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Why Every ICU Should Measure Transpulmonary Pressure Because it Makes $ense

precision ventilation makes clinical and economic sense

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Disclosures

I work at Sharp Chula Vista Hospital

No relevant financial relationships or conflicts of interest to disclose

Discussion includes nitric oxide outside FDA-approved indications

Research study submitted for peer-reviewed publication

IRB consent obtained; no identifiable patient data used

Participated in development of the protocol used

All pictures cited; no AI-produced pictures

Objectives

1. Clinical significance of transpulmonary pressure in obese mechanically ventilated patients
2. Personalized ventilation strategies versus ARDSNet FiO_2/PEEP table
3. Benefits of transpulmonary pressure monitoring for patients and hospitals
4. Explain why Transpulmonary Pressure Monitoring makes clinical and economic sense

Opening Case

Project Hail Mary Patient : Baseline

37

years old

54

BMI

100%

FiO_2

16

PEEP

156

P/F Ratio

22

Driving Pressure

Audience Question

Team preparing to start inhaled nitric oxide as a salvage strategy

Would you increase PEEP beyond 16?

Would you go to 20?

Would you go to 24?

What data would make you comfortable?

Project Hail Mary Patient: TPM Response

Before TPM	After 1 Hour TPM
FiO_2 100%	FiO_2 60%
PEEP 16	PEEP 26
PaO_2 156	PaO_2 136
P/F 156	P/F 228
DP 22	DP 8

Project Hail Mary Patient: Outcome

Inhaled nitric oxide was never started

FiO_2 decreased to 40% by day 7 of intubation and for remaining ventilator days

Trached on day 10 of intubation due to expected difficulty weaning

47 hospital days total LOS

Patient SURVIVED — discharged home

Why This Matters

Obesity changes respiratory mechanics

Obesity and Local Relevance

South Bay obesity estimate: 29% County of San Diego Health and Human Services 8/22

Estimated morbid obesity : 9.4% CDC-NCHS

Sharp Chula Vista ventilated adult population mean BMI: 30.2

Question: are we using evidence-based ventilator settings for this population?

