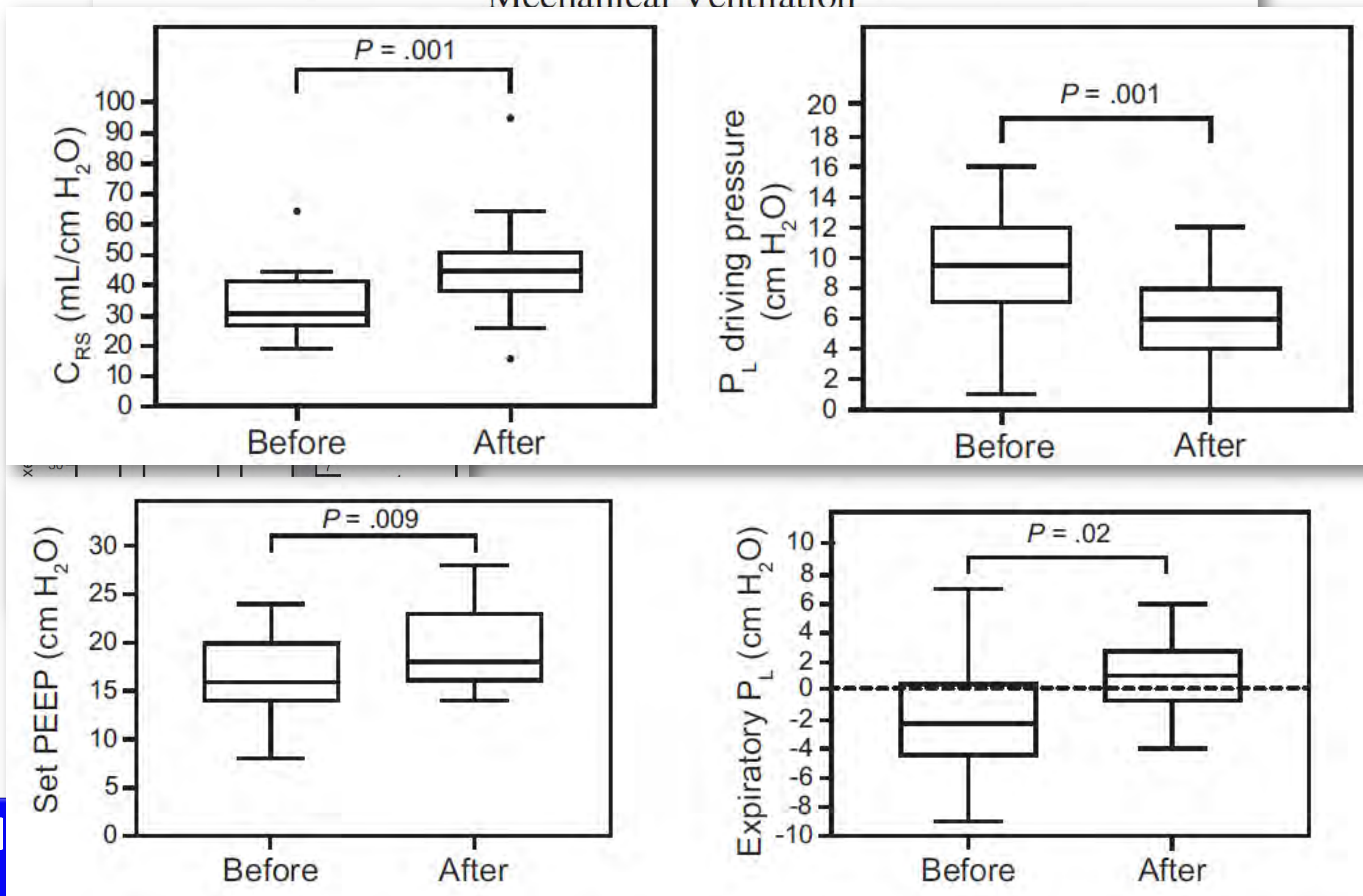




Results: higher PEEP, lower FIO2 , better pulmonary mechanics, and higher oxygenation for adult obese subjects

Transpulmonary Pressure-Guided Lung-Protective Ventilation Improves Pulmonary Mechanics and Oxygenation Among Obese Subjects on Mechanical Ventilation

