Cá thể hóa cài đặt thở máy trong ARDS

(Personalized mechanical ventilation in ARDS)

BS Huỳnh Quang Đại

Bộ môn Hồi sức Cấp Cứu Chống Độc

ĐHYD TP. Hồ Chí Minh

Tại sao cần cá thể hóa cài đặt trong ARDS?

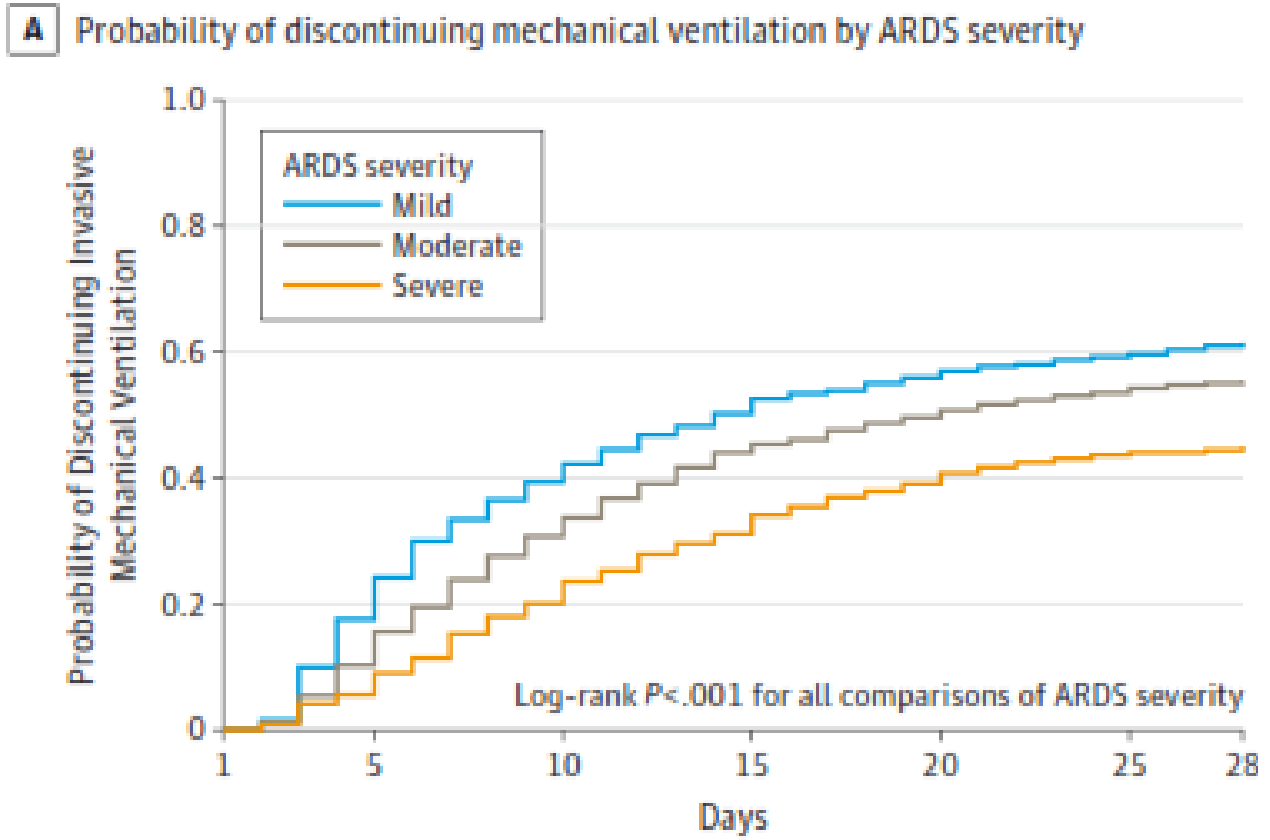
JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

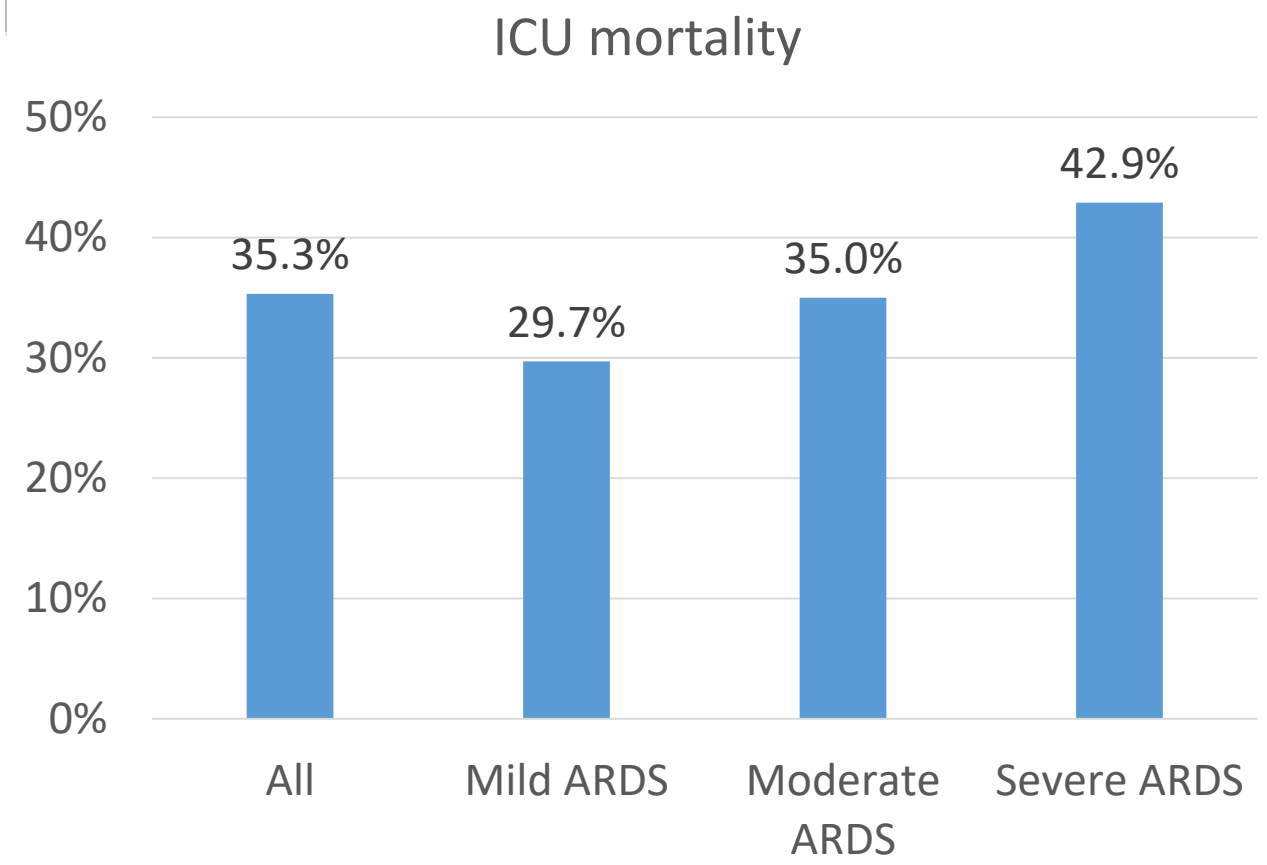
Epidemiology, Patterns of Care, and Mortality for Patients With Acute Respiratory Distress Syndrome in Intensive Care Units in 50 Countries

Giacomo Bellani, MD, PhD; John G. Laffey, MD, MA; Tài Pham, MD; Eddy Fan, MD, PhD; Laurent Brochard, MD, HDR; Andres Esteban, MD, PhD; Luciano Gattinoni, MD, FRCP; Frank van Haren, MD, PhD; Anders Larsson, MD, PhD; Daniel F. McAuley, MD, PhD; Marco Ranieri, MD; Gordon Rubenfeld, MD, MSc; B. Taylor Thompson, MD, PhD; Hermann Wrigge, MD, PhD; Arthur S. Slutsky, MD, MASc; Antonio Pesenti, MD; for the LUNG SAFE Investigators and the ESICM Trials Group

JAMA. 2016;315(8):788-800. doi:10.1001/jama.2016.0291

Tại sao cần cá thể hóa cài đặt trong ARDS?





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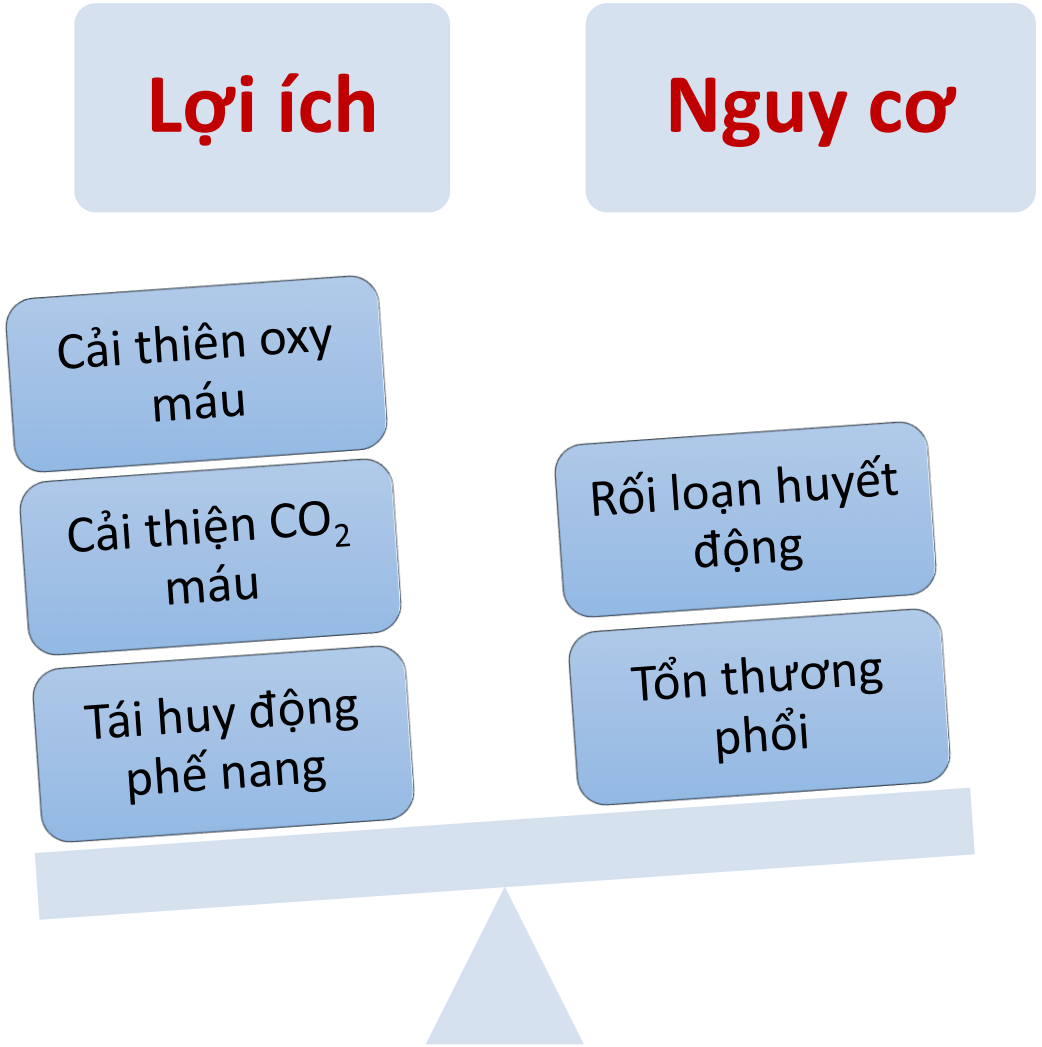


