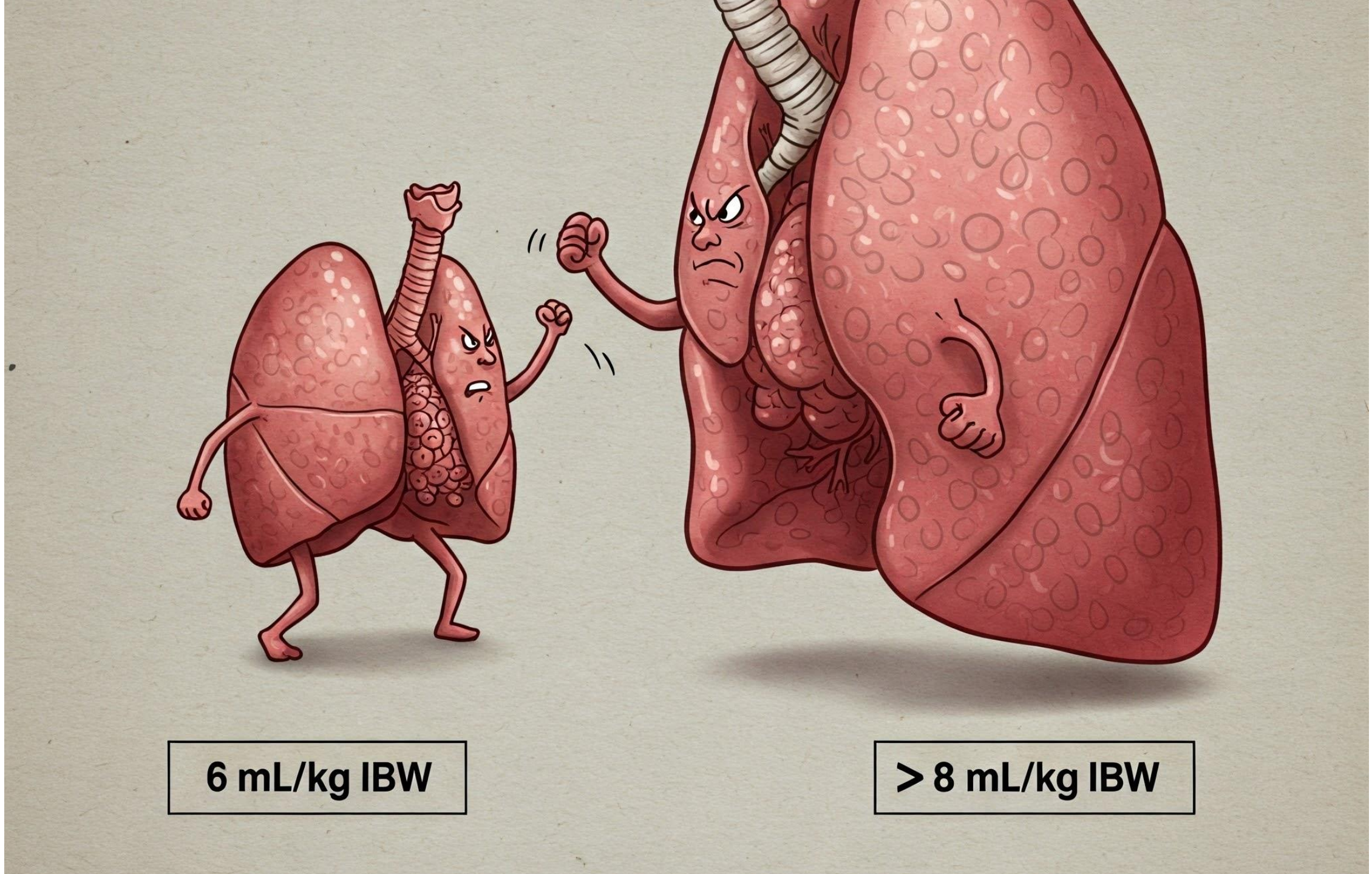
Finding the Perfect Tidal Volume: 6-8 ml/kg for All or > 8 ml/kg in Those without ARDS

Panel Discussion with:

Skyler Lentz, MD and Tara Privee, RRT

Katelin Morrisette, MD and Mike Marciel, RRT


6 mL/kg IBW
> 8 mL/kg IBW

The New England Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

> 8 ml/kg Team

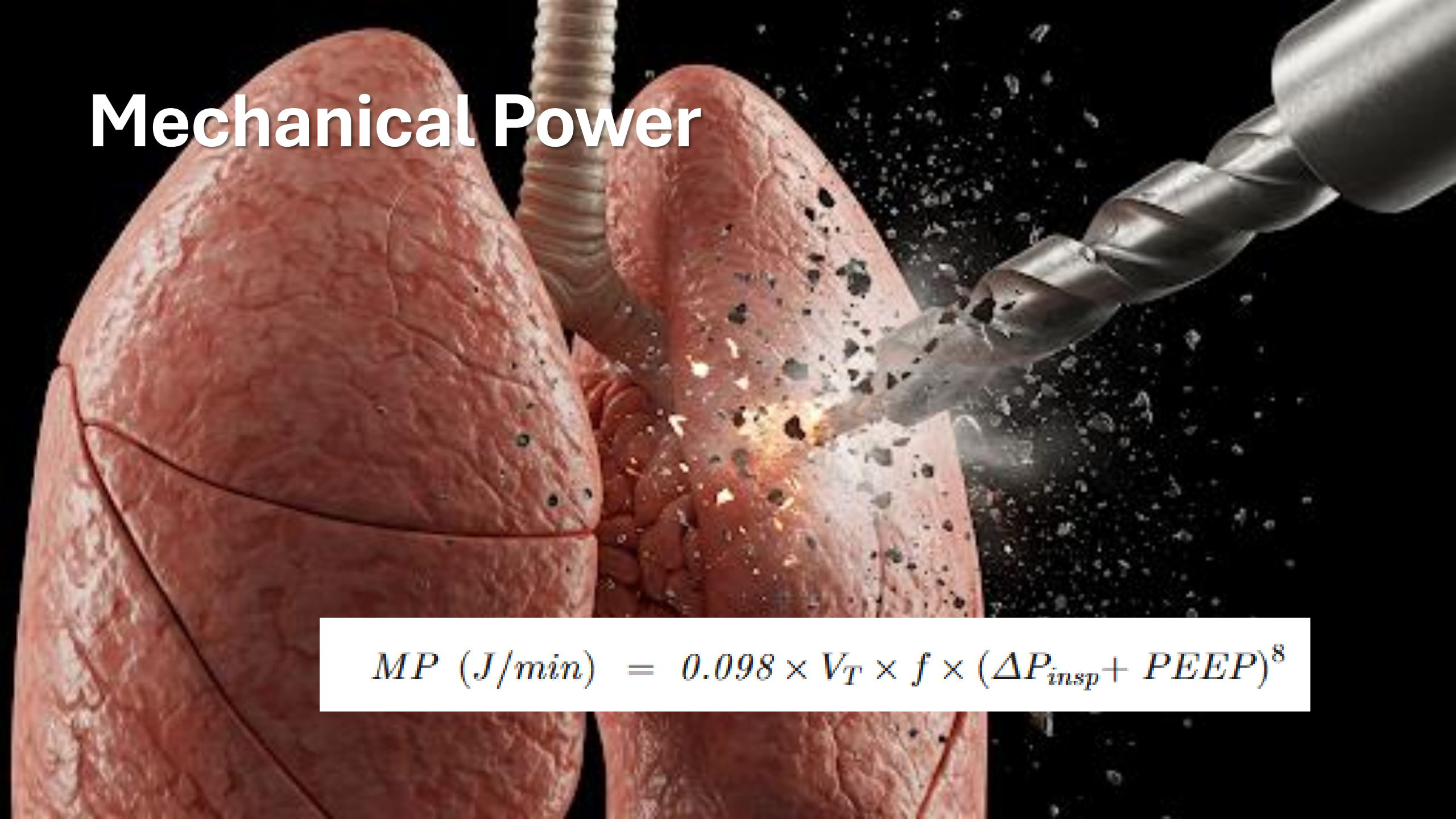
12 ml/kg PBW

vs

6 ml/kg PBW

In patients with ARDS

Mechanical Power



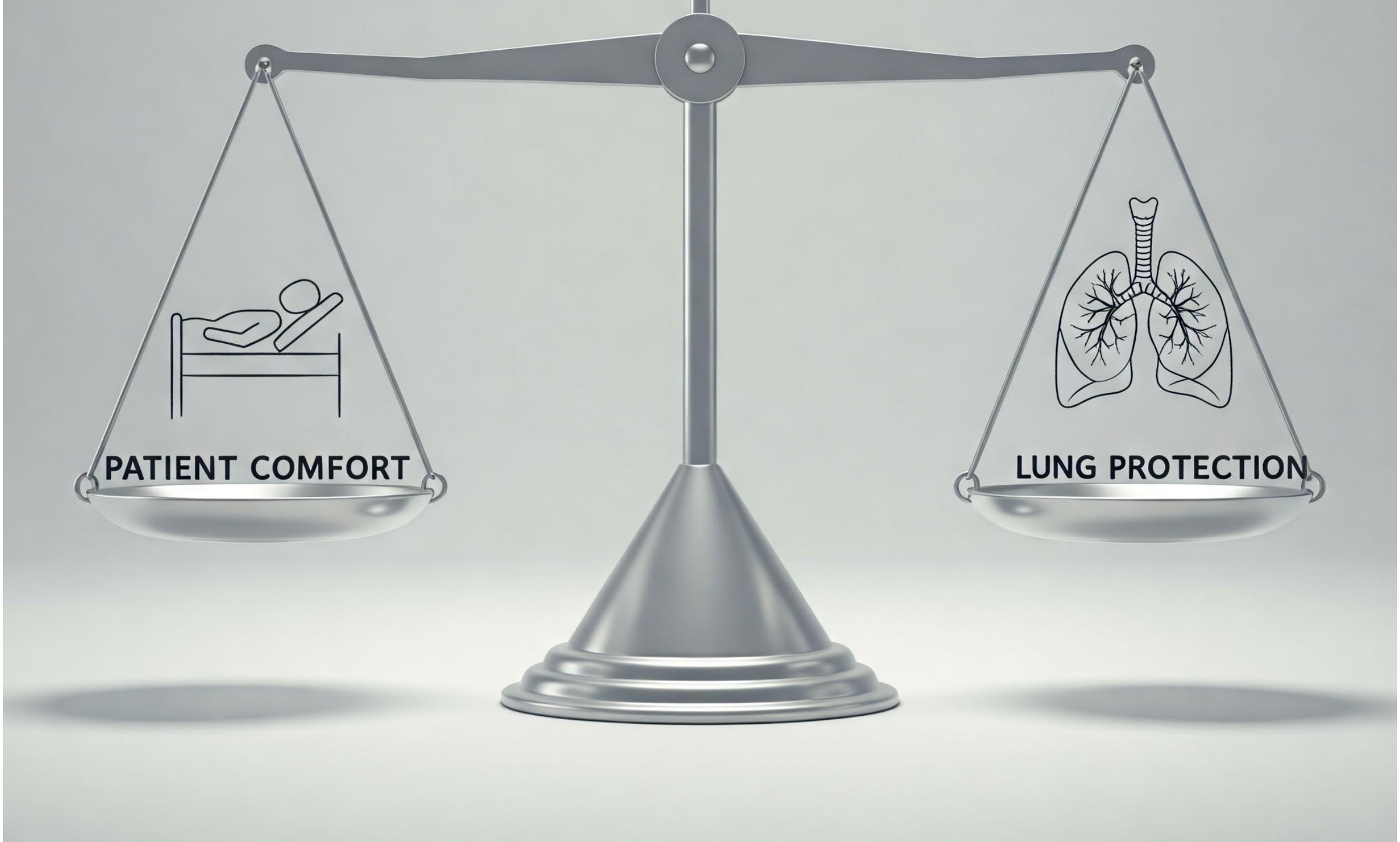
$$MP\ (J/min) = 0.098 \times V_T \times f \times (\Delta P_{insp} + PEEP)^8$$

Anaesthesia 2025, 80, 533-542 doi:10.1111/anae.16537

Original Article

Association of ventilation volumes, pressures and rates with the mechanical power of ventilation in patients without acute respiratory distress syndrome: exploring the impact of rate reduction

Laura A. Buiteman-Kruizinga,[1,2] **David M. P. van Meenen,**[2,3] **Ary Serpa Neto,**[4,5] **Guido Mazzinari,**[6] **Lieuwe D. J. Bos,**[2,7] **Pim L. J. van der Heiden,**[1] **Frederique Paulus,**[2,8] and **Marcus J. Schultz**[2,9] **for the NEBULAE,**[†] **PReVENT**[‡] **and RELAx**[§] **investigators***


PATIENT COMFORT
LUNG PROTECTION

ORIGINAL RESEARCH

Effect of Tidal Volume Size and Its Delivery Mode on Patient–Ventilator Dyssynchrony

Juan B. Figueroa-Casas[1] and Ricardo Montoya[2]

[1]Division of Pulmonary and Critical Care Medicine, Texas Tech University Health Sciences Center, El Paso, Texas; and [2]Respiratory Care Department, University Medical Center of El Paso, El Paso, Texas

ORCID ID: 0000-0003-3057-3849 (J.B.F.-C.).