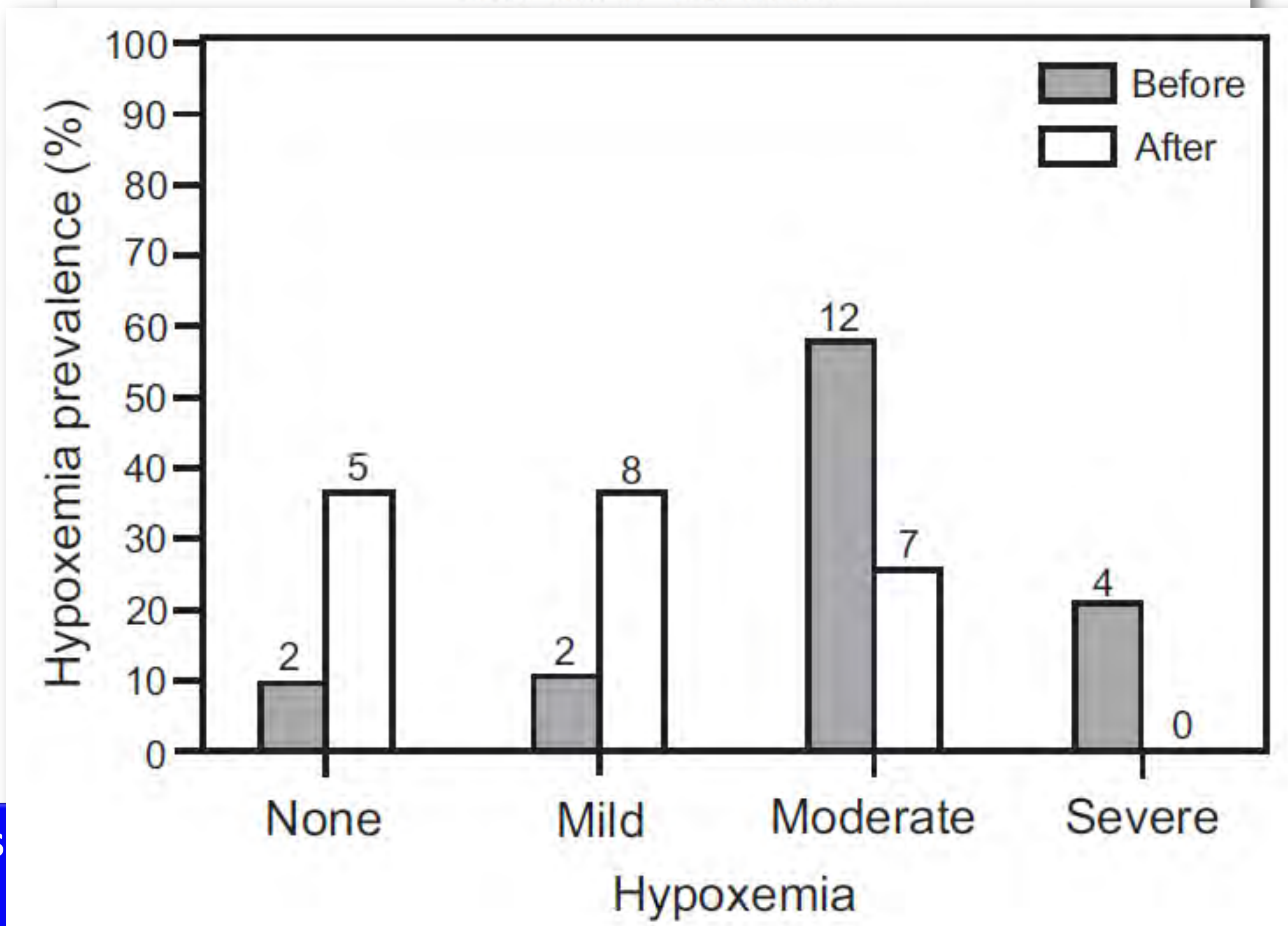
Retrospective



Resul … **er**

Retrospective

Transpulmonary Pressure-Guided Lung-Protective Ventilation Improves Pulmonary Mechanics and Oxygenation Among Obese Subjects on Mechanical Ventilation



Results

gher

aCare

Retrospective

Florio *et al. Critical Care* (2020) 24:4
https://doi.org/10.1186/s13054-019-2709-x

Critical Care

RESEARCH Open Access

A lung rescue team improves survival in obesity with acute respiratory distress syndrome

Gaetano Florio[1], Matteo Ferrari[1], Edward A. Bittner[1], Roberta De Santis Santiago[1], Massimiliano Pirrone[1],

- Single center retrospective study at MGH
- Class III Obesity (BMI > 40) with ARDS and mechanical ventilation > 48 hours
- Compared ARDSnet Low PEEP Table to PEEP settings determined by a Lung Rescue Team using:
  - Lung recruitment maneuvers
  - Esophageal manometry
  - Hemodynamic monitoring
- Decreased mortality in the group with settings determined by the Lung Rescue Team

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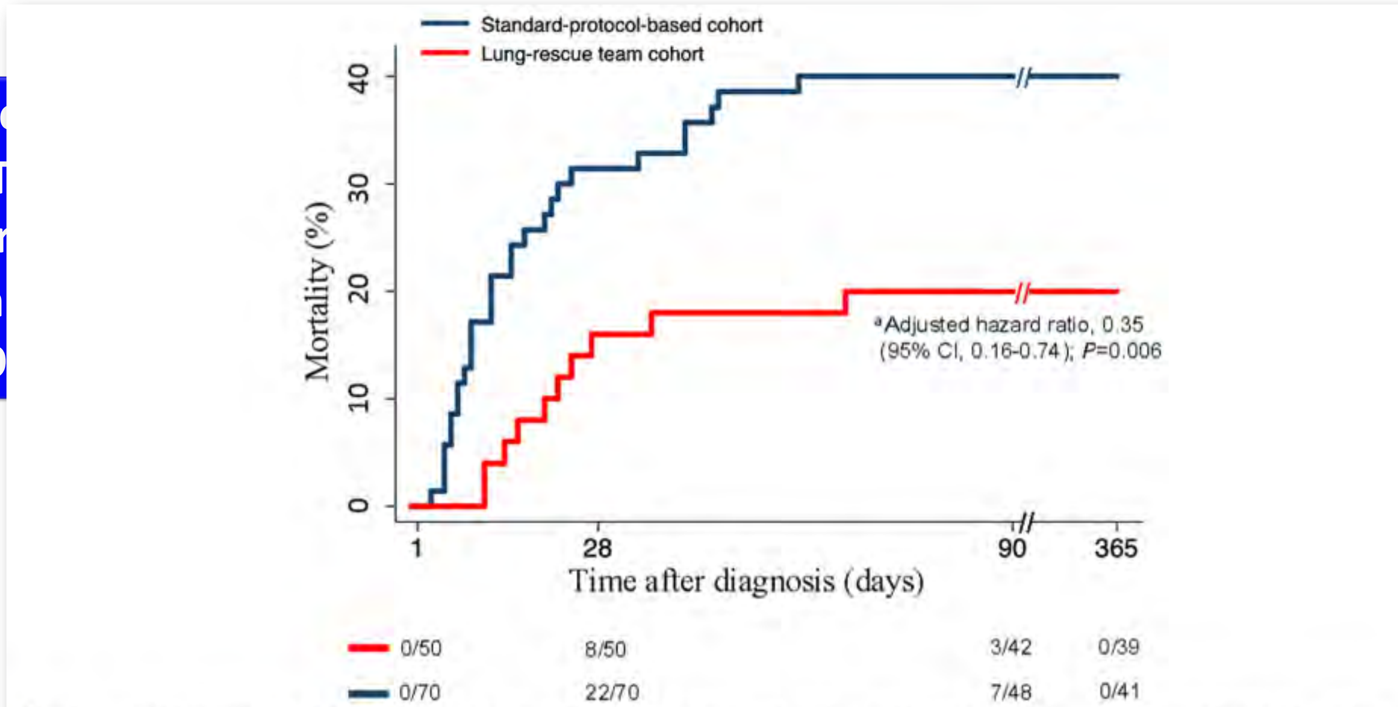
- PEEP incr
- End-exp T
- Driving pr
- Complian
- PaO2/FiO