Chen et al. Critical Care (2017) 21:84

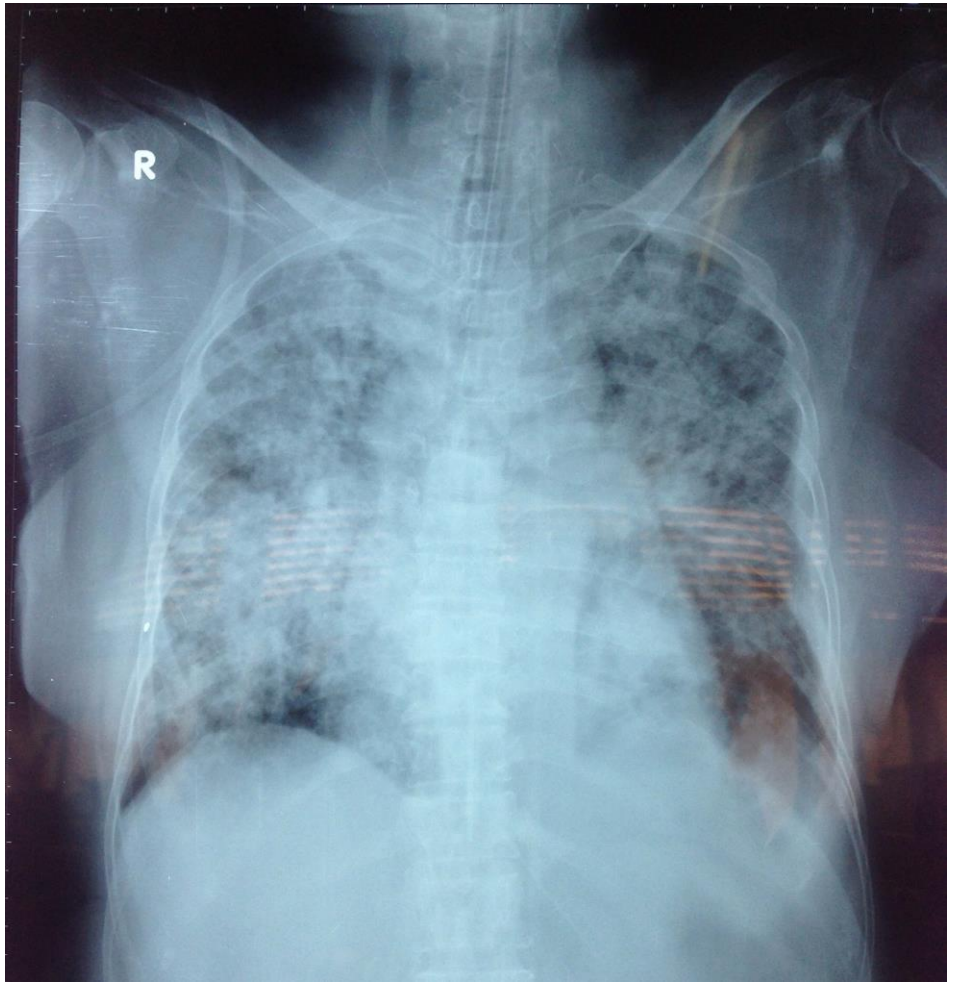
Thông khí bảo vệ phổi trong ARDS

- **Cài đặt:**
  - Vt thấp
  - PEEP cao
  - Tần số cao
- Liệu pháp bổ sung
  - Giãn cơ
  - Mở phổi
  - Nằm sấp
  - …

- **Mục tiêu:**
  - PaO2 55-80 mmHg
  - SaO2 88-95%
  - PaO2 40-55mmHg, pH > 7.25
- **Điều chỉnh để**
  - Pplat <30 cmH20

Cài đặt Tidal Volume (TV)?

Cài đặt tidal volume?