More dyssynchrony in low tidal volume group as compared to 9 ml/kg in VC mode.

Adaptive mode less dyssychrony at set low tidal volume - allowed larger tidal volume.

Original Investigation | Caring for the Critically Ill Patient

FREE

November 13, 2018

Effect of a Low vs Intermediate Tidal Volume Strategy on Ventilator-Free Days in Intensive Care Unit Patients Without ARDS

A Randomized Clinical Trial

Writing Group for the PReVENT Investigators

Article Information

JAMA. 2018;320(18):1872-1880. doi:10.1001/jama.2018.14280

6 ml/kg

vs

10 ml/kg
(plateau pressure < 25 cm H2O)

In those without ARDS

Driving Pressure

Low tidal volume **10 cm H2O**

Intermediate tidal volume **14 cm H2O**

Plateau Pressure

Low tidal volume **18-20 cm H2O**

Intermediate tidal volume **20-22 cm H2O**

Respiratory Rate

Low tidal volume **25-30/min**

Intermediate tidal volume **15-18/min**

No difference!

Ventilator free days
Mortality
Development of ARDS
Pneumothorax

Are there any patients that > 8 ml/kg may be better?

ORIGINAL ARTICLE

Lung-Protective Mechanical Ventilation in Patients with Severe Acute Brain Injury

A Multicenter Randomized Clinical Trial (PROLABI)

Luciana Mascia[1], Vito Fanelli[2,3], Alice Mistretta[4], Matteo Filippini[5], Mattia Zanin[2], Maurizio Berardino[4], Anna Teresa Mazzeo[6], Anselmo Caricato[7], Massimo Antonelli[8,9], Francesco Della Corte[10,11], Francesca Grossi[11], Marina Munari[12], Massimiliano Caravello[12], Francesco Alessandri[13], Irene Cavalli[14], Mario Mezzapesa[13], Lucia Silvestri[13], Marilena Casartelli Liviero[16], Paolo Zanatta[16], Paolo Pelosi[17,18], Giuseppe Citerio[19,20], Claudia Filippini[2], Paola Rucci[15], Frank A. Rasulo[5], and Tommaso Tonetti[14,21]

Protective:
6 ml/kg PBW PEEP 8 cm H_2O

vs

Conventional:
≥ 8 ml/kg PBW PEEP 4 cm H_2O

Tidal Volume

6.6 ml/kg vs 8.5 ml/kg PBW

Driving pressure

8.5 cm H_2O vs 10.5 cm H_2O

Respiratory Rate

21/min vs 15/min

$PaCO_2$

38.4-39.8 mm Hg vs 36.4-37.5 mm Hg

Outcomes in 200 patients

Protective vs. Conventional

Mortality 28 days 28.9% vs 15.1%

Vent Dependency at 28 days 42.3% vs 27.9%

ARDS at 28 days 30.8% vs 22.1% * (p 0.179)

Pro Conclusion

Higher Vt probably causes less dyssynchrony

10 ml/kg PBW safe in those without ARDS

Preliminary data supports higher Vt in brain injured without ARDS

6-8ml/kg Team

1994

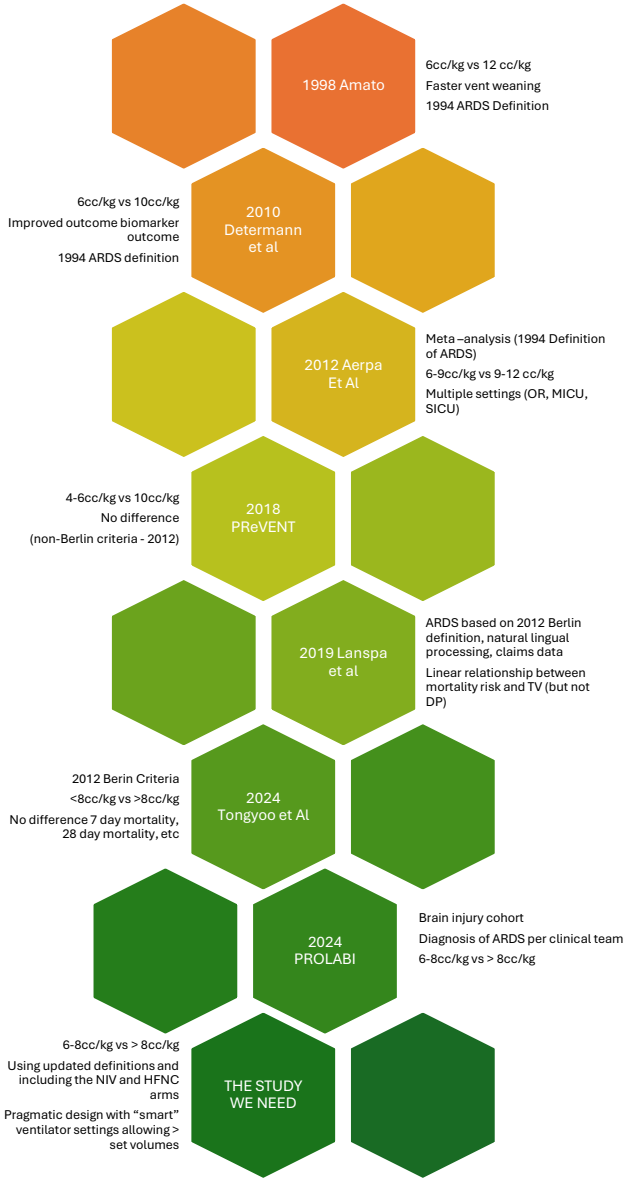
- the syndrome must present acutely
- hypoxemia, measured as PaO2/FIO2 ratio <200 (the ratio is >450 in healthy persons)
- bilateral infiltrates on chest radiograph
- cannot be due to cardiac failure (elevated left atrial pressure), as evidenced by either clinical examination or a PCWP >18 cm H2O