Physiology: Morbid Obesity Changes the Lung Environment

↓ Functional residual capacity

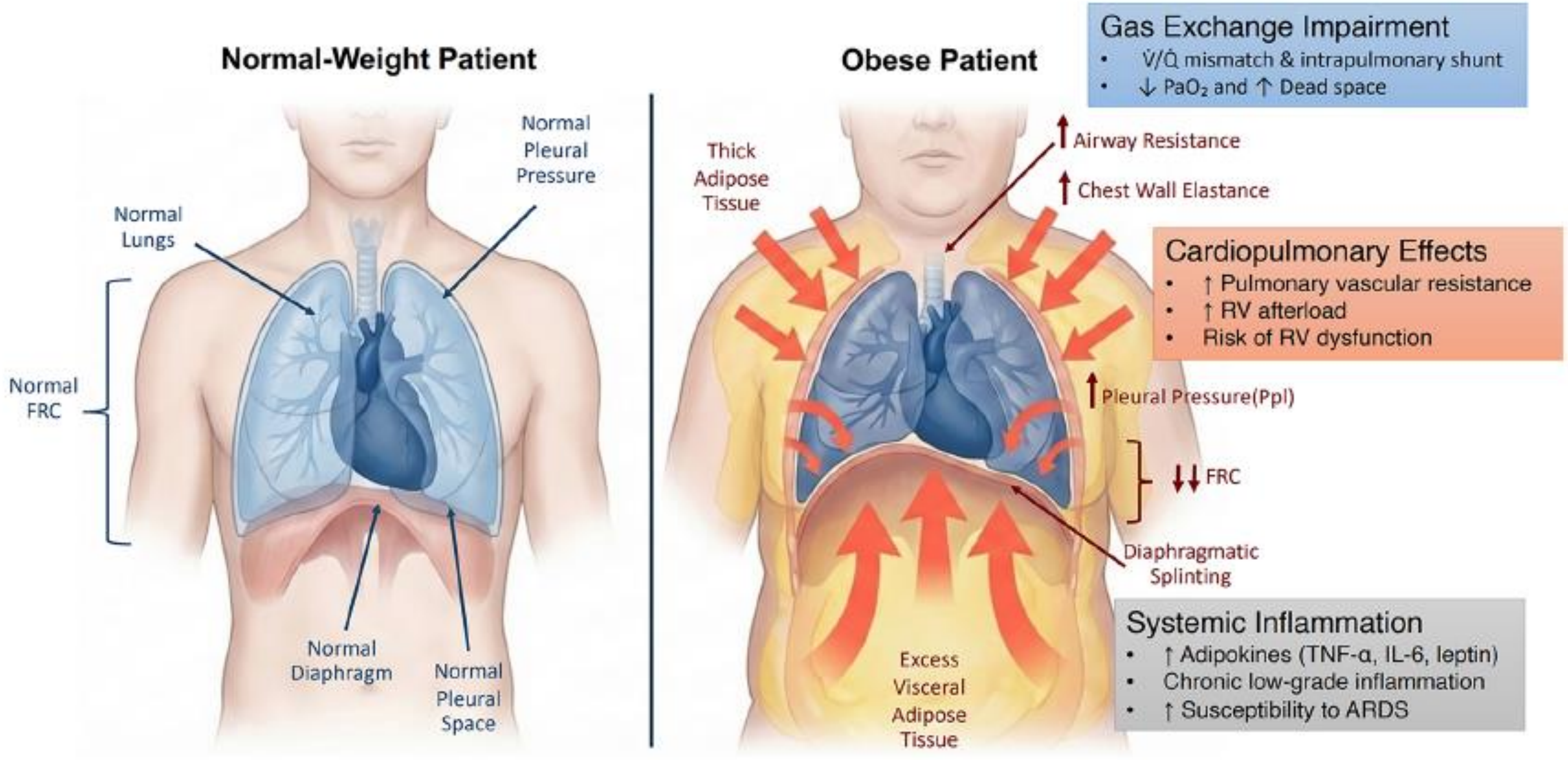
↑ Pleural pressure

↑ Dependent atelectasis

↑ Airway closing/opening pressure

PEEP needs may differ from table-based settings

How Obesity Affects the Lungs



Intensive Care Med
https://doi.org/10.1007/s00134-026-08397-3

