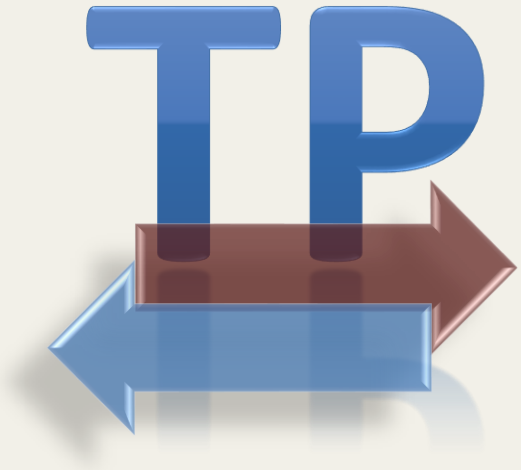
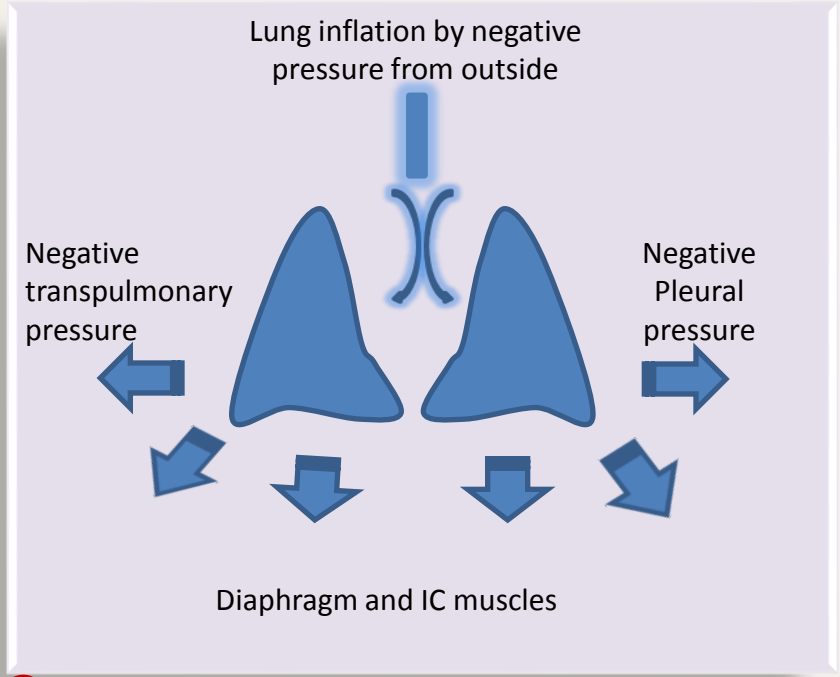
Sameer Jog, Consultant Intensivist, Deenanath Mangeshkar Hospital. Pune INDIA
M.D. (Int Med) EDIC IDCCM