2O

"We found that in patients with an average BMI of > 50 kg/m2 , an individualized lung rescue approach based on individualized cardiopulmonary physiology is associated with a decreased in-hospital mortality"

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Esophageal Balloon:
The ChristianaCare Experience

44 esophageal balloon patients (out of 2205 vent patients Dec 2019-Sep2020)
- 2% of ventilator patients used a balloon (balloons are ~$40)

We increased PEEP an average of 6 cmH2O above standard clinical PEEP settings prior to balloon use (next slide)

Patients with BMI > 35 and high PEEP requirements outcomes were compared to the previous year without balloon management:

2020 population with balloon management resulted in 8% reduction in mortality

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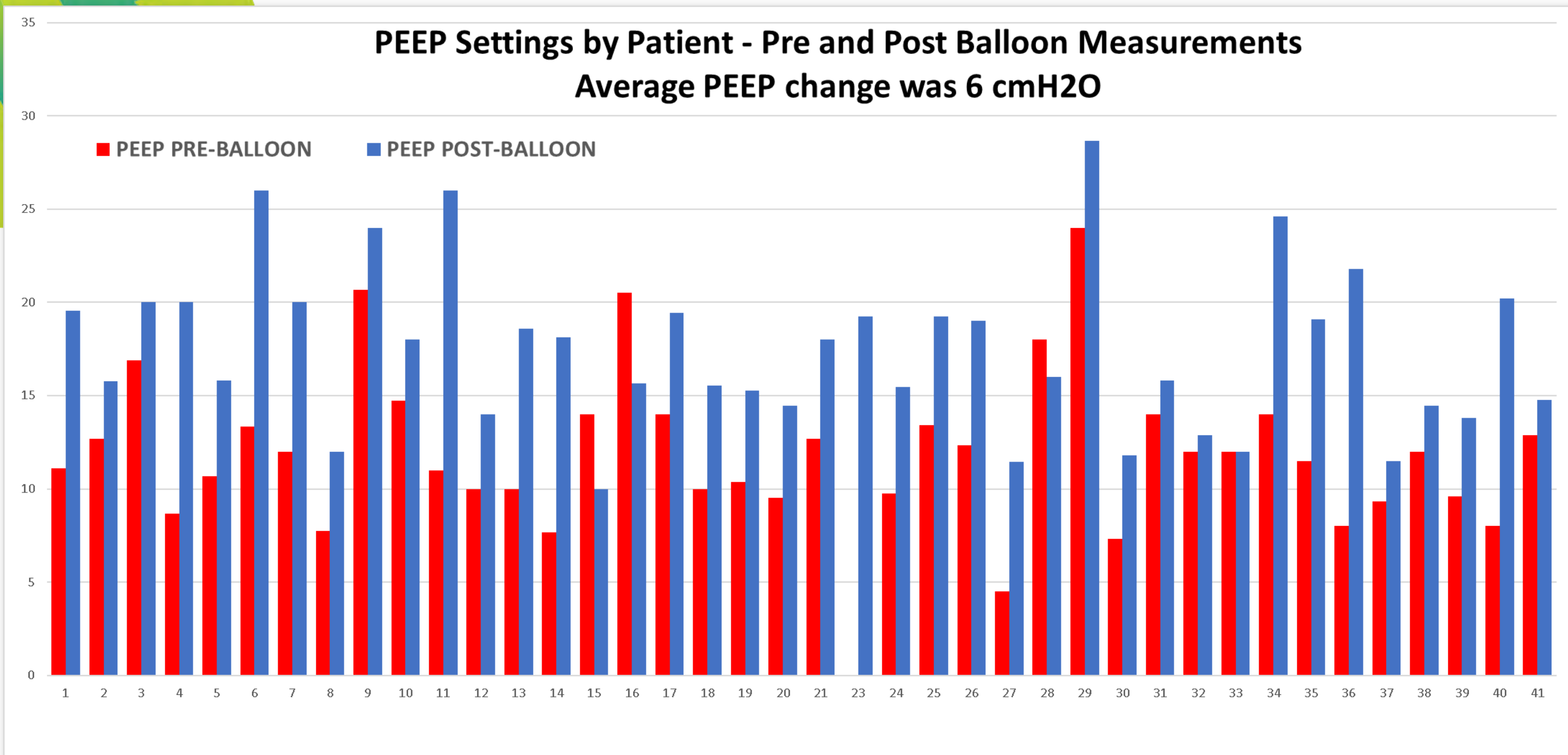