PBW

12

10

8

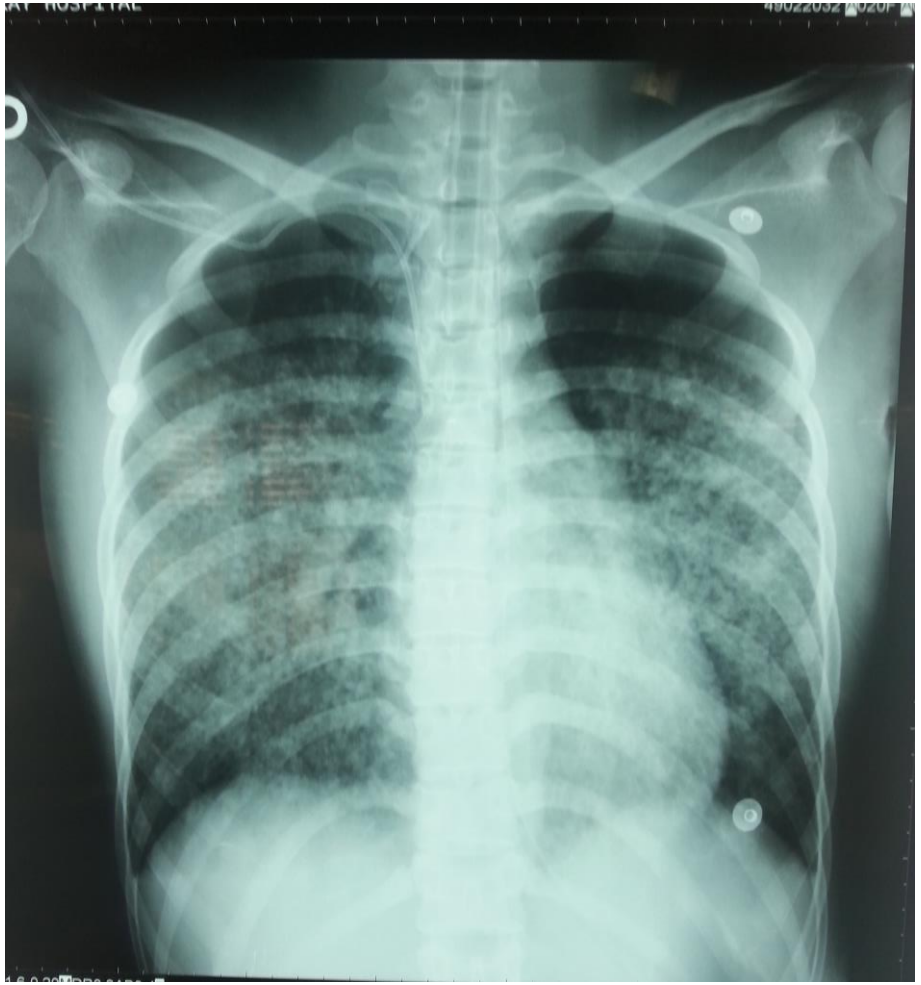
7

6

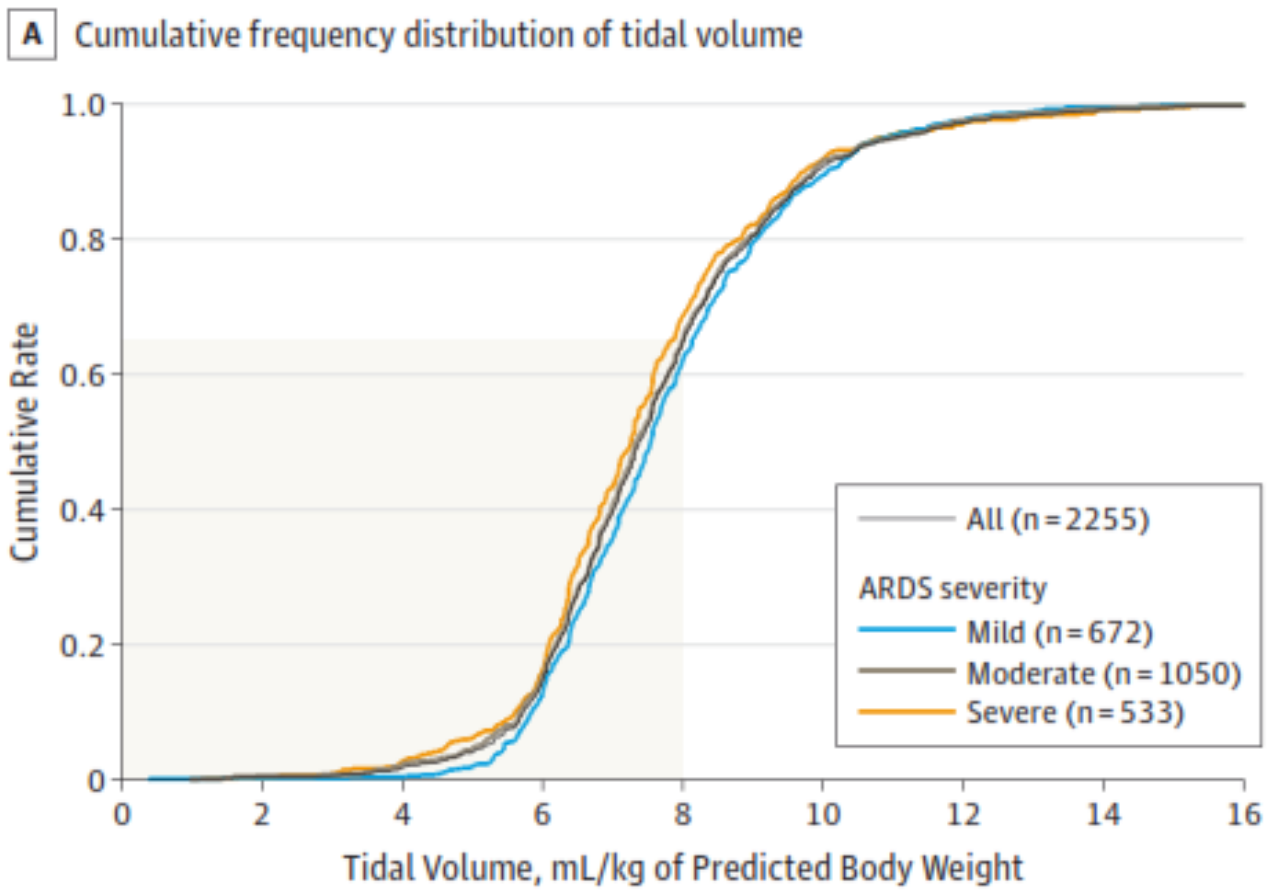
5

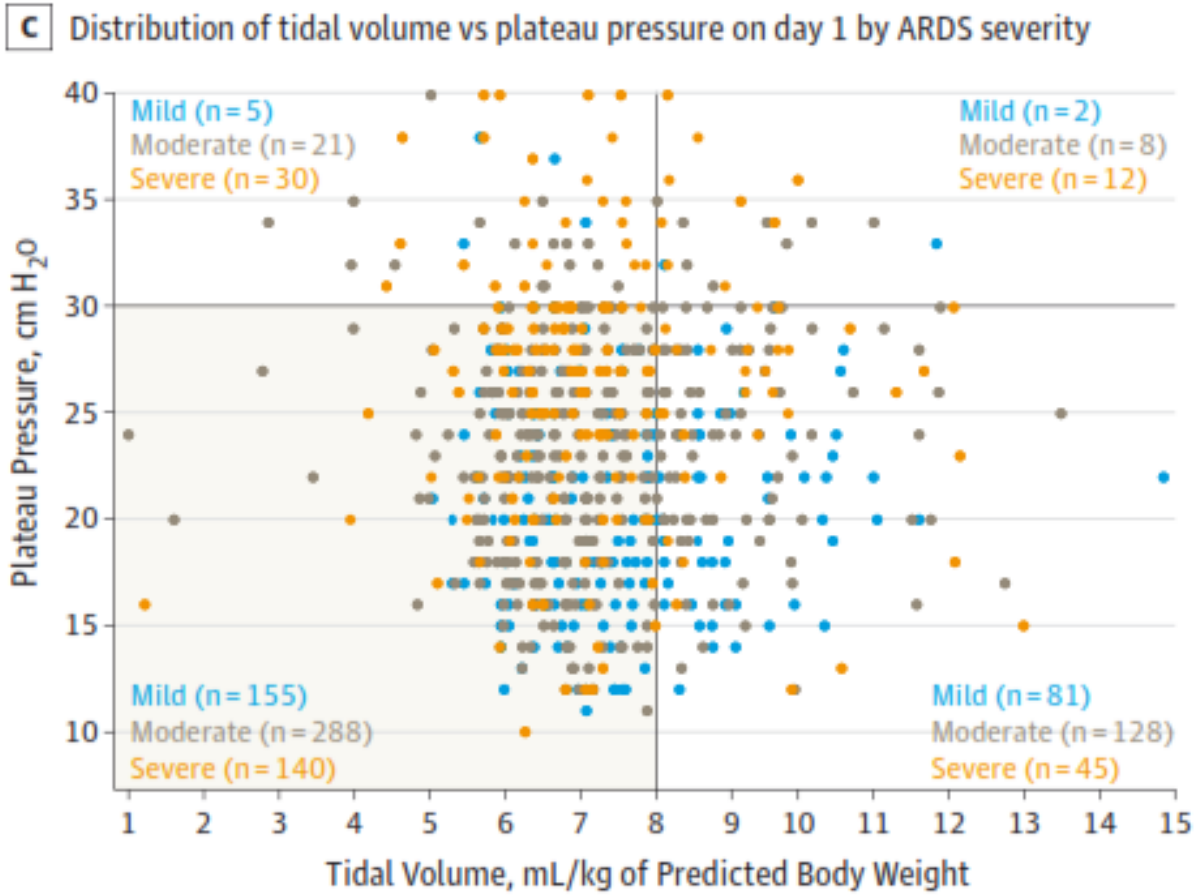
4

3



Cài đặt tidal volume?





JAMA. 2016;315(8):788-800. doi:10.1001/jama.2016.0291

Cài đặt tidal volume?

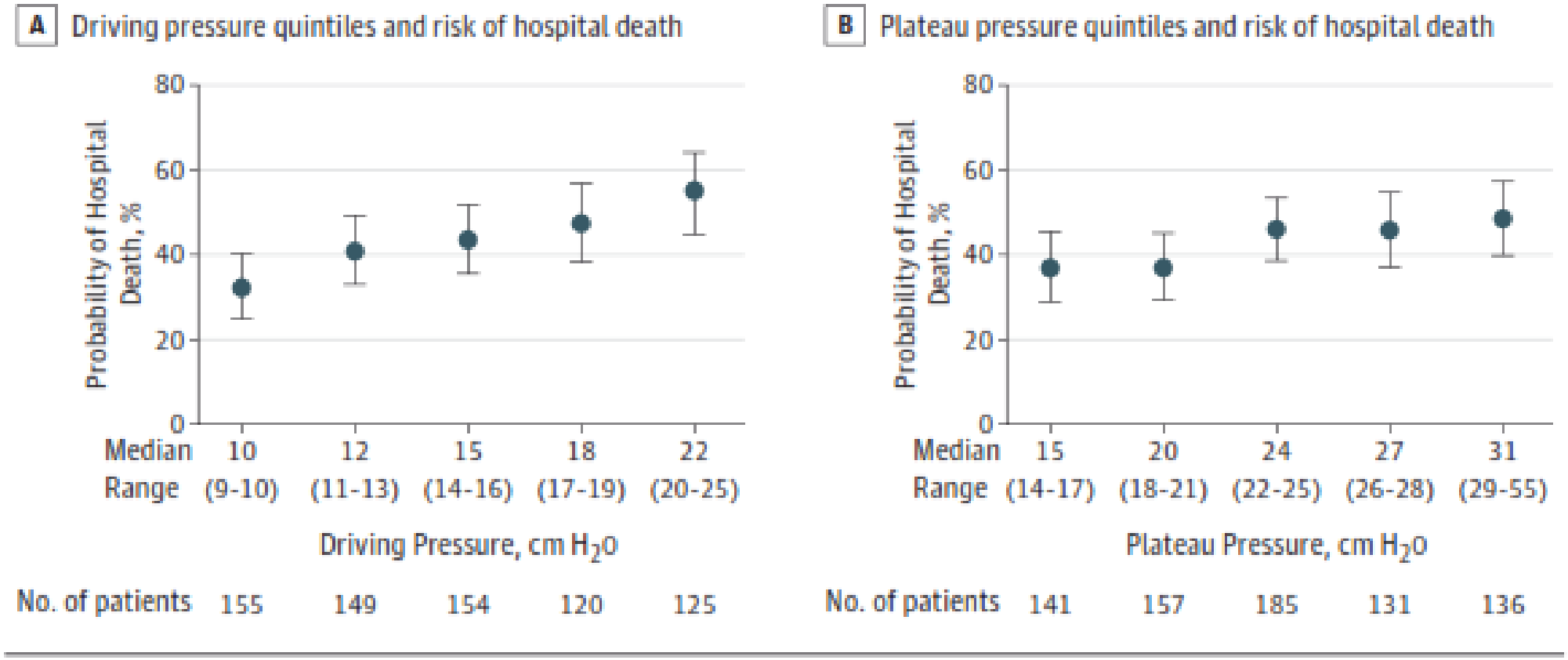
- **PBW?**
  - PBW =50.0+0.91 (height in cm-152.4) for men
  - PBW =45.5+0.91 (height in cm-152.4) for women.

- **Plateau pressure?**
  - **Pplat = PIP - Pres**

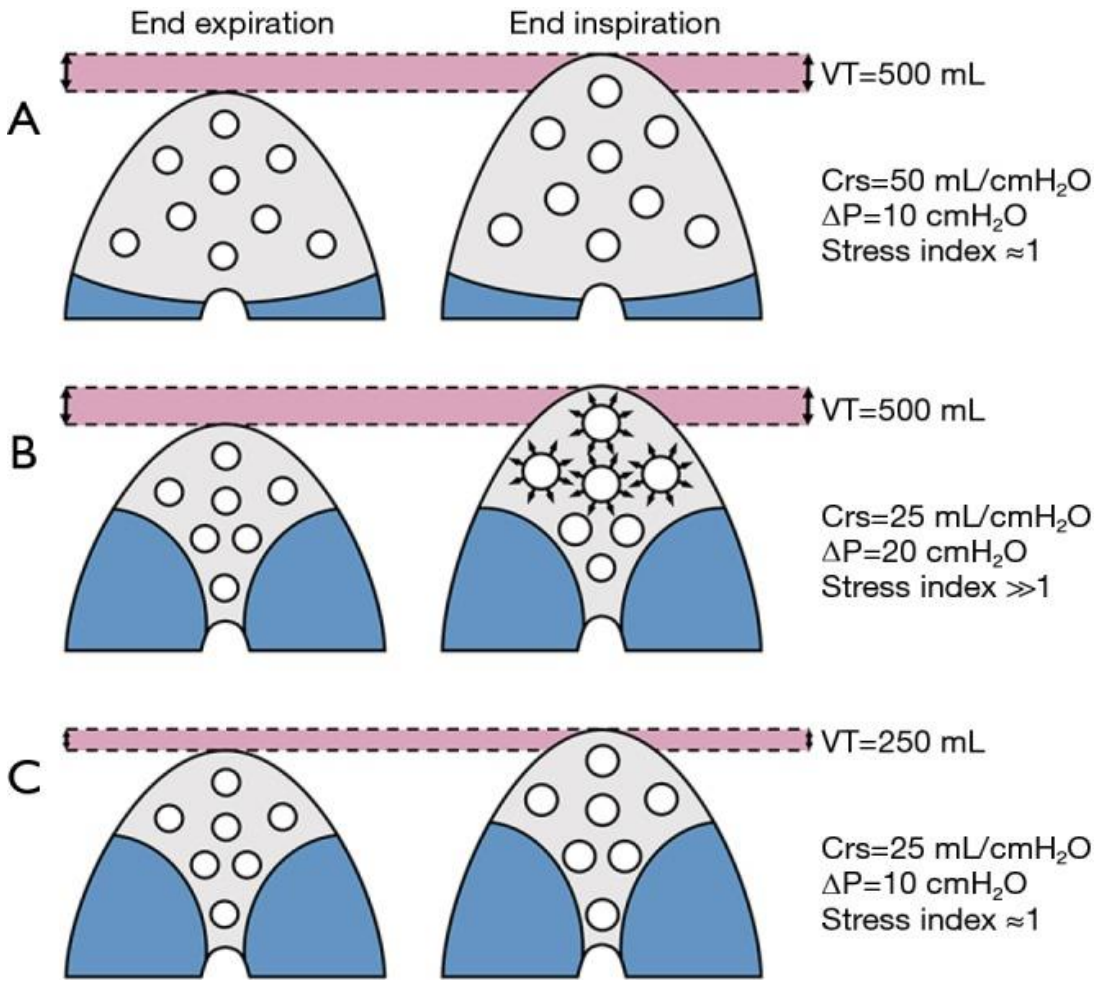
- **Driving pressure?**
  - **ΔP = Pplat - PEEP**
  - **$\Delta P = V_T/C_{rs}$**

Cài đặt tidal volume?