Deenanath Mangeshkar Hospital And Research Centre, Pune, India

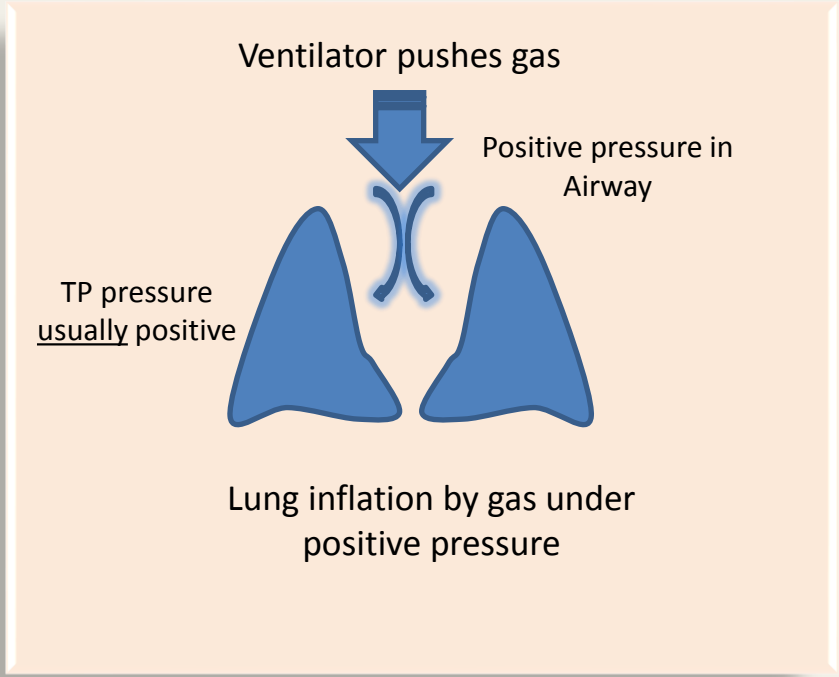


Trans –Pulmonary Pressure & Its Applications

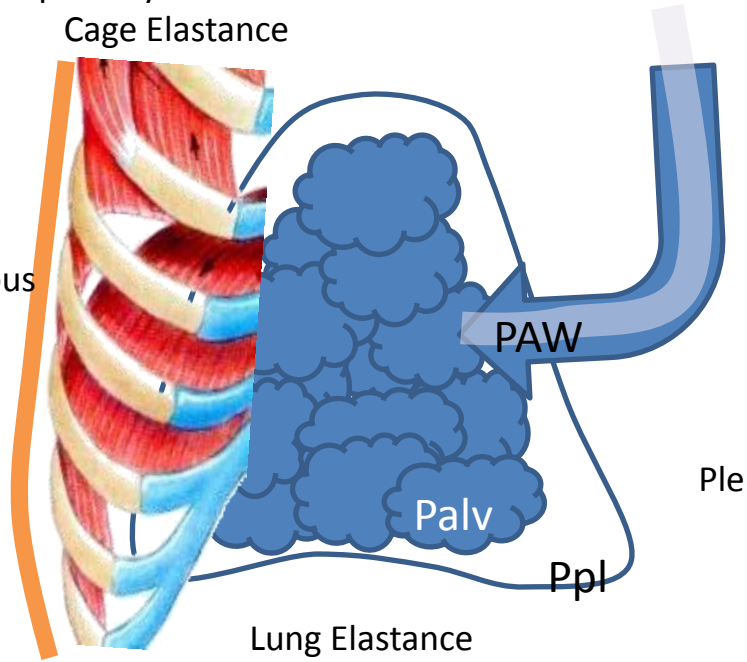
How we inspire?



Physiological (Non Ventilated Breathing)



Ventilated (Un-physiological) Breathing



TP- Driving pressure of ventilation

Pleural Elastance

TP

The Concept

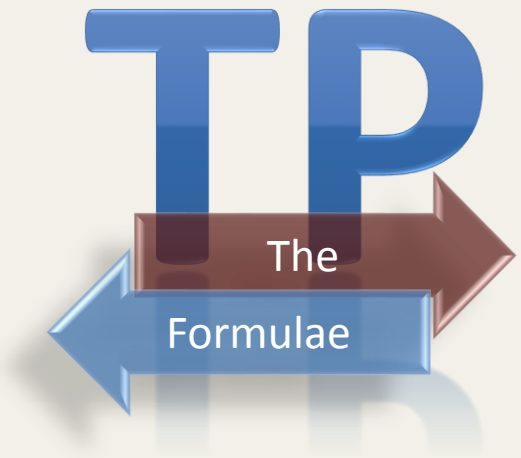
To know lung pressure and Extrapulmonary pressure

To know the lung stress

How powerful is the inspiratory drive of a patient?

Is current Ventilatory settings harmful or inadequate?