PEEP Settings by Patient - Pre and Post Balloon Measurements
Average PEEP change was 6 cmH2O
PEEP PRE-BALLOON
PEEP POST-BALLOON
0
5
10
15
20
25
30
35
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

Further Analysis

52 patients – 92% success rate inserting balloon

31 Patients with BMI > 35

	EndInsp	End Exp	SpO2	FiO2	PEEP	MAP	DP	PLAT	PIP	Vt	Vt ml/kg	Cst
Baseline			94.6	79.8	12.8	19.1	15.2	28.5	44.6	428.7	6.9	28.9
Optimized with Balloon	10.3	-0.9	96.7	57.1	19.2	25.0	13.3	31.9	45.3	436.3	6.9	36.0
Change			2.1	-22.7	6.4	5.9	-2.1	4.6	0.7	7.7	0.0	8.3

Demonstration

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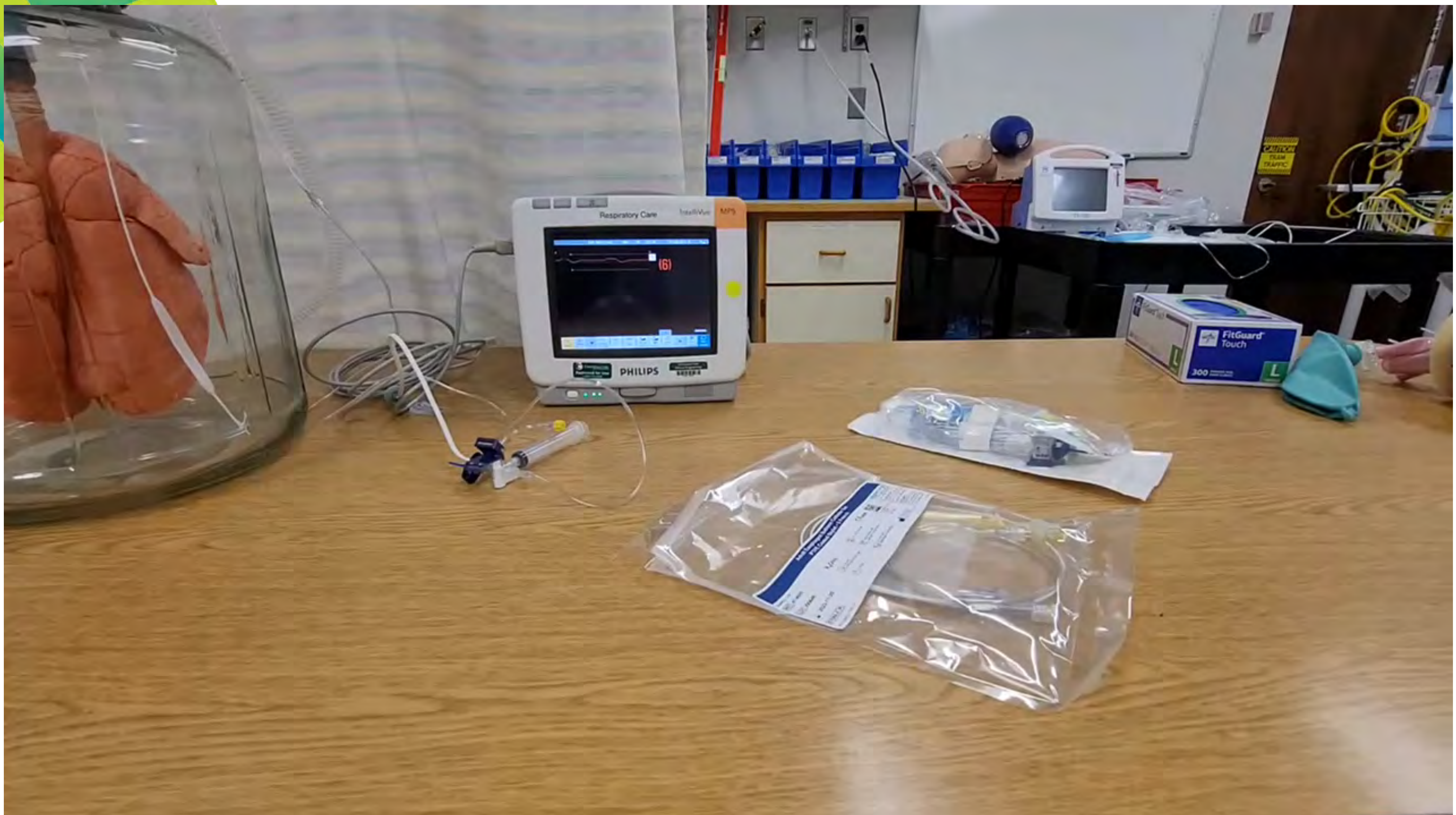
Bedside Components Needed

- Pressure Monitor – Patient Monitor with pressure measurement module
- Transducer set and cable
- Syringe
- Catheter with Balloon – we use Cooper Surgical