Figure 5. Driving Pressure and Plateau Pressure and Outcome From ARDS



Cài đặt tidal volume?



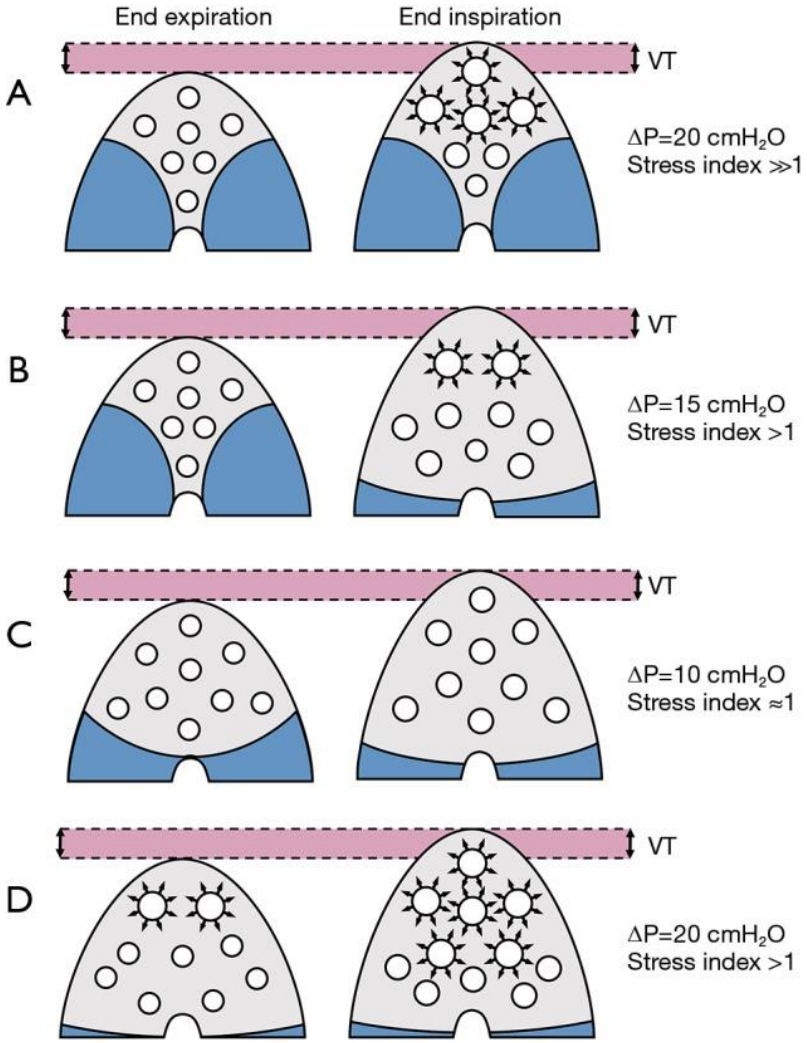
Effects of loss of aeration on the driving pressure.

- The use of 500 mL tidal volume applied to a lung with no loss of aeration and high compliance does not result in tidal hyperinflation (A).
- The same tidal volume applied to a lung with lower compliance and relevant loss of aeration can result in relevant tidal hyperinflation, as suggested by the presence of high ΔP and a stress index above 1 (B).
- The reduction of V_T to 250 mL can balance this phenomenon (C).

V_T, tidal volume; Crs, compliance of the respiratory system; ΔP, driving pressure.

Ann Transl Med. 2018 Oct;6(19):389. doi: 10.21037/atm.2018.09.48.

Cài đặt tidal volume?



Effects on driving pressure and stress index of the application of the same tidal volume on lungs with different characteristics.

- In lungs with relevant loss of aeration and poor recruitment potential, the tidal volume is distributed to a small aerated volume, which undergoes tidal hyperinflation, with very high ΔP and stress index well above 1 (A).
- In similar conditions but with lungs that can be opened during the respiratory cycle, ΔP will be high and stress index slightly increased (B).
- With a modest loss of aeration, ΔP and stress index can be kept within acceptable ranges easily (C).
- In a lung where static hyperaeration is present already at end-expiration, such as in a patient where the lung is kept open with the use of an unnecessarily high PEEP, tidal hyperinflation can overlap to the static hyperaeration (D).

Ann Transl Med. 2018 Oct;6(19):389. doi: 10.21037/atm.2018.09.48.

Cài đặt tidal volume?

Should we use driving pressure to set tidal volume?

Domenico L. Grieco[a,b,c,d], *Lu Chen*[a,b], *Martin Dres*[a,b,e,f], *and Laurent Brochard*[a,b]

Summary

Driving pressure is a bedside available parameter that may help identify patients prone to develop VILI and at increased risk of death. No study had prospectively evaluated whether interventions on DP may provide a relevant clinical benefit, but it appears physiologically sound to try titrating V_T to minimize DP, especially when it is higher than 14 cmH2O and when it has minimal costs in terms of CO2 clearance.

Cài đặt tidal volume?

Review Article

Should we titrate ventilation based on driving pressure? Maybe not in the way we would expect

Paolo Pelosi[1,2], Lorenzo Ball[1,2]

- In non-ARDS patients, ΔP was not found even associated with morbidity and mortality. In ARDS patients, an association between ΔP (higher than 13-15 cmH_2O) and mortality has been reported.
- In several RCTs, when ΔP was minimized by the use of higher PEEP with or without recruitment maneuvers, this strategy resulted in equal or even higher mortality.
- No clear data are currently available about the interpretation and clinical use of ΔP during assisted ventilation.

Ann Transl Med. 2018 Oct;6(19):389. doi: 10.21037/atm.2018.09.48.

Cài đặt tidal volume?

Review Article

Should we titrate ventilation based on driving pressure? Maybe not in the way we would expect

Paolo Pelosi[1,2], Lorenzo Ball[1,2]

- Optimization of mechanical ventilation is important to minimize ventilator-induced lung injury and improve outcome.
- ΔP is an indicator of severity of the lung disease, mainly related to V_T size and associated with complications and mortality. We recommend the use of ΔP to optimize V_T but not PEEP during surgery, and in critically ill patients with and without ARDS. Further information is needed about the possible use of ΔP to optimize ventilator setting during assisted mechanical ventilation.

Ann Transl Med. 2018 Oct;6(19):389. doi: 10.21037/atm.2018.09.48.

Cài đặt tidal volume?

Review Article

Tidal volume in acute respiratory distress syndrome: how best to select it

Michele Umbrello[1], Antonella Marino[2], Davide Chiumello[1,2]

- Plateau pressure
- Driving pressure
- Stress/strain
- VILI and mechanical power

$$POWER = 0.098 \times RR \times TV^2 \times \left(Ers \times \frac{1}{2} RR \times \frac{(1 + I:E)}{60 \cdot I:E} \times Raw \right) + TV \times PEEP$$

Cài đặt PEEP?

Cài đặt PEEP?

- **Hiệu quả của PEEP:**
  - Tái huy động phế nang
  - Cải thiện oxy hóa máu
  - Cải thiện compliance phổi
- **Hậu quả của PEEP**
  - Căng quá mức phế nang (Overdistension)
  - Tổn thương phổi: tăng stress và strain
  - Rối loạn huyết động
  - Tăng khoảng chết

JAMA. 2016;315(8):788-800. doi:10.1001/jama.2016.0291

Cài đặt PEEP?

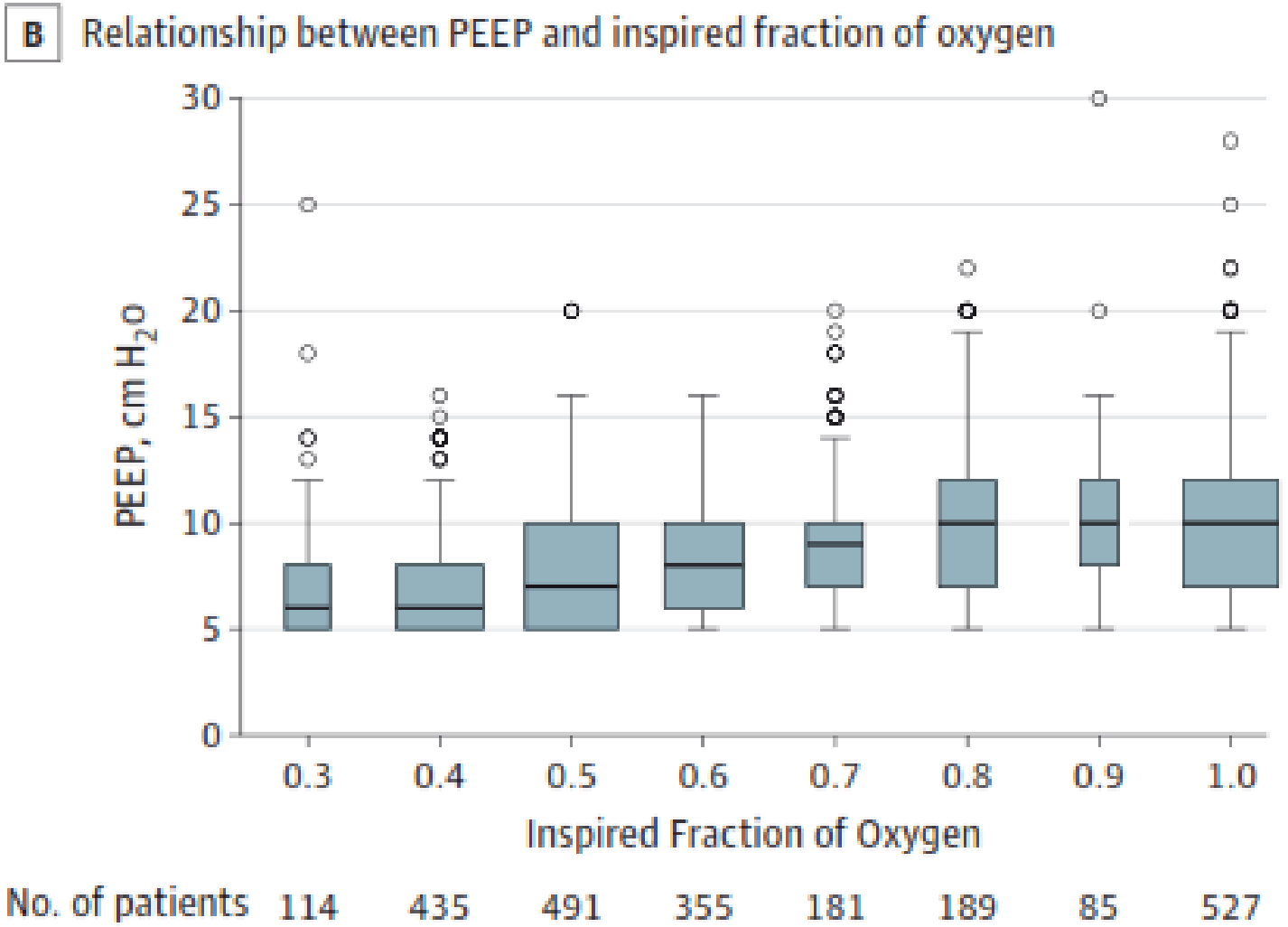
Lower PEEP/F_{IO_2} Combination*													
F_{IO_2}	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0
PEEP, cm H_2O	5	5	8	8	10	10	10	12	14	14	14	16	18	18–24