Airway Pressure – Intrapleural (Esophageal) Pressure

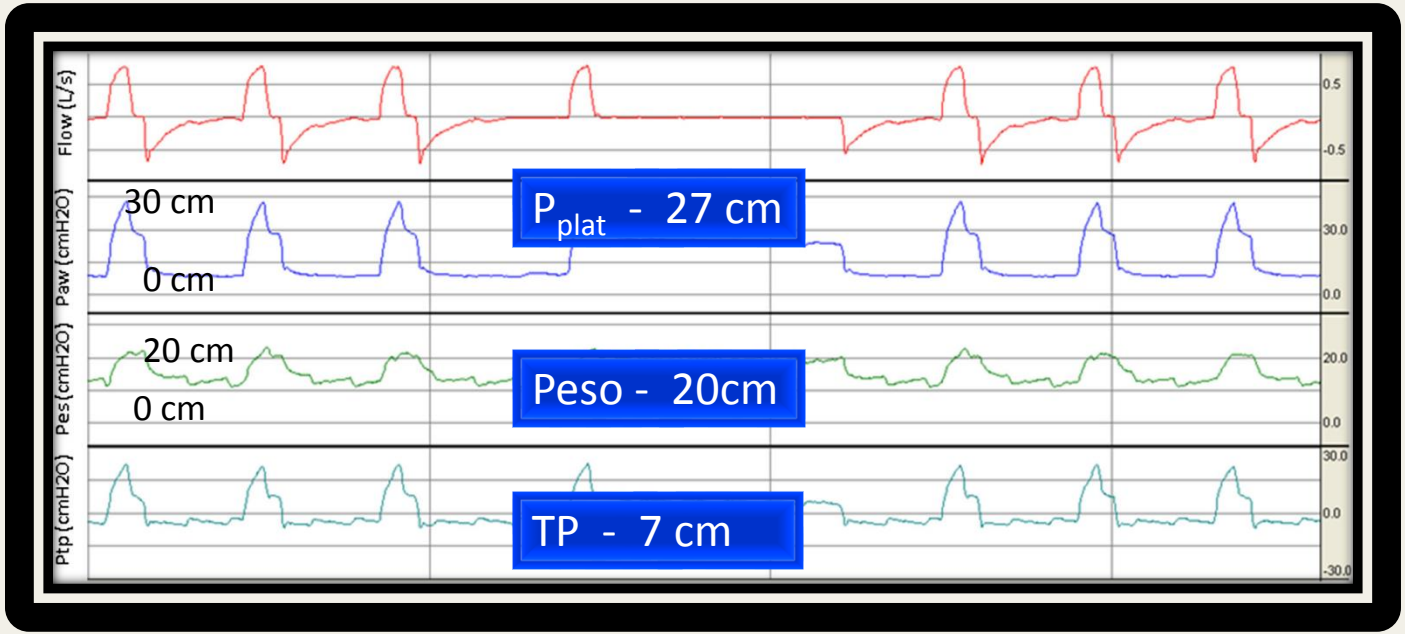


End Inspiratory	• PIP - P eso
Plateau	• P plat - P eso
End Expiratory	• PEEP- P eso