Respiratory Care
PHILIPS
FitGuard
Touch

Closer Look at the Catheter

- **Balloon** – Cooper Surgical adult esophageal balloon, 5 french
- **Stylet**

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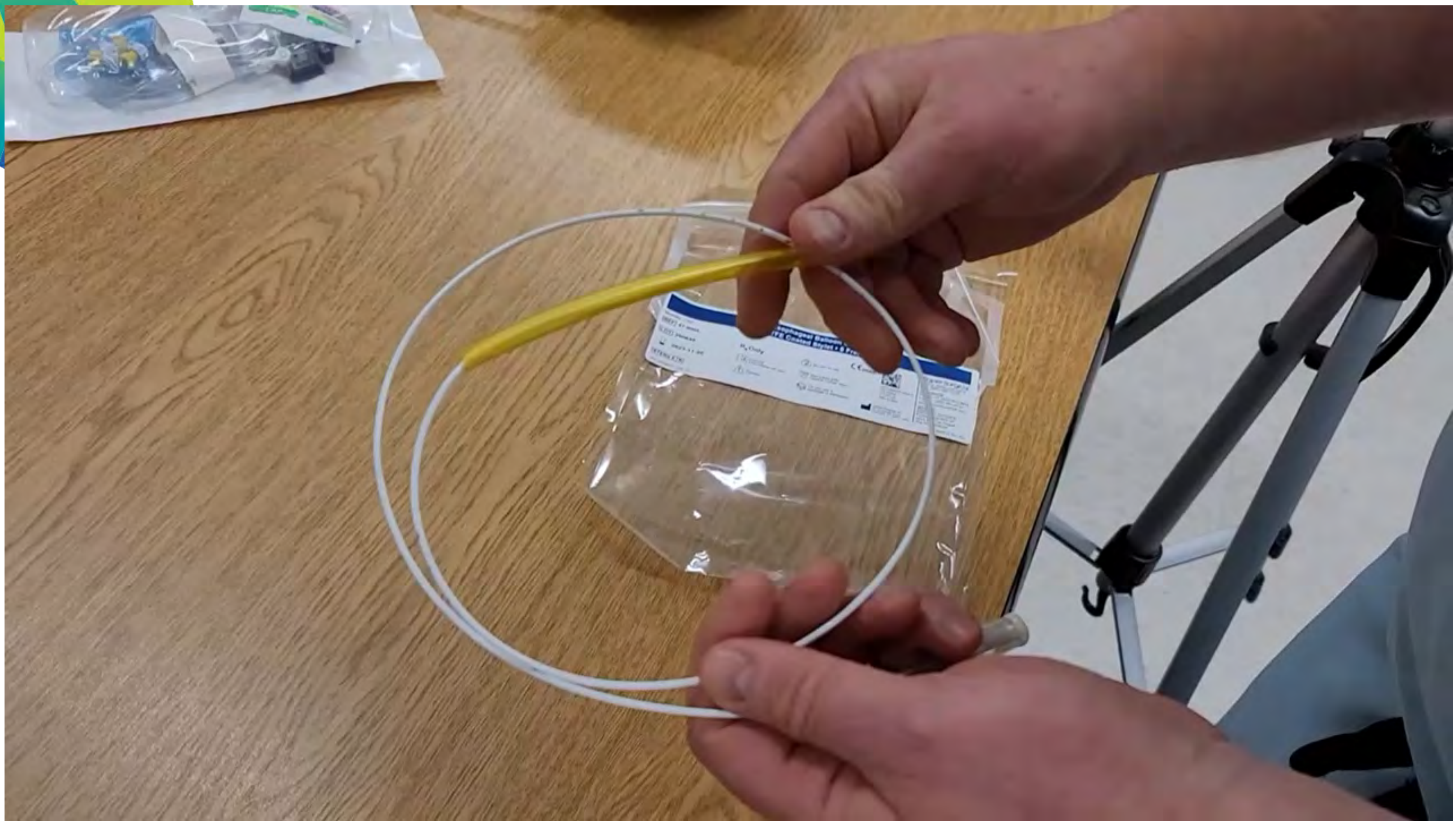