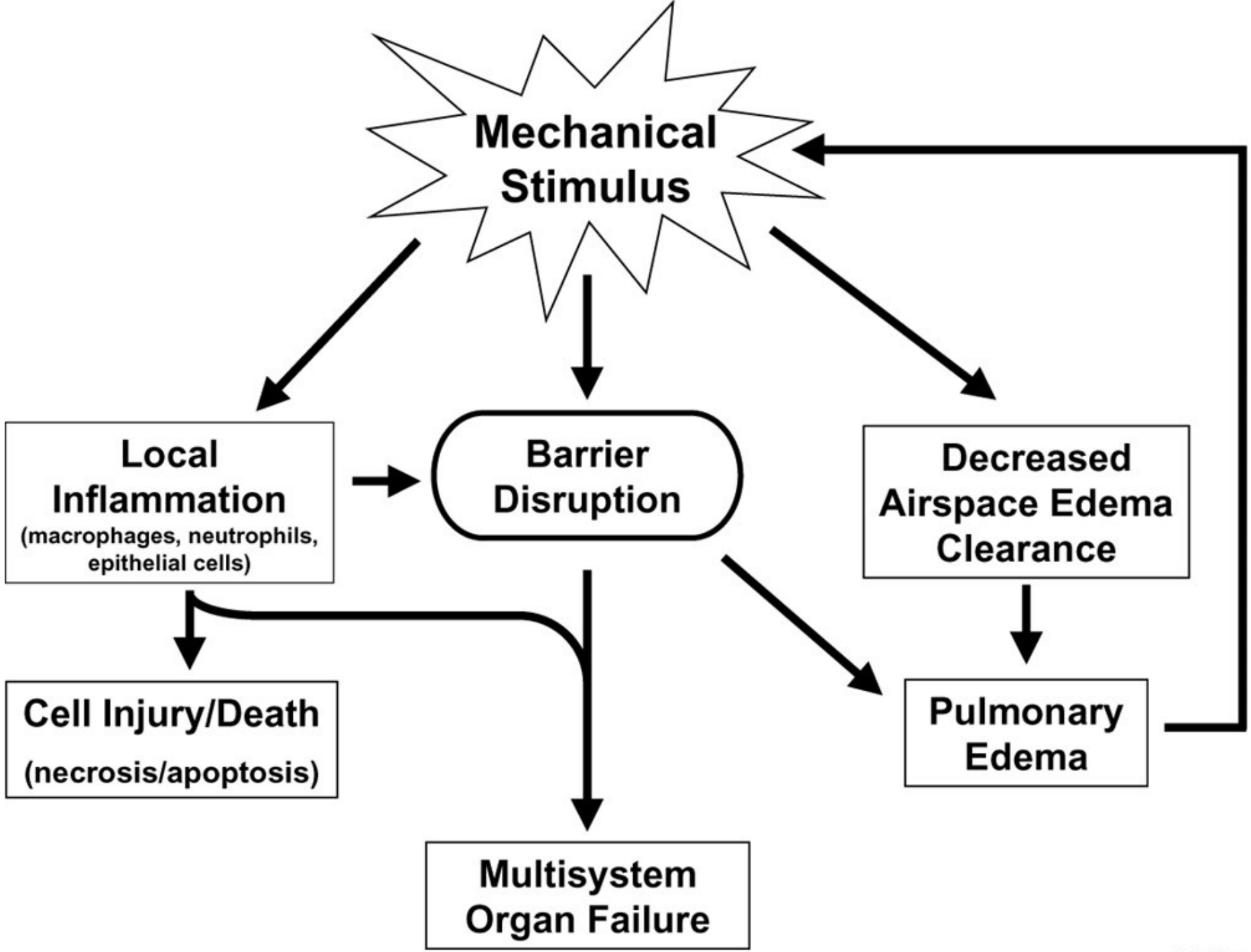
2012- Berlin

- Defines “acute” to be < 1 week
- Severity scoring introduced
- PEEP requirement for Pa/FiO2 measurements

2023

- Modified in the post-COVID era to allow HFNC and NIV




Mechanical Stimulus
Local Inflammation
(macrophages, neutrophils, epithelial cells)
Barrier Disruption
Decreased Airspace Edema Clearance
Cell Injury/Death
(necrosis/apoptosis)
Pulmonary Edema
Multisystem Organ Failure

Research indicates that excessive tidal volume is recognized as the first cause of VILI.

Use of lower Vt at the start and throughout mechanical ventilation in healthy lungs is associated with lower risk of developing ALI/ARDS.

Ventilation with lower tidal volumes as compared with conventional tidal volumes for patients without acute lung injury: a preventive randomized controlled trial

Determann *et al. Critical Care* 2010, **14**:R1

Methods

Compared tidal volumes of 10 ml *versus* 6 ml /kg of PBW in patients without ALI at start of MV.

Primary end point was cytokine levels in bronchoalveolar lavage fluid and plasma.

Secondary end point was development of lung injury, duration of mechanical ventilation, and mortality.

MV with 10cc tidal volumes:

Associated with sustained cytokine production.

Contributes to the development of lung injury.

MV with 6cc tidal volumes:

The use of lower tidal volumes did not affect sedation needs or vasopressor use.

Was not associated with altered requirements for higher PEEP or additional FiO2.

Review Article

Low Tidal Volume Ventilation in Patients without Acute Respiratory Distress Syndrome: A Paradigm Shift in Mechanical Ventilation

Critical Care Research and Practice
Volume 2012, Article ID 416862, 12 pages

Conclusion

There is clear evidence from large randomized trials that protective ventilation can reduce morbidity and mortality in patients with ALI and ARDS.

More recently, significant data has emerged suggesting that a protective ventilation strategy in patients without ALI/ARDS may lead to a reduction in inflammation, less organ dysfunction, and less ALI.

Chose the right tool for the job…

“Double cycling is uncommon but occurs in all patients. Periods without double cycling alternate with periods with clusters of double cycling. The volume of the stacked breaths can double the set tidal volume in volume control-continuous mandatory ventilation with constant flow…”

Double Cycling During Mechanical Ventilation: Frequency, Mechanisms, and Physiologic Implications*

de Haro, Candelaria MD[1,2]; López-Aguilar, Josefina PhD[1,2]; Magrans, Rudys PhD[1,2]; Montanya, Jaume MScEng[3]; Fernández-Gonzalo, Sol PhD[1,4]; Turon, Marc PhD[1,2]; Gomà, Gemma BScN[1]; Chacón, Encarna BScN[1]; Albaiceta, Guillermo M. MD, PhD[2,5,6]; Fernández, Rafael MD, PhD[2,7]; Subirà, Carles MD[7]; Lucangelo, Umberto MD, PhD[8]; Murias, Gastón MD[9]; Rué, Montserrat PhD[10,11]; Kacmarek, Robert M. RTT, PhD[12,13]; Blanch, Lluís MD, PhD[1,2]

Author Information

Critical Care Medicine 46(9):p 1385-1392, September 2018. | **DOI:** 10.1097/CCM.0000000000003256

Chose the right tool for the job…

"During reverse triggering, patient inspiratory efforts start after the passive insufflation by mechanical breaths…Reverse triggering can cause breath-stacking and loss of protective lung ventilation when triggering a second cycle."