TP

Plateau

= 7 cm

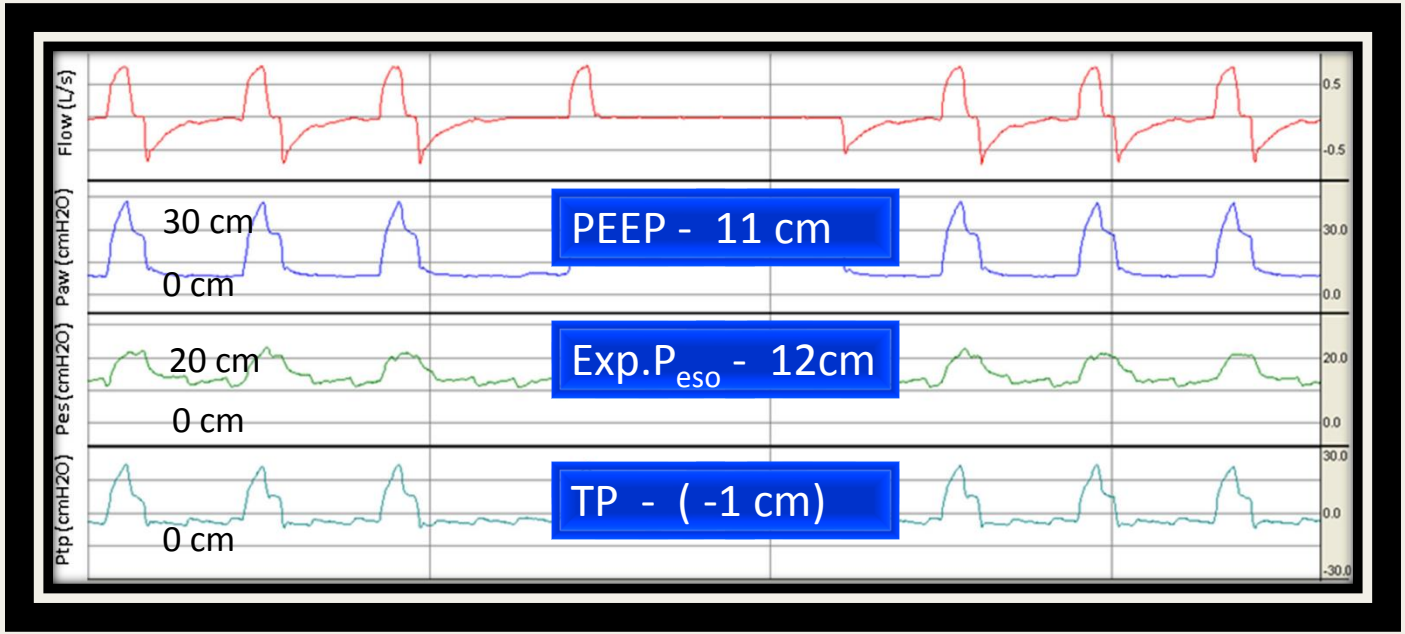


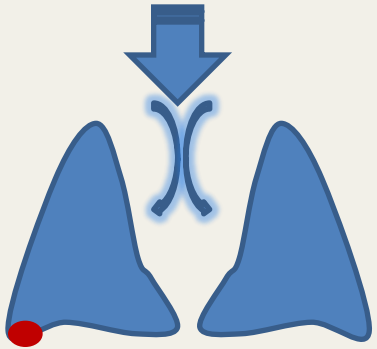
TP

End Expiratory

= -1 cm

Lung can even collapse at PEEP of 12 cm !! ??





American Physiological Society

Journal of Applied Physiology

Search

HOME ARTICLES INFO FOR... EDITORS SUBSCRIBE SUBMIT

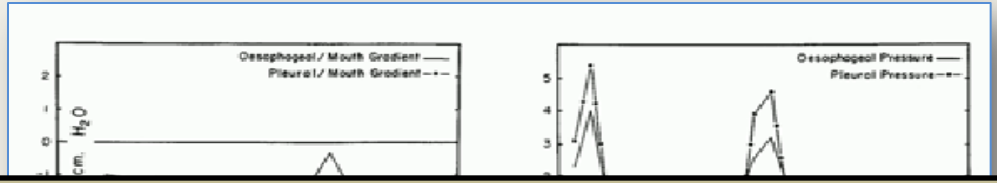
A Comparison of Esophageal and Intrapleural Pressure in Man

Reuben M. Cherniack , Leon E. Farhi , Bruce W. Armstrong , Donald F. Proctor

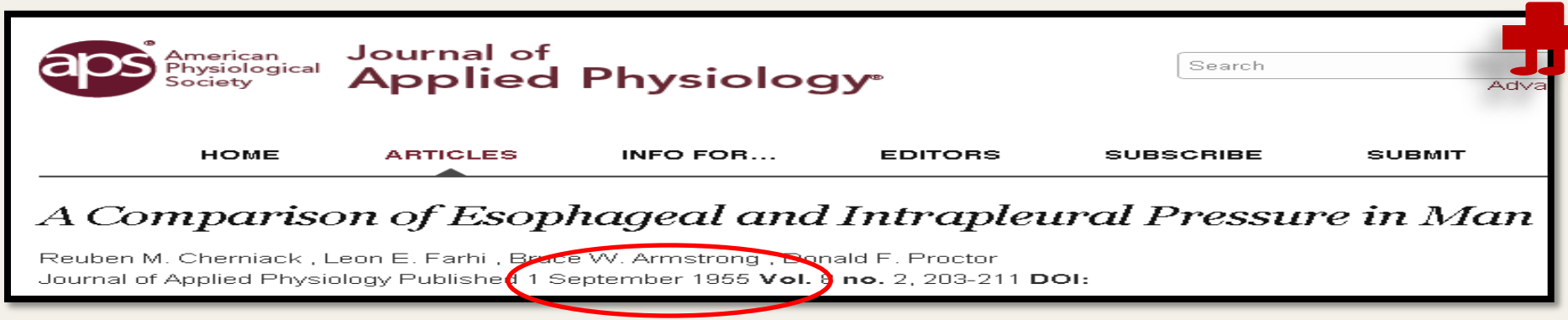
Journal of Applied Physiology Published 1 September 1955 **Vol.** 8 **no.** 2, 203-211 **DOI:**

TP

The Archives



Changes in pleural pressure were similar to changes in esophageal pressure, although the absolute values of pressures in the pleural space were often more negative than in the esophagus