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Lab Setup – Healthy Lung

- Recruited well – ventilating
- No pleural pressure on the chest

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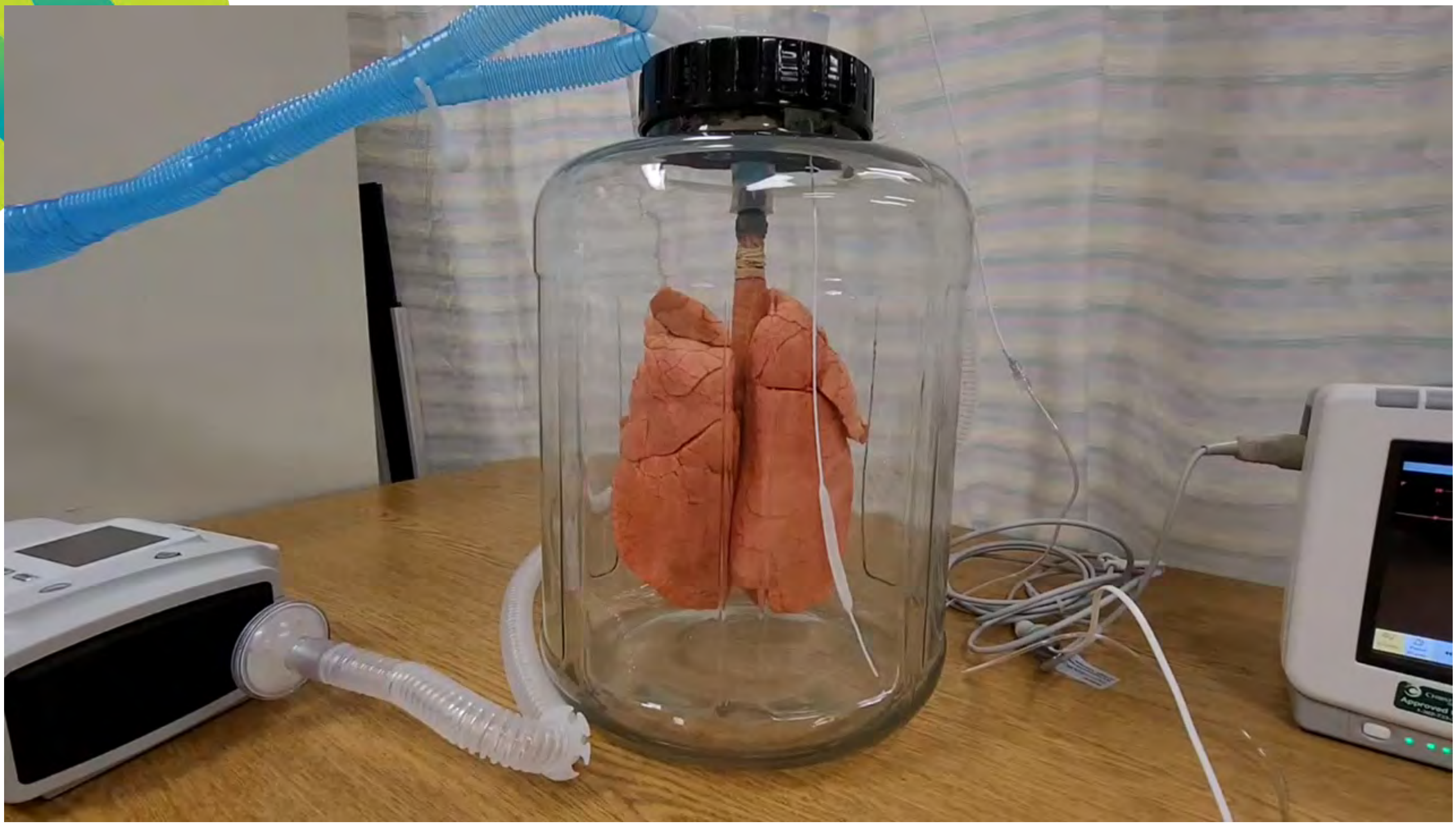

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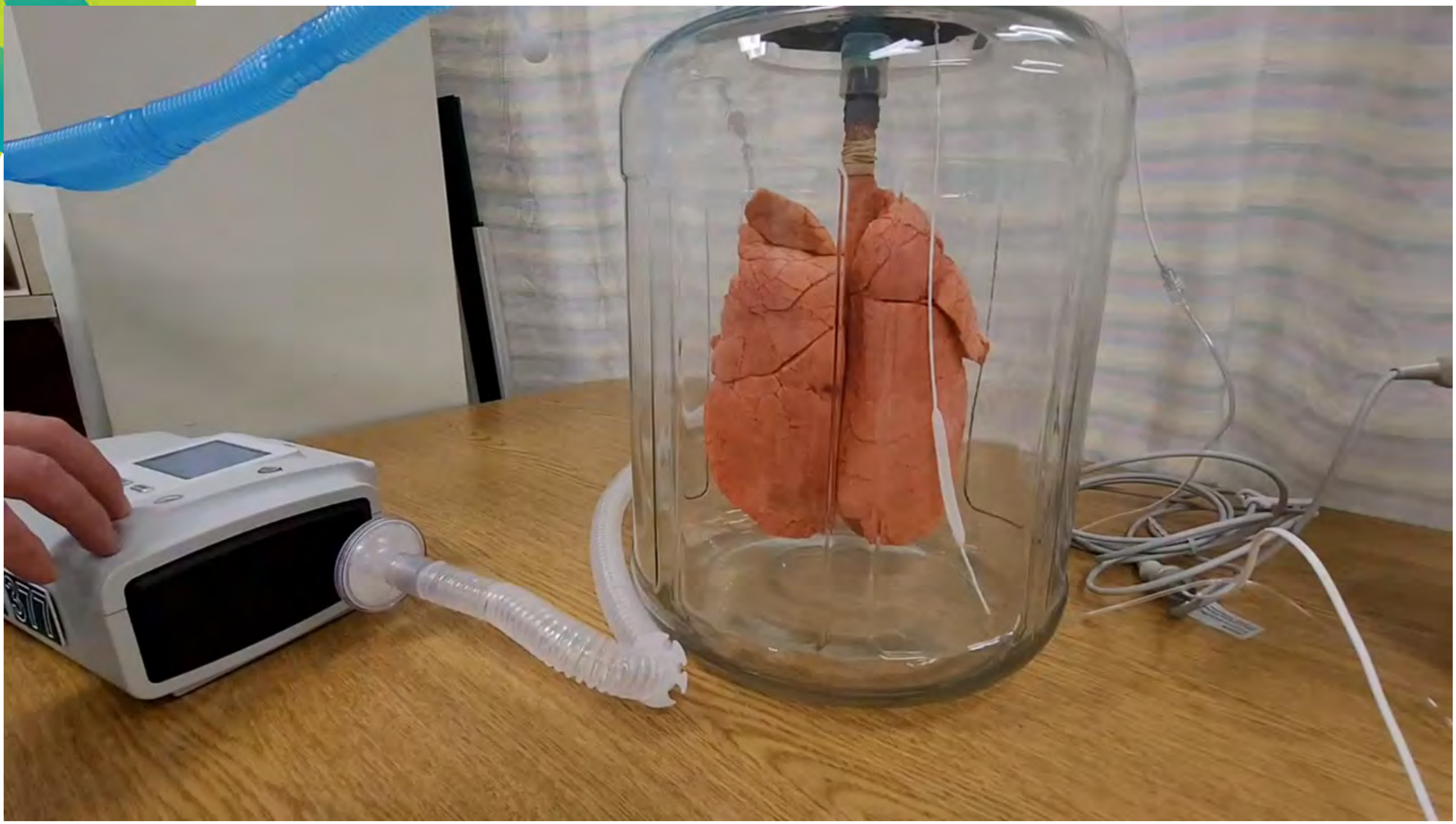
Lab Setup:
High Pleural Pressure