Higher PEEP/F_{IO_2} Combination†													
F_{IO_2}	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.7	0.8	0.8	0.9	1.0
PEEP, cm H_2O	12	14	14	16	16	18	20	20	20	20	22	22	22–24

Definition of abbreviation: PEEP = positive end-expiratory pressure.

https://doi.org/10.1164/rccm.201610-2035CI

Cài đặt PEEP?



JAMA. 2016;315(8):788-800. doi:10.1001/jama.2016.0291

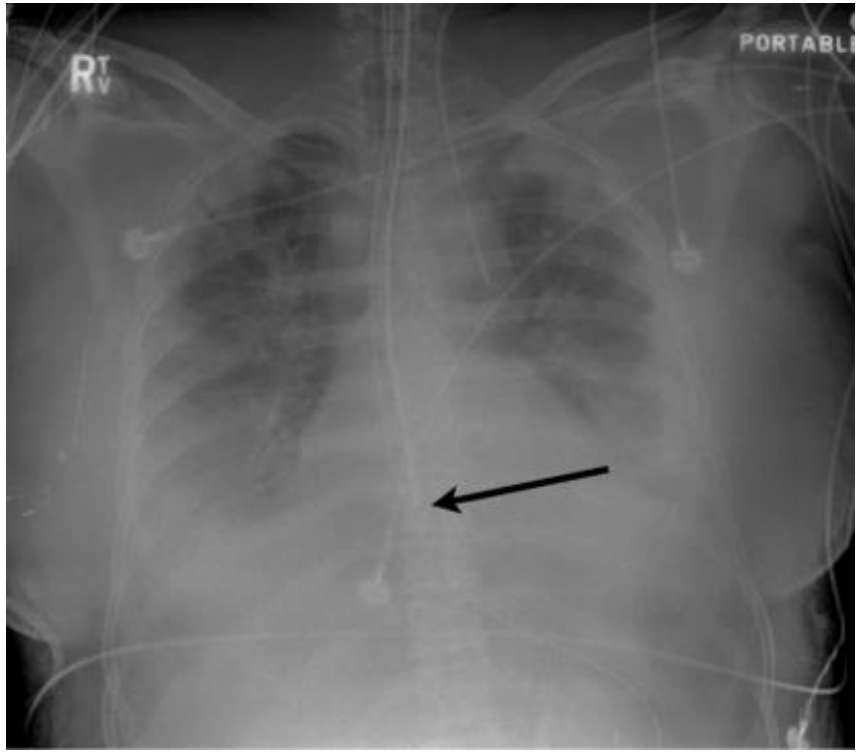
Cài đặt PEEP theo áp lực xuyên phổi

Optimal PEEP Guided by Esophageal Balloon Manometry

Tom Piraino and Deborah J Cook

Respiratory Care April 2011, 56 (4) 510-513; DOI: https://doi.org/10.4187/respcare.00815

- Bệnh nhân nữ, 46 tuổi, BMI 22.5, sốc nhiễm khuẩn do sỏi niệu quản, nhập ICU sau khi hồi sức với rất nhiều dịch (>5000ml), sử dụng vận mạch liều cao.
- Thở máy FiO2 100%, PEEP 24, mở phổi nhiều lần, SpO2 78-85%.
- Báng bụng nhiều. Áp lực ổ bụng 29mmHg



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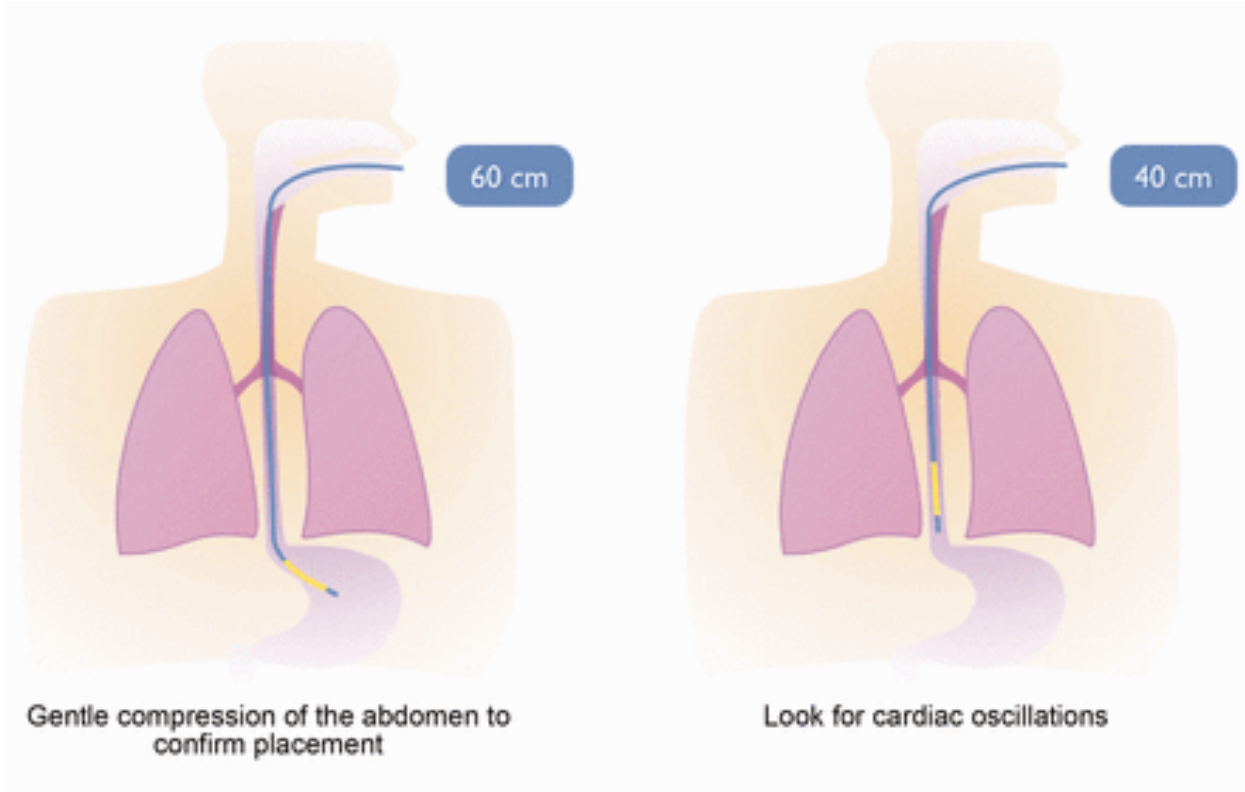

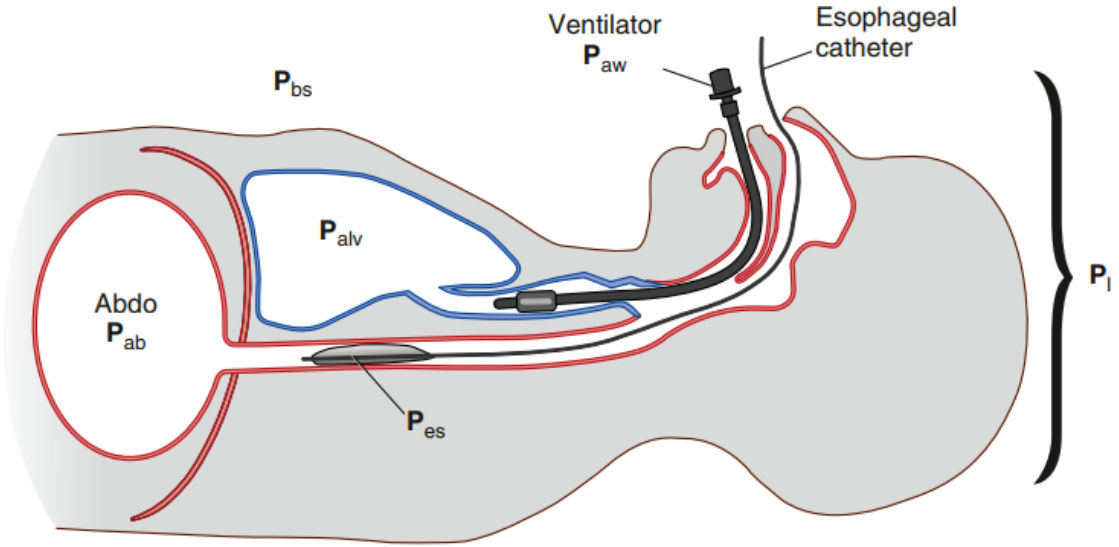

Figure 2. The clinician can directly measure the pressure from the ventilator at the airway opening (airway pressure [Paw]) and reference it to body surface pressure (Pbs). Esophageal pressure (Pes) may also be directly measured with a balloon manometer. Transpulmonary pressure (P_L) = Paw − Pes. The 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.