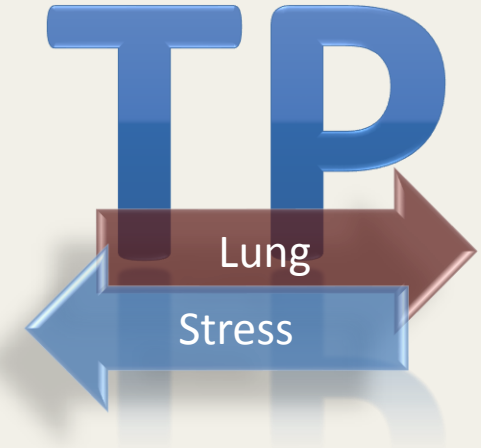


TP

The

Archives

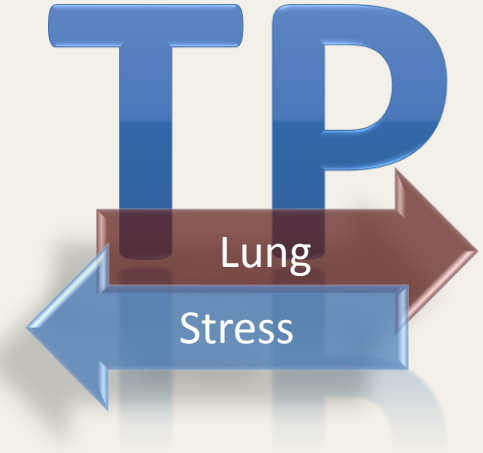
Esophageal Pressure ~ PleuralPressure

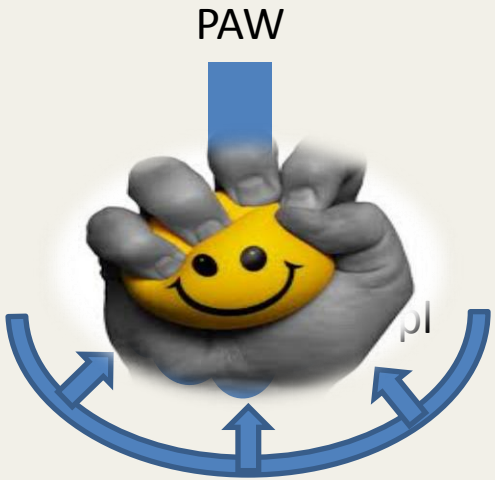


In PHYSICS stress is defined as the distribution of internal forces per unit of area induced by an external force applied onto a specific material.

Lung stress is defined as the pressure developed within the lung structures onto which the distending force is applied.

Such distending force corresponds to the Trans Pulmonary pressure (P_L), that is, the difference between airway (P_{AW}) and pleural pressures (P_{pl}):





In humans, tidal Trans Pulmonary pressure greater than 22–23 cmH_2O creates dangerous stress on lung parenchyma which may lead to VILI, Pneumothorax

Clinical practice TP < 25 cm is desirable

TP

Understanding

TP

Mr Laurel

PEEP 17 cm

P plat
30 cm

P pl 5cm

Trans Pulmonary Pressure
(P_{alv} minus P_{pl}= 25 cm)

Mr Hardy

PEEP 17 cm

P plat
30 cm

P pl 12cm

Trans Pulmonary Pressure
(P_{alv} minus P_{pl}= 18 cm)

TP

Understanding TP

Mr Veeru

PEEP 12 cm

Mr Jai

PEEP 12 cm

Lung collapse even at PEEP of 12 cm ?!?!

P plat 25 cm

End Expiratory Pleural Pressure 5cm

Trans Pulmonary Pressure
(P_{alv} minus P_{pl}= 7 cm)

P plat 25 cm

End Expiratory Pleural Pressure 14 cm

Trans Pulmonary Pressure
(P_{alv} minus P_{pl}= -2 cm)

TP

Research

Data

The NEW ENGLAND JOURNAL of MEDICINE

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

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.

TP

Research

Data

The NEW ENGLAND JOURNAL of MEDICINE

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

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.