- Lung collapse that can occur with morbid obesity, abdominal distension etc..
- Negative expiratory transpulmonary pressure
- Means that pressure pushing on the lungs > pressure in the lungs



Patient Example

- Catheter is inserted to ~60 cm
- Verifying that the balloon catheter made it into the stomach by gently pushing on the stomach

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Patient Example

(2 patient examples)

- After verifying stomach placement
- Pull catheter back to distal third of the esophagus and above the diaphragm (~40 cm deep)
- Proper placement

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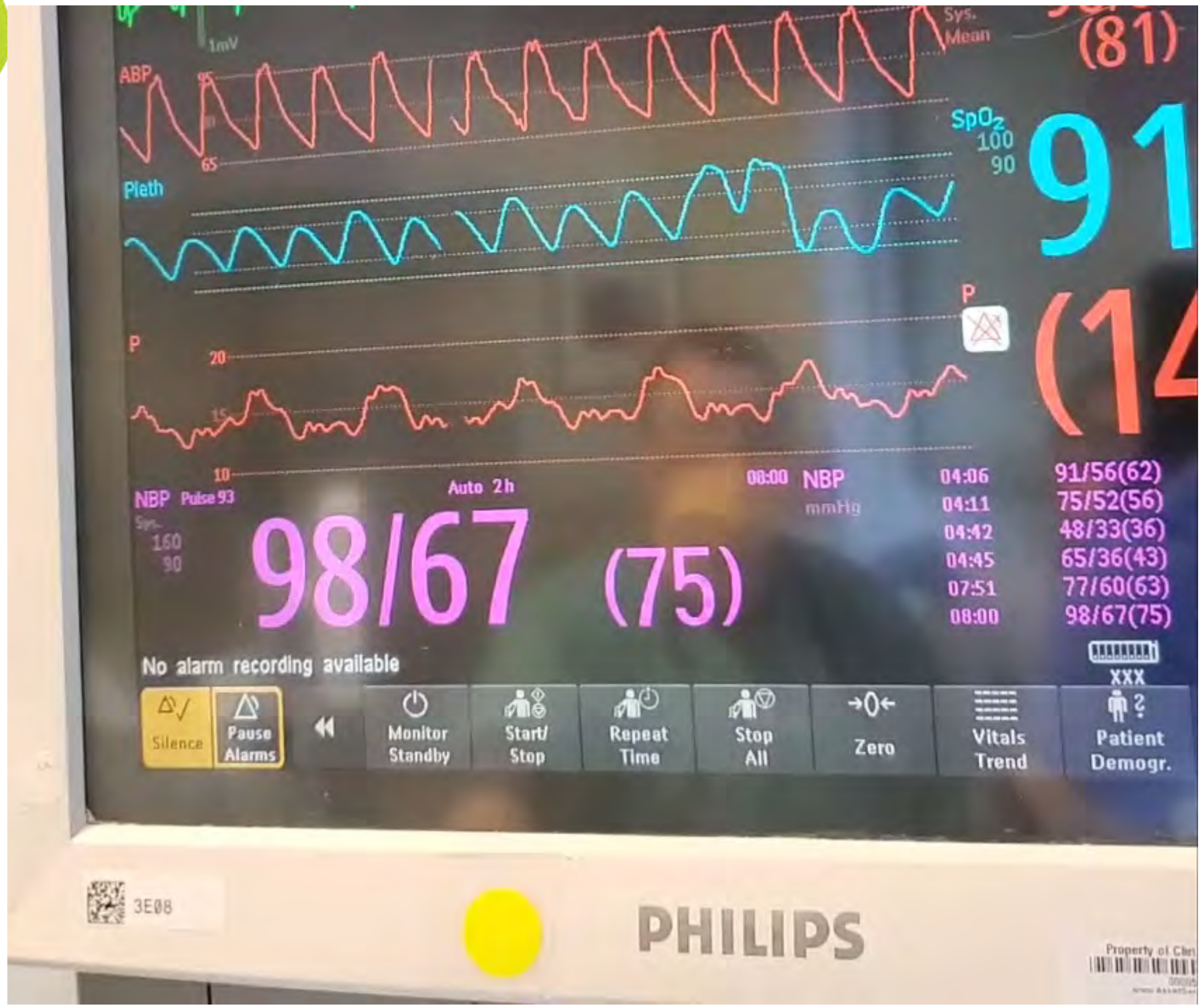