Reverse Triggering during Controlled Ventilation: From Physiology to Clinical Management

Antenor Rodrigues [1], Irene Telias [1,2,3], L. Felipe Damiani [4], and Laurent Brochard [1,2]

- Auto-triggering: triggering due to something other than patient breath initiation (NOT a volume problem)
- Inadequate flow (NOT the same as volume problem)
- Flow overshoot (NOT a volume problem)
- Premature cycling (NOT the same as volume)
- Delayed cycling (NOT a volume problem)

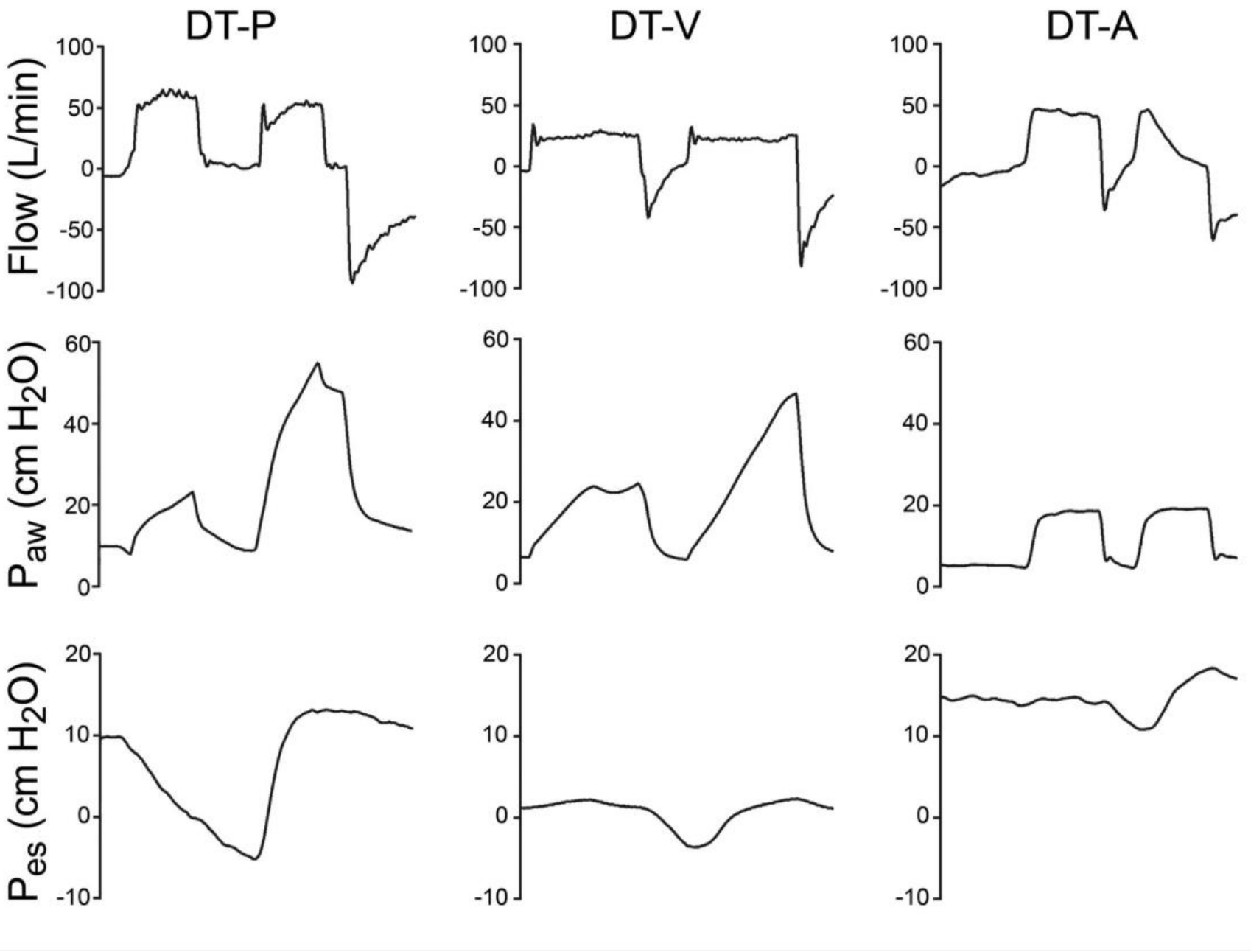
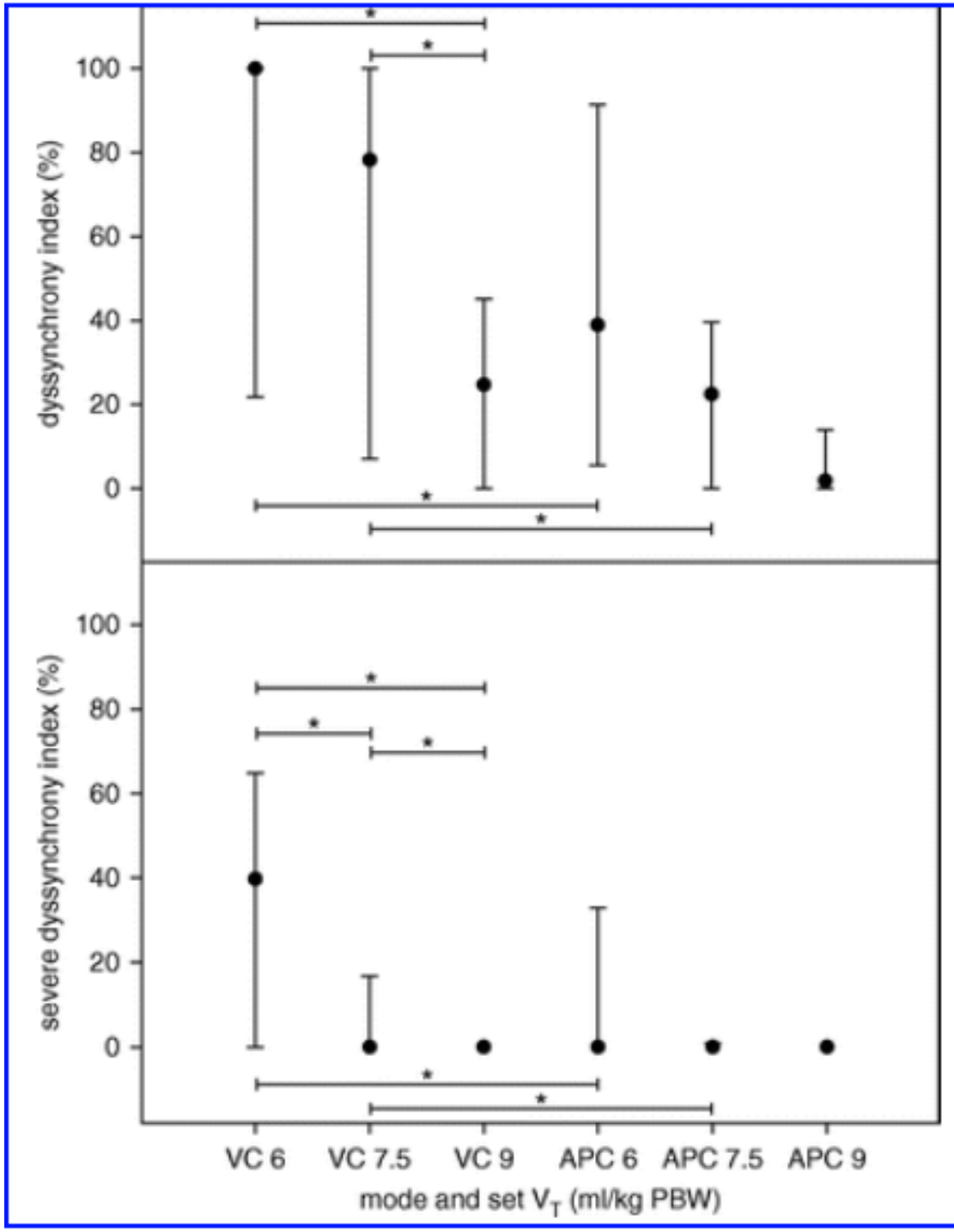