Trans Pulmonary Pressure Group	Conventional ARDSnet group
Tidal volume 6 ml / kg PBW, Lower if Transpulm	Tidal volume 6 ml / kg PBW,

Esophageal-Pressure–Guided Group

FIO_2	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0
P_{Lexp}	0	0	2	2	4	4	6	6	8	8	10	10

Control Group

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	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	20–24

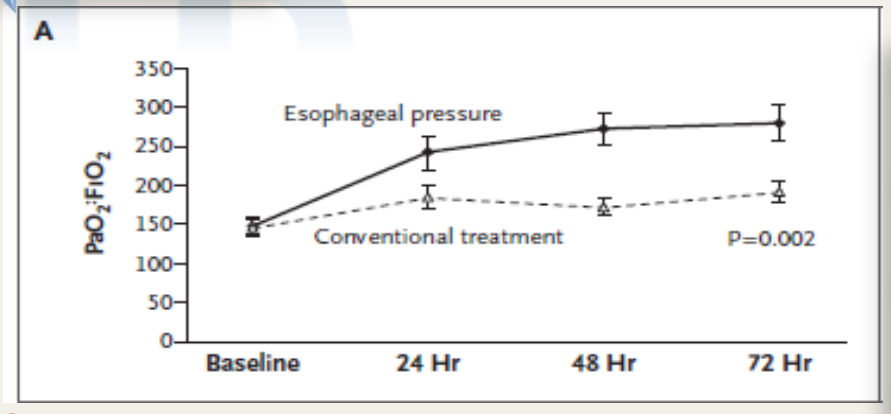
TP

Research

Data

The NEW ENGLAND JOURNAL of MEDICINE

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



- Better P/ F ratio
- Improved lung compliance
- More Ventilator free days p= 0.5
- More survival p=0.05 (Under power study)

Intensive Care Med (2012) 38:395–403
DOI 10.1007/s00134-012-2490-7

ORIGINAL

Salvatore Grasso
Pierpaolo Terragni
Alberto Birocco
Rosario Urbino
Lorenzo Del Sorbo
Claudia Filippini
Luciana Mascia
Antonio Pesenti
Alberto Zangrillo
Luciano Gattinoni
V. Marco Ranieri

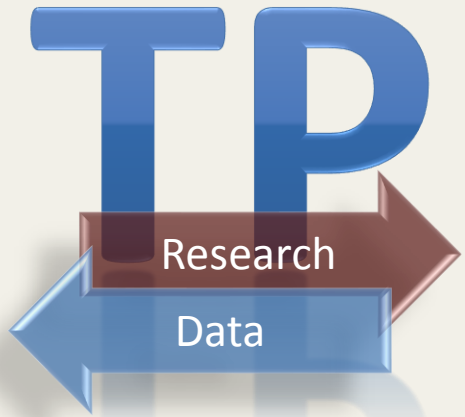
ECMO criteria for influenza A (H1N1)-associated ARDS: role of transpulmonary pressure

- Severe ARDS patients : P/ F Ratio 67 to 75,
- 90 % received Prone trial
- P plat pressure - Average ~31 cm, and PEEP 17 cm
- Transferred to ECMO center for ECMO

Measure TP

If TP < 25 cm-- increase PEEP till TP is 25

If TP > 25 cm ---- ECMO



Intensive Care Med (2012) 38:395–403
DOI 10.1007/s00134-012-2490-7

ORIGINAL

Salvatore Grasso
Pierpaolo Terragni
Alberto Birocco
Rosario Urbino
Lorenzo Del Sorbo
Claudia Filippini
Luciana Mascia
Antonio Pesenti
Alberto Zangrillo
Luciano Gattinoni
V. Marco Ranieri

ECMO criteria for influenza A (H1N1)-associated ARDS: role of transpulmonary pressure

- Average PEEP 22 ± 1.4 cm
- P_{plat} highest was 40 cm, but TP was ≤ 25 cm
- ECMO could be avoided in 7/ 14 patients