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II
Sinus Rhythm
HR
120
55
73
1mV
Pulse
73
PVC
0
P
25
20
15
P
(20)
Pleth
SpO2
100
88
97
Resp
RR
28
1Ohm
NBP Pulse 72
Sys.
150
100
Auto 15 min
99/40
(52)
10:01 NBP
mmHg
09:00 103/42(56)
09:15 108/43(57)
09:30 113/43(56)
09:45 105/45(56)
10:00 98/40(53)
10:01 99/40(52)
Clock
10:08
No alarm recording available
Silence
Pause Alarms
Monitor Standby
Start/ Stop
Repeat Time
Stop All
Zero
Vitals Trend
Patient Demogr.
Main Setup
Main Screen

Patient Example – End Exp TPP

- 4 second expiratory hold without patient effort
- Monitor is in mmhg and ventilator is in cmH2O
- We have conversion factors to cmH2O

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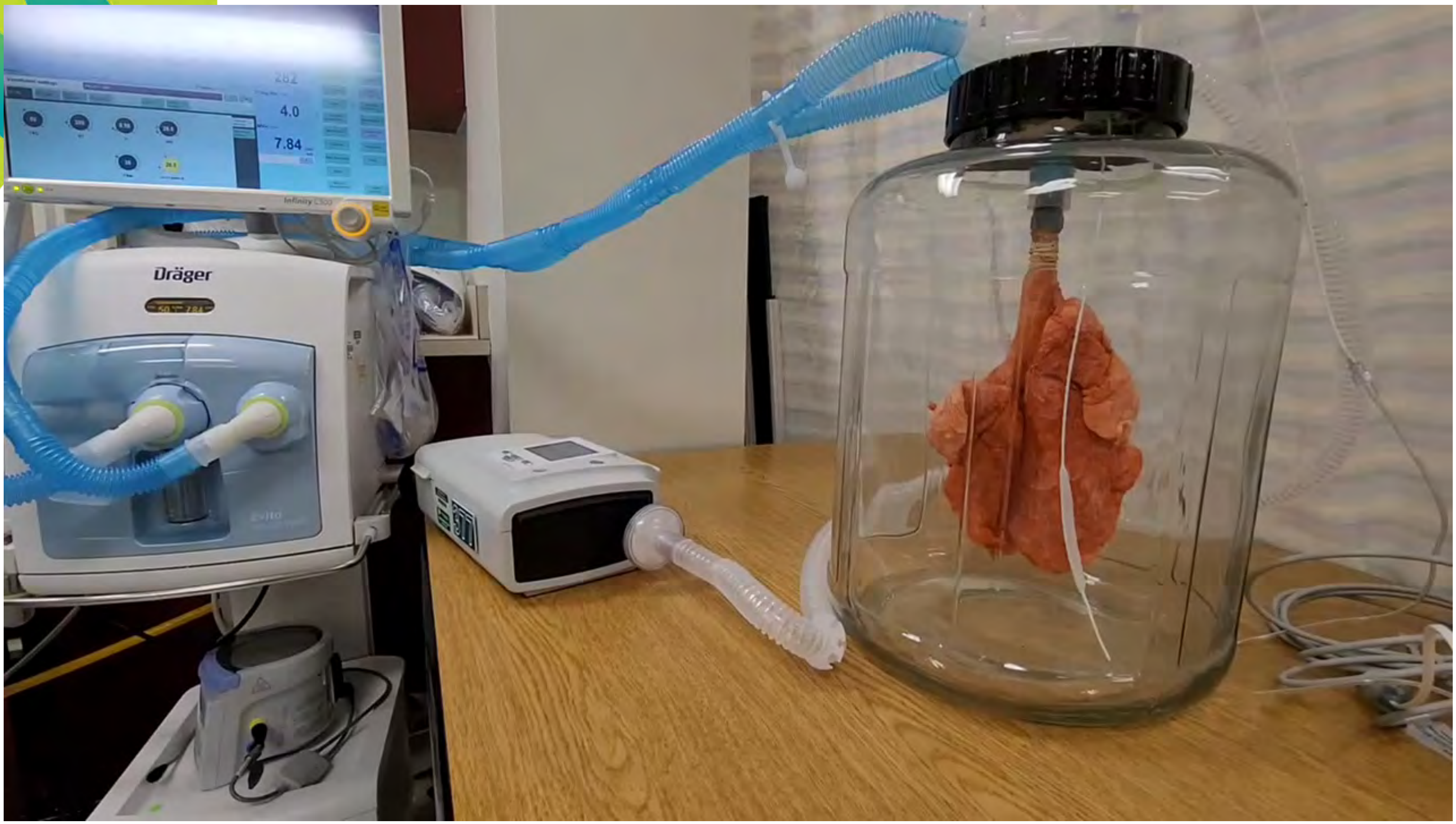
Lab Example: Recruit the Lung with High Pleural Pressure

- Collapsed ventilated lung

- Determine what PEEP will get the End Expiratory TPP upto O or slightly positive



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Summary / Take Home Points

TPP – measured with an esophageal balloon
Driving Pressure – Ventilating Pressure

ARDS Patients:
- TPP – hopeful for improved management of ARDS? EPVent 1 & 2
- DP – correlates to mortality, keep under 15

Morbidly Obese Patients:
- TPP – manage PEEP needs to keep pleural pressure (+) and avoid lung collapse
- DP – does not seem to correlate to mortality in this population

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Thank you!

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