Cài đặt PEEP theo áp lực xuyên phổi

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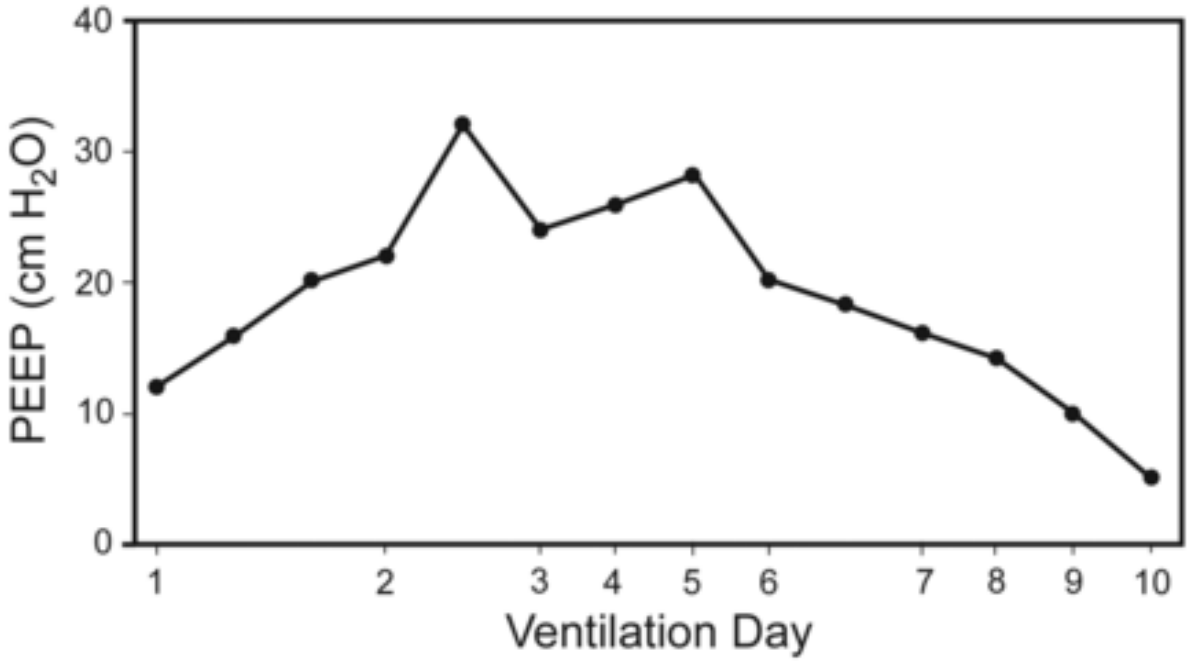

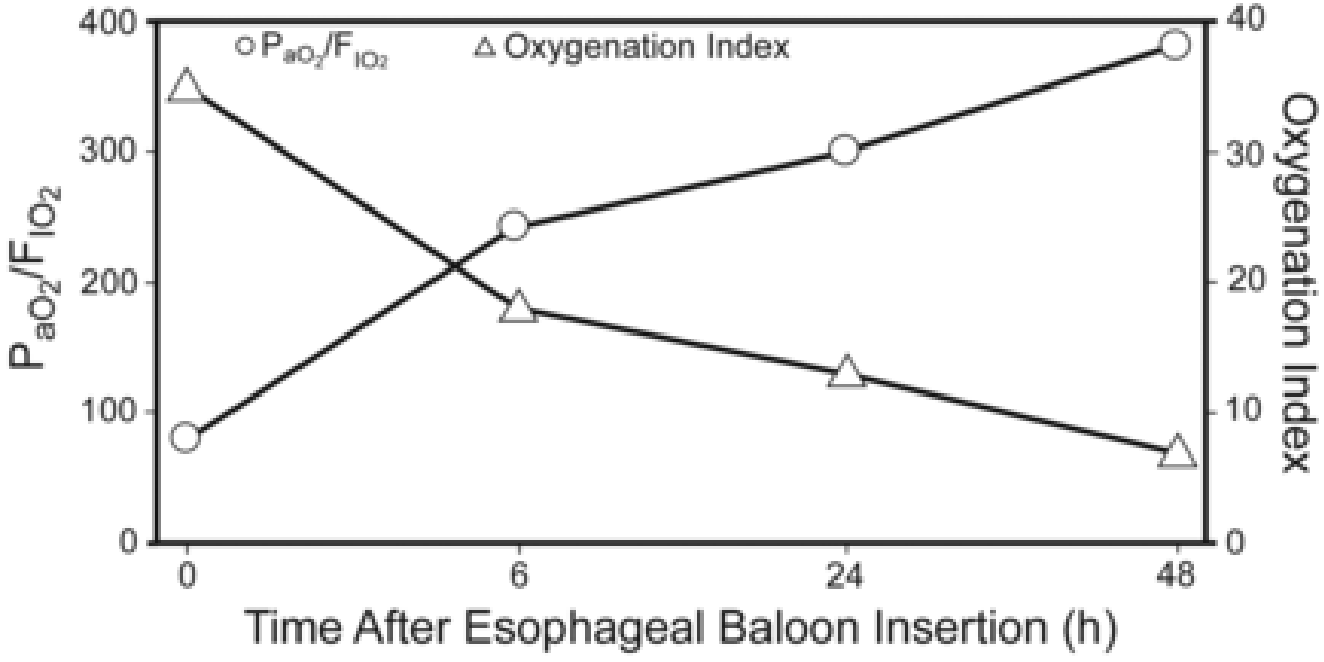

Cài đặt PEEP theo áp lực xuyên phổi

Perspective

Should we titrate peep based on end-expiratory transpulmonary pressure?—yes

Elias Baedorf Kassis[1], Stephen H. Loring[2], Daniel Talmor[2]

- Measuring the esophageal pressures and adjusting PEEP to make transpulmonary pressures positive can decrease atelectasis, derecruitment of lung, and cyclical opening and closing of airways and alveoli, thus optimizing lung mechanics and oxygenation.
- Multiple studies have illustrated the benefit of using esophageal pressures to titrate PEEP in patients with obesity and with ARDS.
- Esophageal pressure monitoring provides a window into the unique physiology of a patient and helps improve clinical decision making at the bedside.

http://dx.doi.org/10.21037/atm.2018.06.35

Cài đặt PEEP theo áp lực xuyên phổi

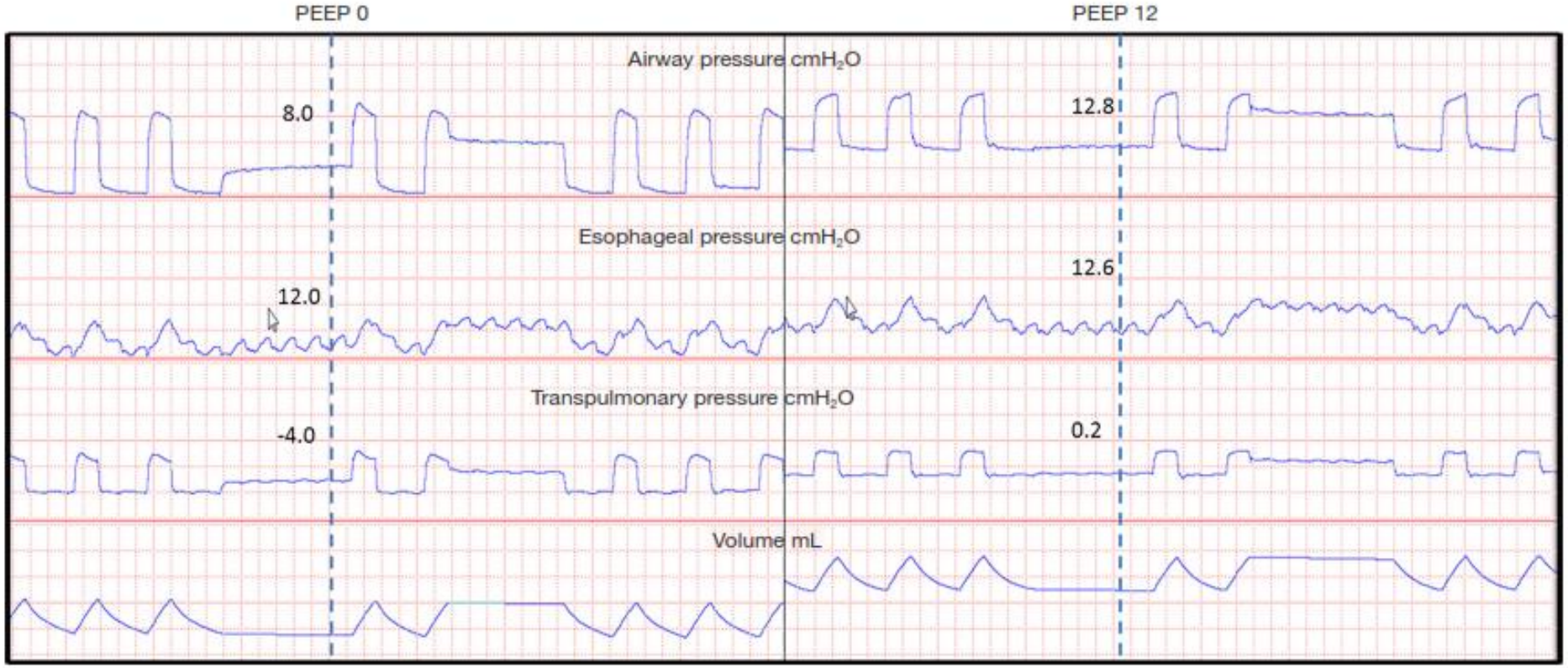

Figure 3 A study patient with obesity and volume overload. Waveforms were collected at zero PEEP initially where significant intrinsic PEEP is noted to 8 cmH_2O. Esophageal pressures are elevated to 12 cmH_2O resulting in a negative transpulmonary pressure that encourages collapse. PEEP was adjusted to 12 cmH_2O until the total PEEP matched the measured esophageal pressures resulting in transpulmonary pressures greater than zero. PEEP, positive end expiratory pressure.

http://dx.doi.org/10.21037/atm.2018.06.35

Cài đặt PEEP theo áp lực xuyên phổi

Bergez *et al. Ann. Intensive Care* (2019) 9:81
https://doi.org/10.1186/s13613-019-0554-3

Annals of Intensive Care

RESEARCH Open Access

PEEP titration in moderate to severe ARDS: plateau versus transpulmonary pressure

Marie Bergez[1], Nicolas Fritsch[1], David Tran-Van[1], Tahar Saghi[2], Tan Bounkim[3], Ariane Gentile[1], Philippe Labadie[1], Bruno Fontaine[1], Alexandre Ouattara[4,5] and Hadrien Rozé[4*]

Cài đặt PEEP theo áp lực xuyên phổi

RESEARCH Open Access

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- **Background**
- Although lung protection with low tidal volume and limited plateau pressure (P_{plat}) improves survival in acute respiratory distress syndrome patients (ARDS), the best way to set positive end-expiratory pressure (PEEP) is still debated.