Why Standard Settings May Be Inadequate

Baby lung physiology may exist before the acute lung injury

Airway pressure does not show pleural pressure

FiO_2 may rise when the real issue is under-recruitment

A PEEP table cannot fully personalize chest wall mechanics

TPM Fundamentals

A 3-D view of lung mechanics

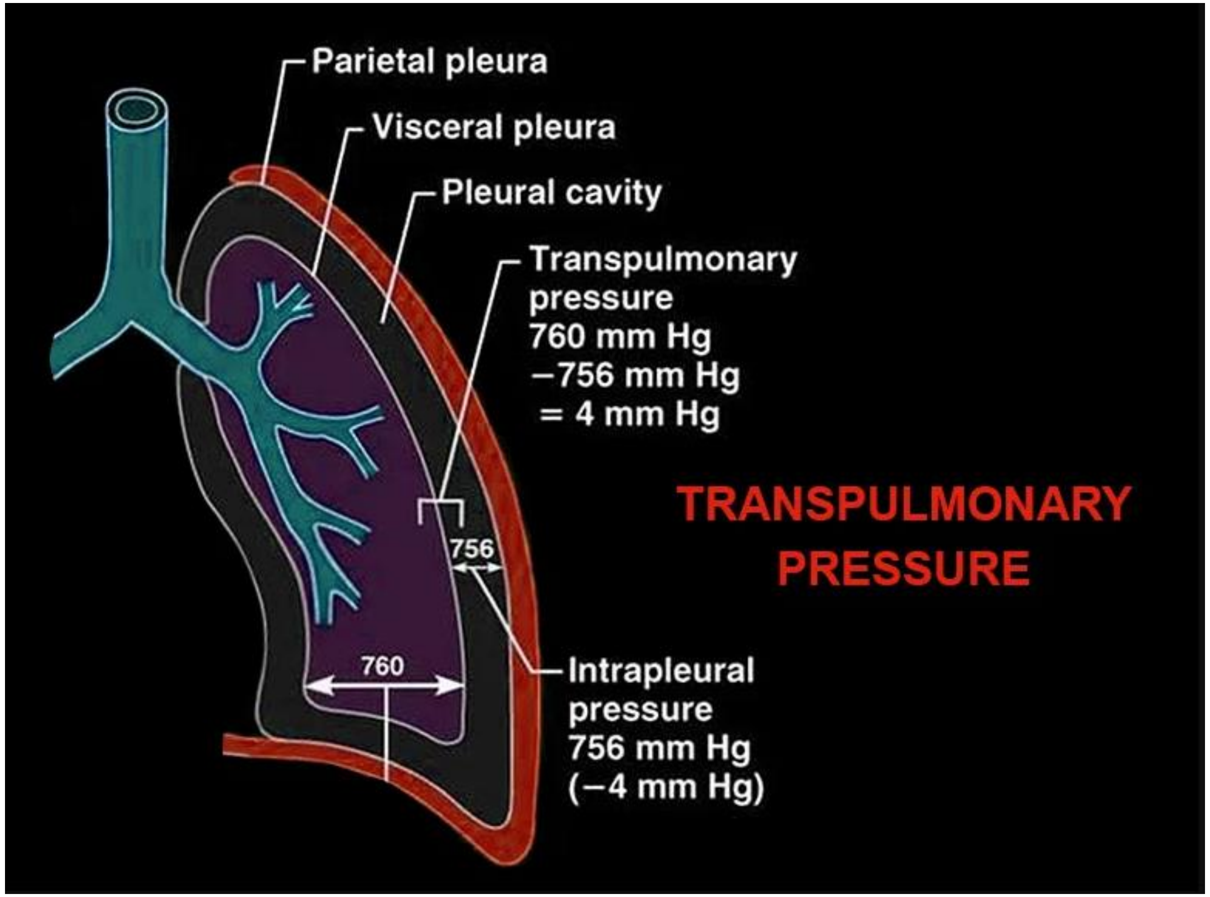
What Is Transpulmonary Pressure?