TP

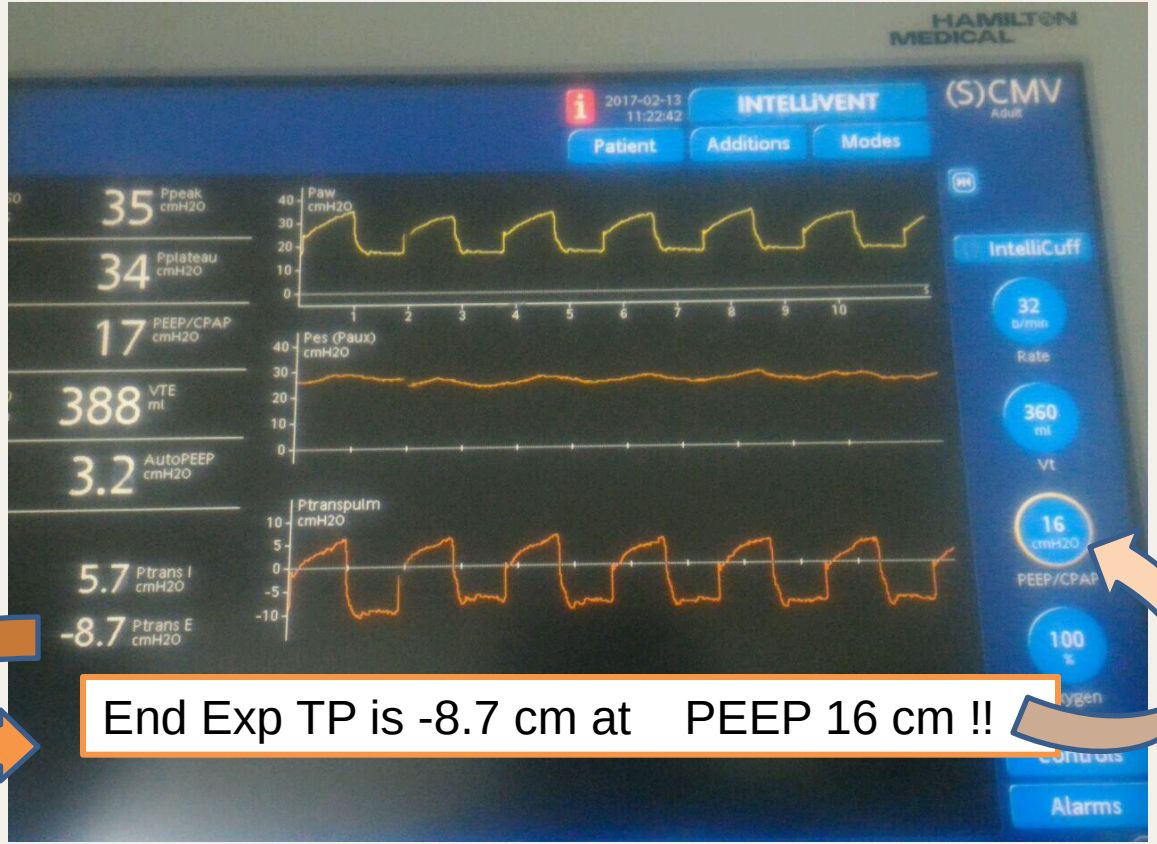
Esophageal

Balloon Cath (RT)