Cài đặt PEEP theo áp lực xuyên phổi

RESEARCH Open Access

PEEP titration in moderate to severe ARDS: plateau versus transpulmonary pressure

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- **Methods**
- This study aimed to compare two strategies using individual PEEP based on a maximum P_{plat} (28–30 cmH_2O, the Express group) or on keeping end-expiratory transpulmonary pressure positive (0–5 cmH_2O, P_{Lexpi} group).
- We estimated alveolar recruitment (Vrec), end-expiratory lung volume and alveolar distension based on elastance-related end-inspiratory transpulmonary pressure ($P_{L,EL}$).

Cài đặt PEEP theo áp lực xuyên phổi

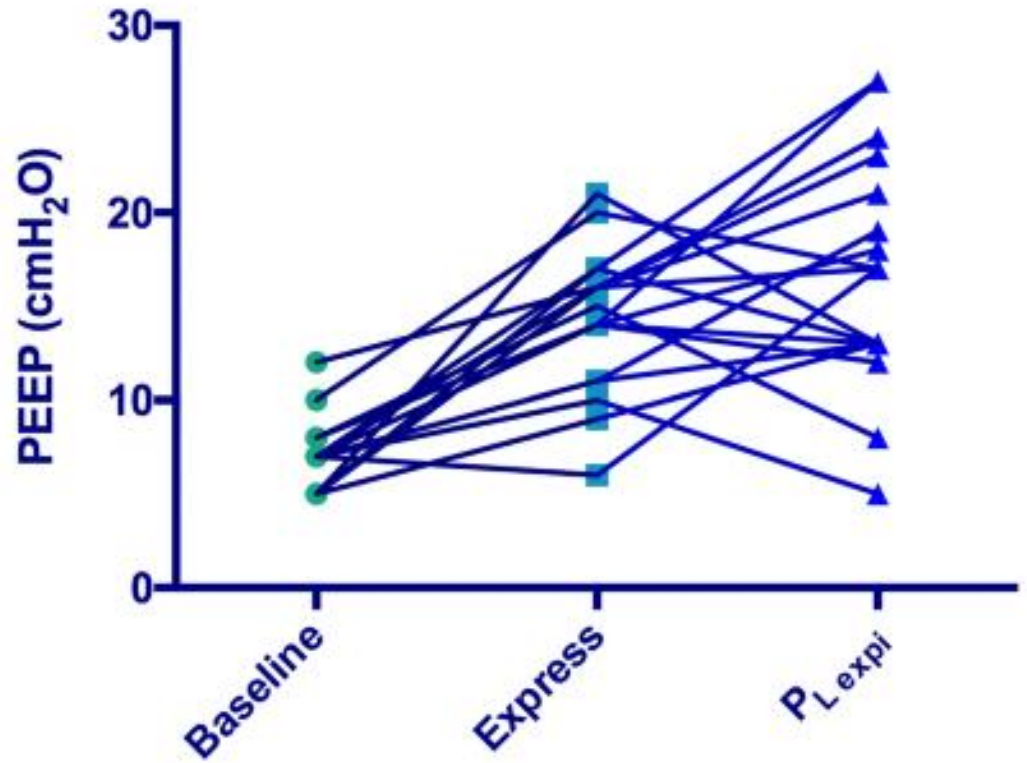

Fig. 1 Individual PEEP levels according to the Express or P_{Lexpi} protocol. PEEP increased from baseline but is individually different for almost all patients with each protocol Express or P_{Lexpi}

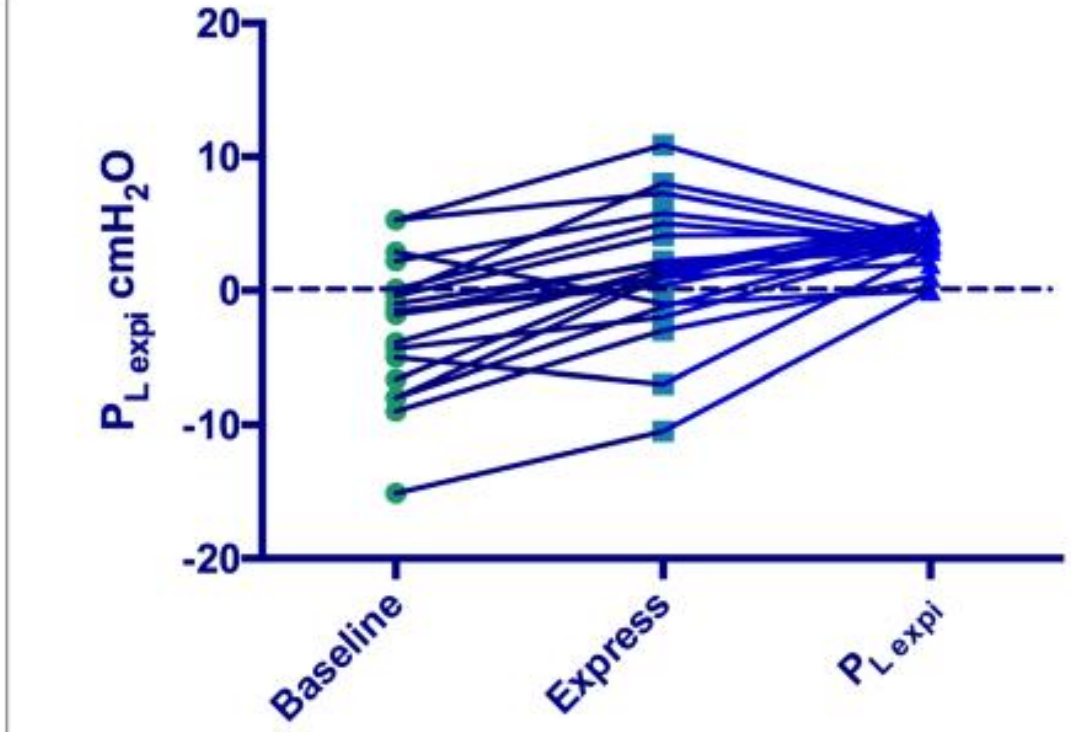

Fig. 2 Individual P_{Lexpi} levels according to baseline, Express and P_{Lexpi} protocols. P_{Lexpi} = positive end-expiratory transpulmonary pressure. Dash line represents the limit of 0 cmH_2O; more patients had negative P_{Lexpi} with the Express protocol

Cài đặt PEEP theo áp lực xuyên phổi

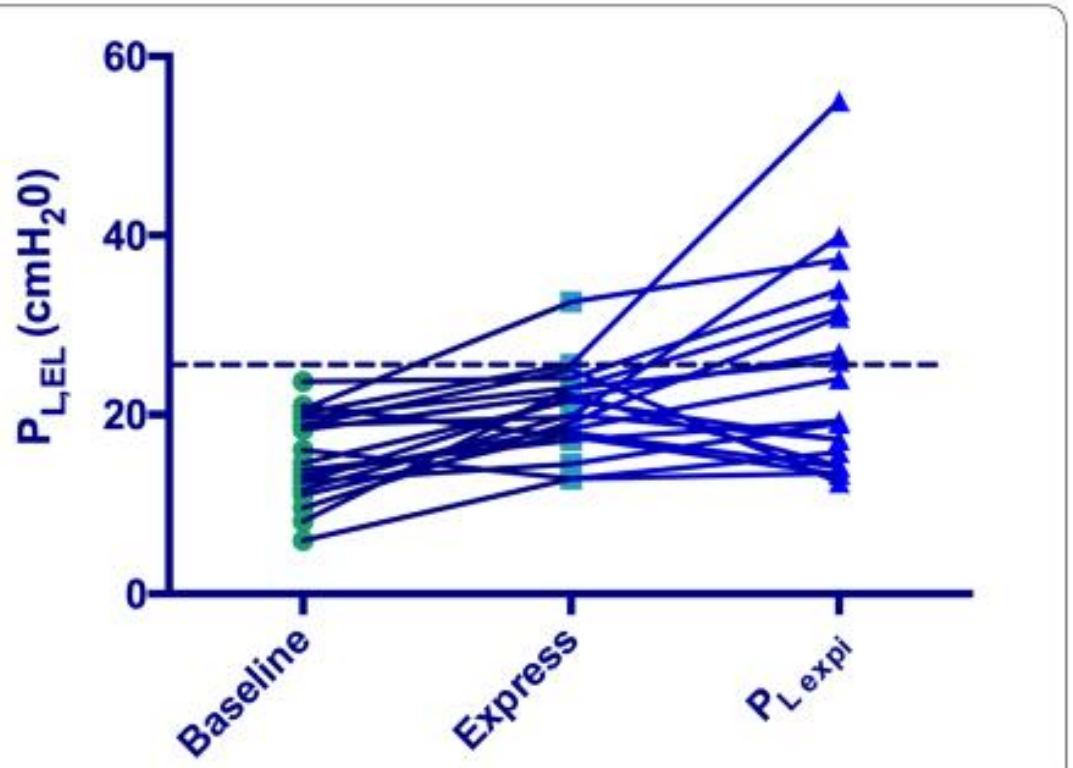

Fig. 3 Individual $P_{L,EL}$ with baseline, Express and P_{Lexpi} protocols. $P_{L,EL}$ = elastance-derived calculation of relative end-inspiratory transpulmonary pressure. Dash line represents the limit of 25 cmH_2O; more patients had $P_{L,EL}$ above 25 cmH_2O with the P_{Lexpi} protocol

- There is a great heterogeneity of P_{Lexpi} when P_{plat} is used to titrate PEEP but with limited risk of over-distension.
- A PEEP titration for a moderate positive level of P_{Lexpi} might slightly improve alveolar recruitment and oxygenation but increases the risk of over-distension in one-third of patients.

Cài đặt PEEP theo áp lực xuyên phổi

Perspective

Should we titrate positive end-expiratory pressure based on an end-expiratory transpulmonary pressure?

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Ann Transl Med. 2018 Oct; 6(19): 391.