TPP = Airway Pressure − Pleural Pressure

Represents the distending pressure across the lung

Helps separate airway pressure from lung stress

Guides ventilation beyond a 2-D airway pressure view



Why TPM Matters

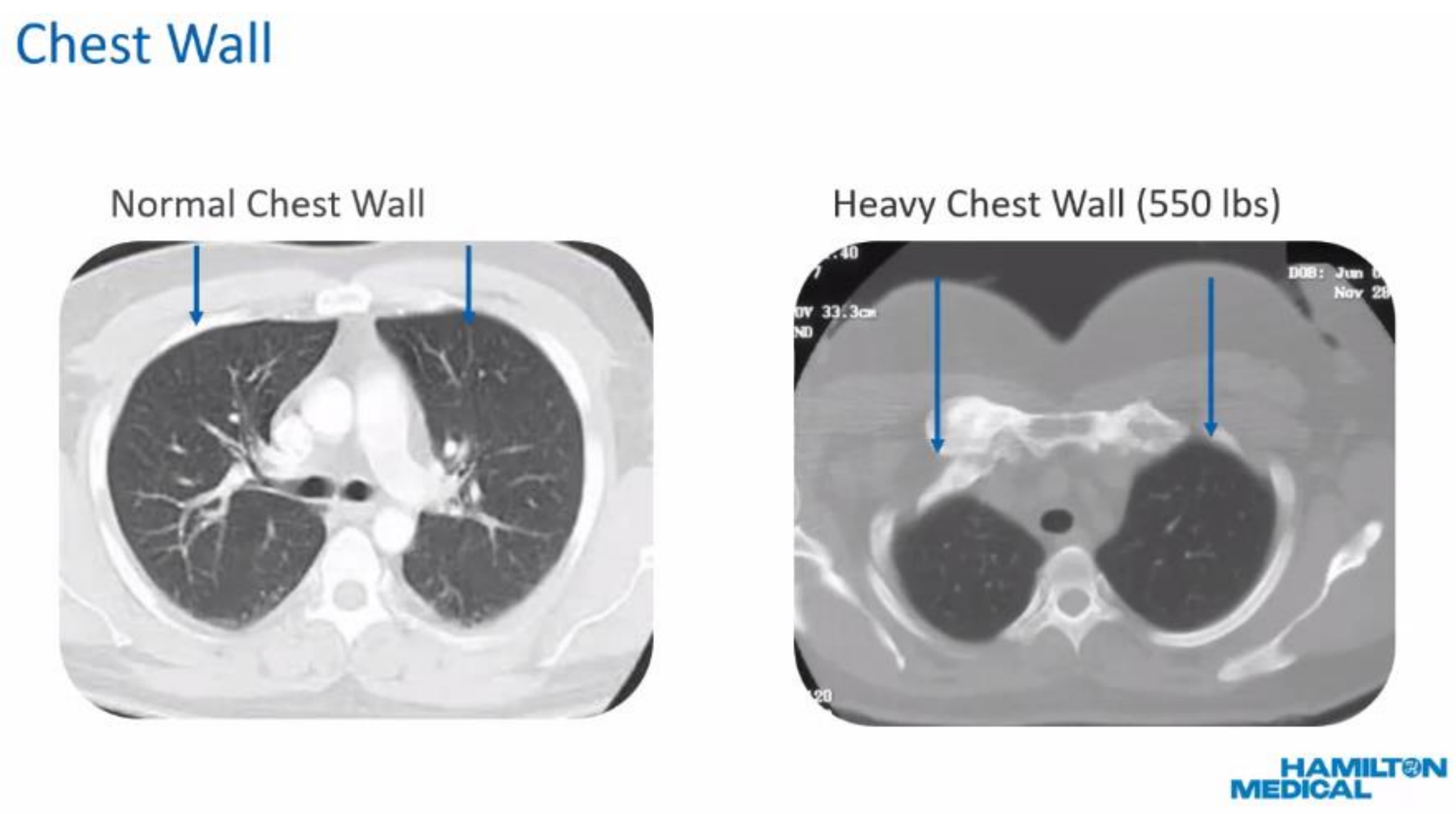
Personalized PEEP

Improved oxygenation

Reduced under-recruitment

Reduced risk of overdistention

More confidence when higher PEEP is physiologically appropriate



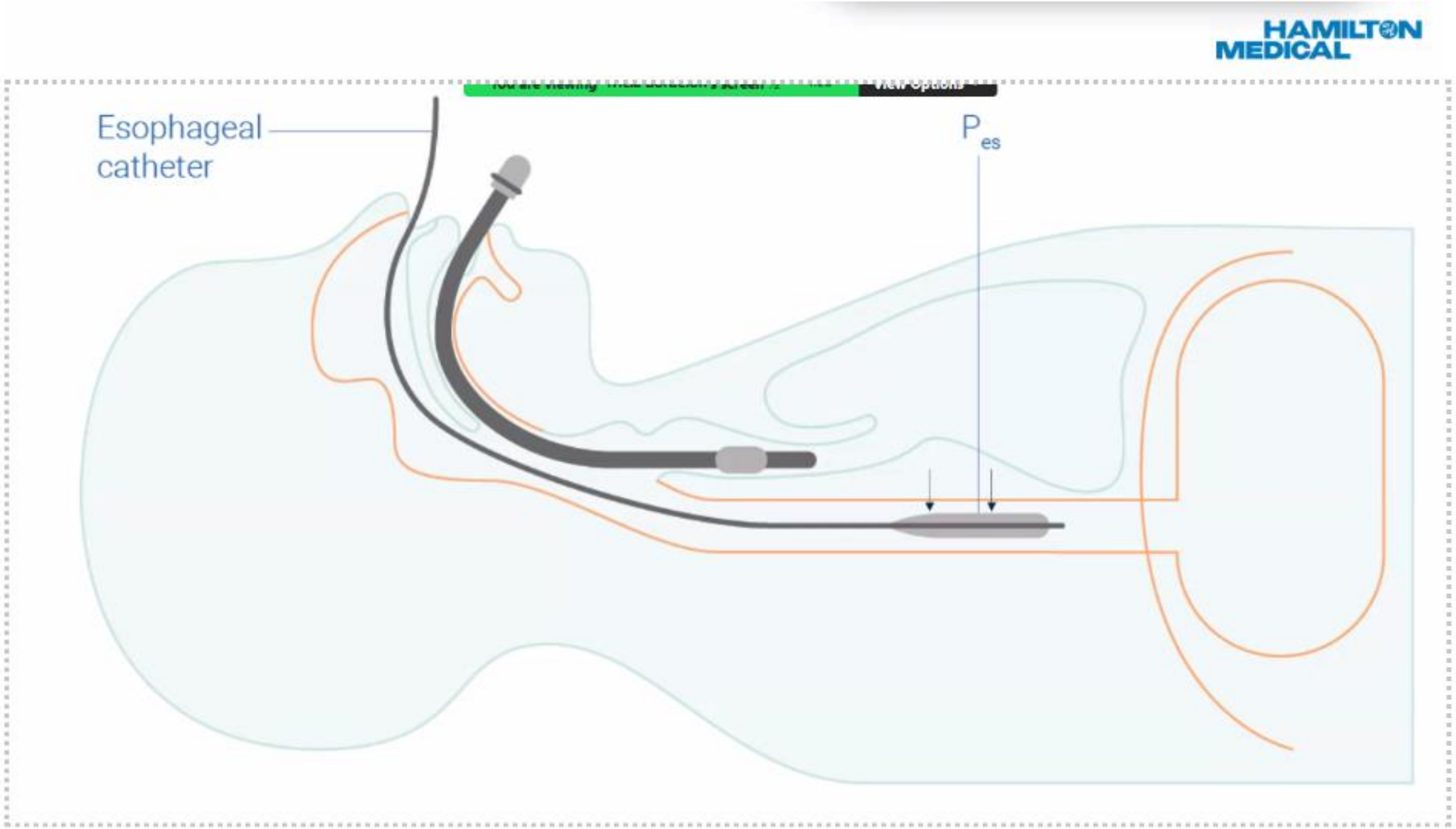
How the Esophageal Balloon Works

Esophagus sits within the thorax

The balloon passively transmits surrounding pressure

Pes estimates mid-thoracic pleural pressure

Pressure swings help estimate pressure outside the lung



Esophageal Balloon: Indications & Contraindications

INDICATIONS

- Chest wall compliance is suspected (in consultation with attending MD)
- Obese intubated patients with BMI > 30 considered for preferential inclusion, especially the morbidly obese
- Intra-abdominal hypertension (abdominal compartment syndrome)
- Pregnancy
- Certain chest wall deformities
- Consider TPP when driving pressures above 15 cmH_2O

CONTRAINDICATIONS

- Esophageal varices, trauma, surgery, tumors, ulcerations, diverticulitis
- Recent gastric surgery (since current admission)
- Severe coagulopathy
- Transesophageal fistula
- Exclusion for NG tube placement
- If placement in nares: sinusitis, epistaxis, recent nasopharyngeal surgery