Fig. 1. Typical flow, airway pressure, and esophageal pressure tracings of double-triggering, by the patient (DT-P), the ventilator (DT-V), and auto-triggering (DT-A).

Effect of Tidal Volume Size and Its Delivery Mode on Patient–Ventilator Dyssynchrony

Juan B. Figueroa-Casas [1] and Ricardo Montoya [2]



Conclusion slide for Mike/Katelin

Ok the patient is now double triggering on 6 ml/kg

Ok you did 10 ml/kg and the plateau is 26 cm H_2O and driving pressure is 16 cm H_2O

Panel Questions


Individualize Tidal Volume
6-10 ml/kg PBW
Monitor for Safe Pressure
Plateau < 25 cm H_2O
Driving Pressure < 15cm H_2O

Evidence

Acute Respiratory Distress Syndrome Network; Brower RG, Matthay MA, Morris A, Schoenfeld D, Thompson BT, Wheeler A. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. N Engl J Med. 2000 May 4;342(18):1301-8. doi: 10.1056/NEJM200005043421801. PMID: 10793162.

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Figueroa-Casas JB, Montoya R. Effect of Tidal Volume Size and Its Delivery Mode on Patient-Ventilator Dyssynchrony. Ann Am Thorac Soc. 2016 Dec;13(12):2207-2214. doi: 10.1513/AnnalsATS.201605-362OC. PMID: 27598383.