Cài đặt PEEP theo áp lực xuyên phổi

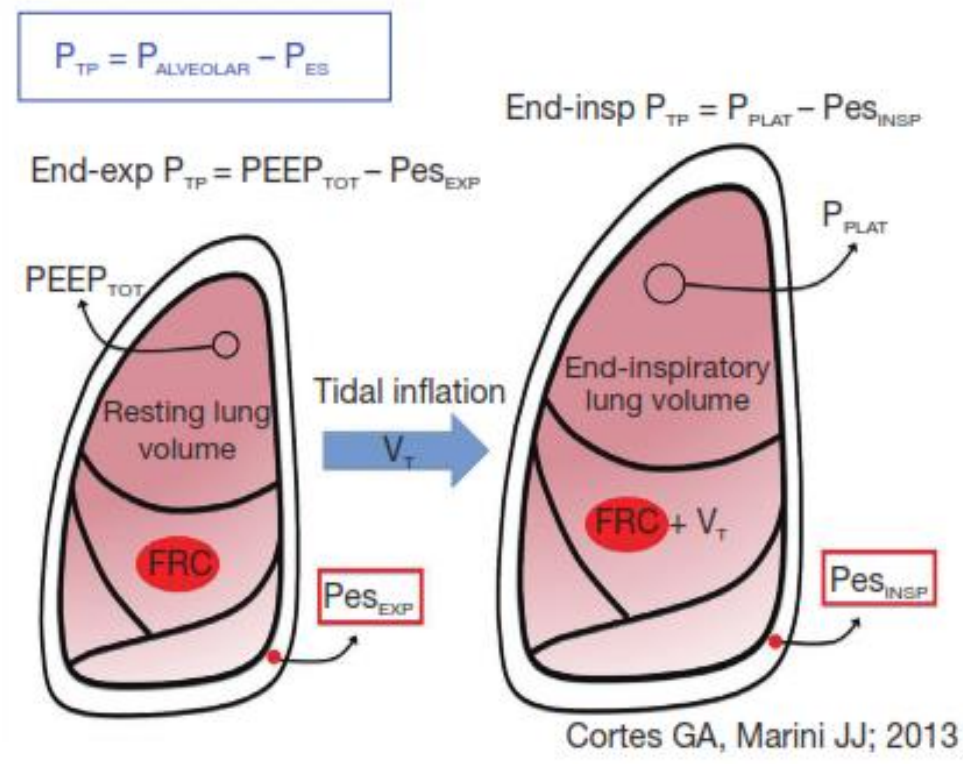
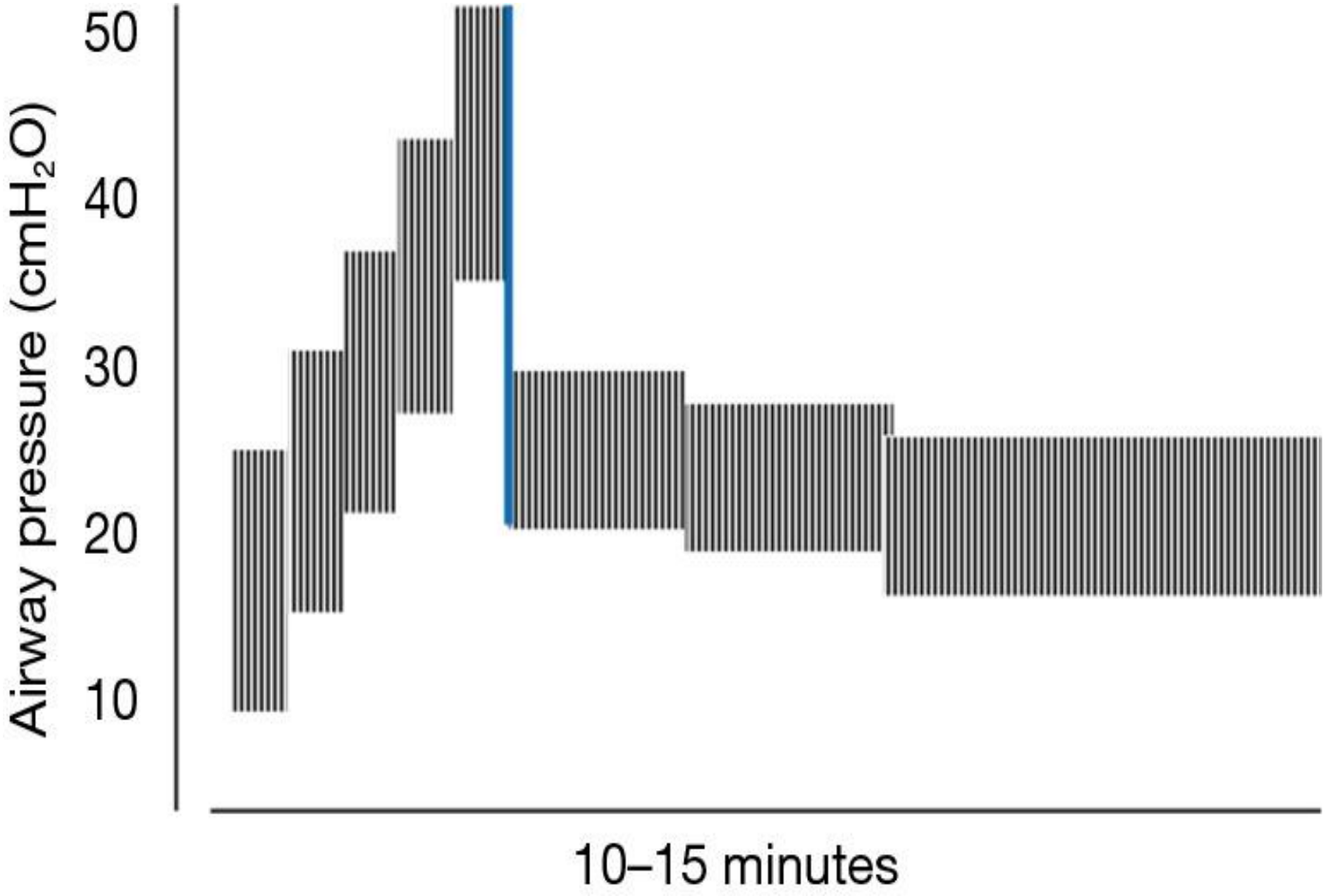


Figure 1 Concept of transpulmonary pressure estimated by the esophageal balloon catheter. PEEP, positive end-expiratory pressure; FRC, functional residual capacity; Pes, esophageal pressure.

- The setting of PEEP by the Pes-guided end-expiratory 'polarity transition' point is limited by its tendency to encourage PEEP levels that are higher than the RM-Dec.
- These are likely unnecessary, and therefore are associated with a relatively high hazard to benefit ratio.

Ann Transl Med. 2018 Oct; 6(19): 391.

Cài đặt PEEP theo áp lực xuyên phổi



- An appropriately conducted RM-Dec that uses modest peak pressures, relatively small PEEP increments and appropriate timing intervals is currently the most logical and therefore an attractive option, particularly when the Pes is used to calculate transpulmonary driving pressures relevant to the lung.

Ann Transl Med. 2018 Oct; 6(19): 391.

Kết luận

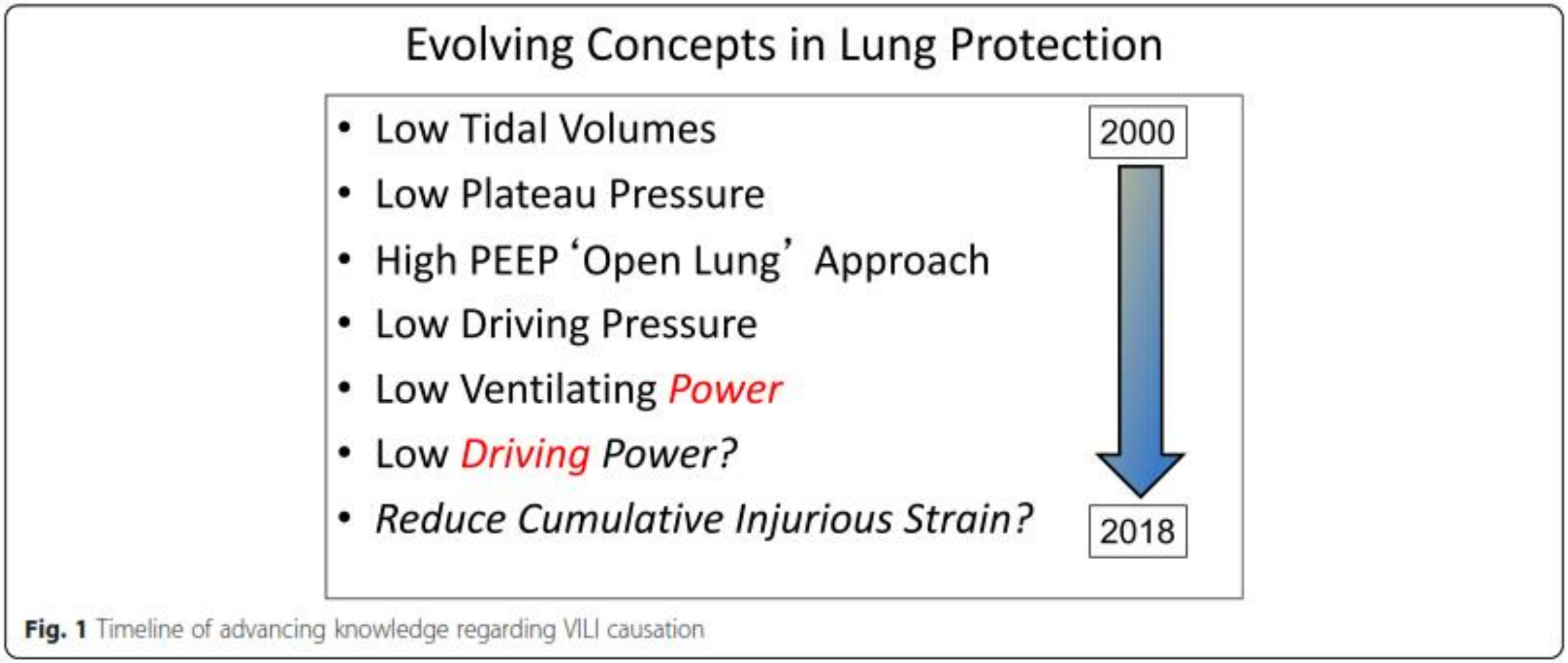


Fig. 1 Timeline of advancing knowledge regarding VILI causation

Marini Critical Care 2019, 23(Suppl 1):114 https://doi.org/10.1186/s13054-019-2406-9