ARDSNet and the Personalization Gap

Expand the gold standard — do not replace it

ARDSNet Changed Critical Care

ARMA trial focused on tidal volume

ALVEOLI trial focused on PEEP/FiO_2 settings

Together they shaped lung-protective ventilation

ARDSNet remains foundational

BOTH STUDIES EXCLUDED OBESE AND MORBIDLY OBESE PATIENTS

Case Study: Finding my PEEPs

77 y/o · BMI 49 · 96 vent hrs · Survived

Initial — **78** P/F ratio
FiO_2 90% · PEEP 12 · DP 12

After 1 hour of TPM — **350** P/F ratio
FiO_2 50% · PEEP 24 · DP 9

After 24 hours of TPM — **350** P/F ratio
FiO_2 40% · PEEP 16 · DP 9

Extubated to BiPAP 18/10/45%

ARDSNet PEEP / FiO_2 Reference

Lower PEEP / higher FiO_2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18-24

Higher PEEP / lower FiO_2

FiO_2	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5-0.8	0.8	0.9	1.0
PEEP	5	8	10	12	14	14	16	18	20	22	22	24

Highlight = patient's FiO_2 at each stage (90% → 50% → 40%)

TPM-guided PEEP (12 → 24 → 16) lifted the P/F ratio from 78 to 350 — beyond standard table settings.

The Gap

Morbidly obese patients were excluded from ARDSnet trials

Obesity changes pleural pressure and chest wall mechanics

A table cannot see the pressure outside the lung

TPM can personalize PEEP for selected patients

Driving Pressure: Bedside Anchor

Driving Pressure = Plateau Pressure – PEEP

Target: <15 cmH_2O

Driving pressure reflects pressure stretching the available lung

Cases repeatedly show improvement after TPM-guided PEEP

Optimized PEEP vs Personalized PEEP

Optimized PEEP

One chosen metric

One "best" PEEP

Examples: FiO_2/PEEP table, driving pressure, P/F ratio

May optimize the wrong variable

Personalized PEEP

Patient-specific physiology

Multiple inputs

Corrects for chest wall pressure

Real-time feedback to clinician

Examples : TPM AND EIT

Research and SCV Data

Audience Case: What Is the Correct P/F Ratio?

40-year-old patient, BMI 53

Admitted for large intracranial bleed

Initial: FiO_2 80%

PEEP 10,

PaO_2 91,

DP=10

P/F 114

TPM Reveals the Answer

After 1 hour TPM: FiO_2 40%, PEEP 18, DP 6, PaO_2 129, P/F 322

After 24 hours: FiO_2 40%, PEEP 14, DP 7, PaO_2 132, P/F 330

Patient survived; transferred ventilator dependent due to neurologic status

Key question: what was the “right” PEEP?

432 total ventilator hours; 18 days in hospital

SCV Evidence-Based Practice Council Study Inclusion

July 2024–January 2026

Mechanically ventilated patients with BMI >30

Driving pressure goal: <15 cmH_2O

PtpPlat target: <10 cmH_2O

PtpPEEP target: 0 to +2 cmH_2O

Transition to conventional ventilation when FiO_2 at 40% for 12–48 hours

Over 28 patients included in research article for publication, over 42 patients it was applied to. Only obese and morbidly obese patients were included in this study.

The protocol research design was to target patients with BMI over 30 to demonstrate feasibility of protocol

BMI >30 is Obese, BMI>40 is Class III (morbidly obese)

SCV TPM Results: Show me the money

51

Mean BMI

128 h

Mean ventilator hours

17→13→11

Mean Driving pressure
Baseline → 1h → 24h

99→172→185

P/F ratio
Baseline → 1h → 24h

70→110→135

PaO_2
Baseline → 1h → 24h

13→20→18

Median PEEP
Baseline → 1h → 24h

Value and Workflow

Clinical impact first, economics second

Case Study: Hypoxic or Unrecruited?

62 y/o · BMI 46 · 72 vent hrs · Survived

Initial
FiO_2 100% · PEEP 16 · DP 8
69 P/F ratio

After 1 hour of TPM
FiO_2 100% · PEEP 25 · DP 12
210 P/F ratio

After 24 hours of TPM
FiO_2 40% · PEEP 20 · DP 7
171 P/F ratio

Survived — SBT on PEEP 10, pressure support 5

ARDSNet PEEP / FiO_2 Reference

Lower PEEP / higher FiO_2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18-24

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PEEP	5	8	10	12	14	14	16	18	20	22	22	24

Highlight = patient's FiO_2 at each stage (100% → 100% → 40%)

TPM-guided PEEP (16 → 25 → 20) lifted the P/F ratio from 69 to 210 and weaned FiO_2 from 100% to 40%.

Why It Makes $ense

TPM balloon cost approximately

- $150 for Hamilton Ventilator
- $550 for Servo Ventilator

INO estimated around $6,000 per 24 hours

Technology already exists on Hamilton and Servo service lines

Potential reduction in salvage therapies

Reduction in ventilator days by 0.5 days for TPP used in conjunction with DWS, SBT's BID, Progressive Mobilization for vented patients

Reduction for ICU length of stay due to reduction in ventilator days and ability to transfer to Ltach sooner

All of these patients were prevented from going on INO or were immediately weaned due to lower oxygen demand

Sending a patient home who was so close to death and watch them recover is Pricele$$

Challenges and Calibration

Estimating pleural pressure is complex

Anatomy and patient positioning affect measurements

Balloon placement and calibration matter

Various methods for balloon volume to improve accuracy

- Baydur modified test,
- Mojoli assessment
- Mari slow-flow calibration are methods to improve accuracy

Training and competency are essential

There is a learning curve with measurements and clinical application

I Am Not Replacing ARDSNet

ARDSNet changed critical care

ARDSNet remains foundational

Morbidly obese patients were excluded

TPM can expand care for a population not fully represented in the original trials

This is precision ventilation — not abandonment of lung-protective ventilation

ARDSnet has been the gold standard in ICU care

This is the platinum standard

Five Take-Home Messages

Morbid obesity changes pleural pressure and lung mechanics

Airway pressure alone may not reflect lung stress

TPM helps personalize PEEP, reduce driving pressure resulting in improved oxygenation faster

Respiratory therapists can lead physiology-guided ventilator precision

It's a small price in equipment but priceless in its impact

Questions

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References

1. Ahn HJ. Driving pressure guided ventilation. *Korean J Anesthesiol*. 2020;73(3):194-204. doi:10.4097/kja.20041
2. American Association of Respiratory Care. Clinical practice guidelines. Accessed March 16, 2026. https://www.aarc.org/resource/clinical-practice-guidelines/
3. ARDSNet.
4. Centers for Disease Control and Prevention. Obesity data and statistics. UCLA CHIS 2020. County of San Diego Community Health Statistics Unit.
5. Centers for Disease Control and Prevention. Obesity data and statistics. Updated December 15, 2023. Accessed May 19, 2026.
6. Emmerich SD, Fryar CD, Stierman B, Ogden CL. Obesity and severe obesity prevalence in adults: United States, August 2021-August 2023. *NCHS Data Brief*. No. 508.
7. Graham JE, Westcott A, Daniels R. Getting high on PEEP: esophageal balloon for PEEP optimization in obese patients with respiratory failure. *Am J Respir Crit Care Med*. 2025;211(suppl 1).
8. Kozdas B. Obesity modified the effect of PEEP during spontaneous breathing in acute hypoxemic respiratory failure. *Respir Care*. 2026;71(4). doi:10.1177/19433654251399184
9. Liou J. Retrospective review of transpulmonary pressure guided positive end expiratory pressure titration for mechanical ventilation in class II and III obesity. *Crit Care Explor*. 2022;4(5).
10. Mari A. Dynamic slow-flow esophageal balloon pressure-volume curve calibration. *Respir Care*. 2023;68(11):1561-1564.
11. Pirrone M. Recruitment maneuvers and PEEP titration in morbidly obese ICU patients. *Crit Care Med*. 2016;44(2):300-307.
12. Westcott A. Person-centered mechanical ventilation using esophageal pressure manometry to improve oxygenation in patients with BMI >30. *Crit Care Nurs Q*. Under peer review.
13. Zambon M, Vincent JL. Mortality rates for acute lung injury/ARDS have decreased over time. *Chest*. 2008;133(5):1120-1127.