TP

Monitor

Graphs



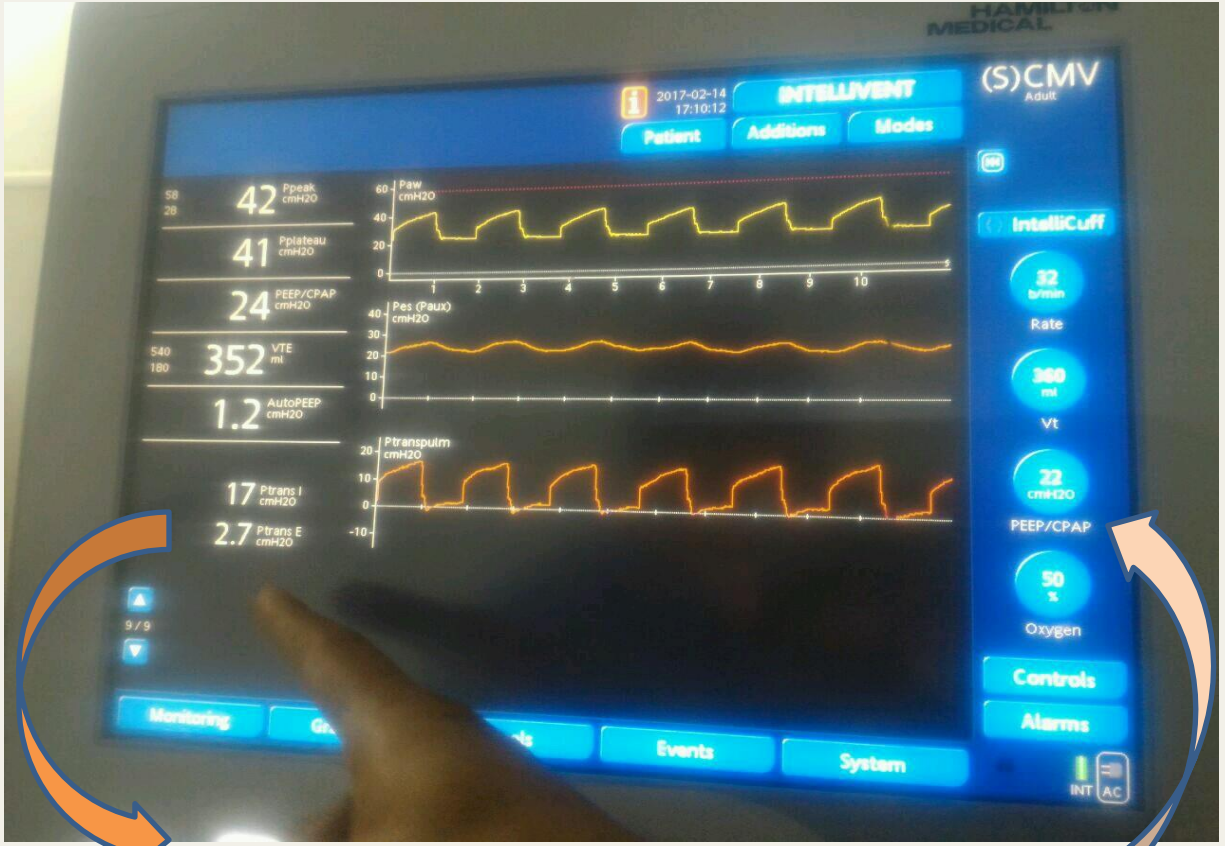
End Exp TP is -8.7 cm at PEEP 16 cm !!

Many Alveoli collapse in Expiration EVEN at 16 cm

TP

Monitor

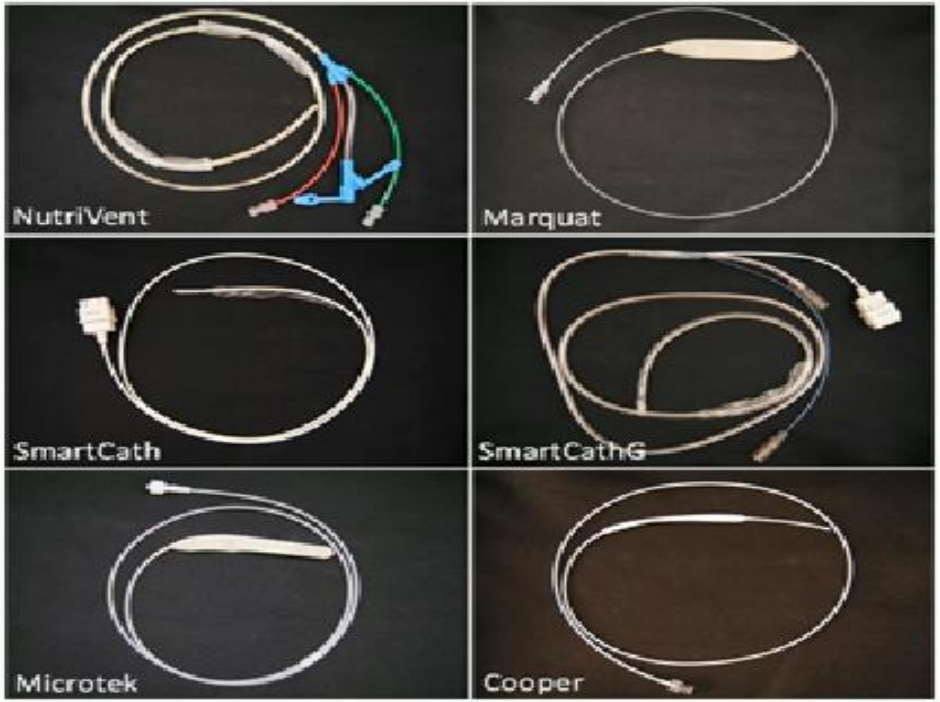
Graphs



Tp is 2.7 cm needing PEEP 22cm !!

TP

Esophageal Catheters

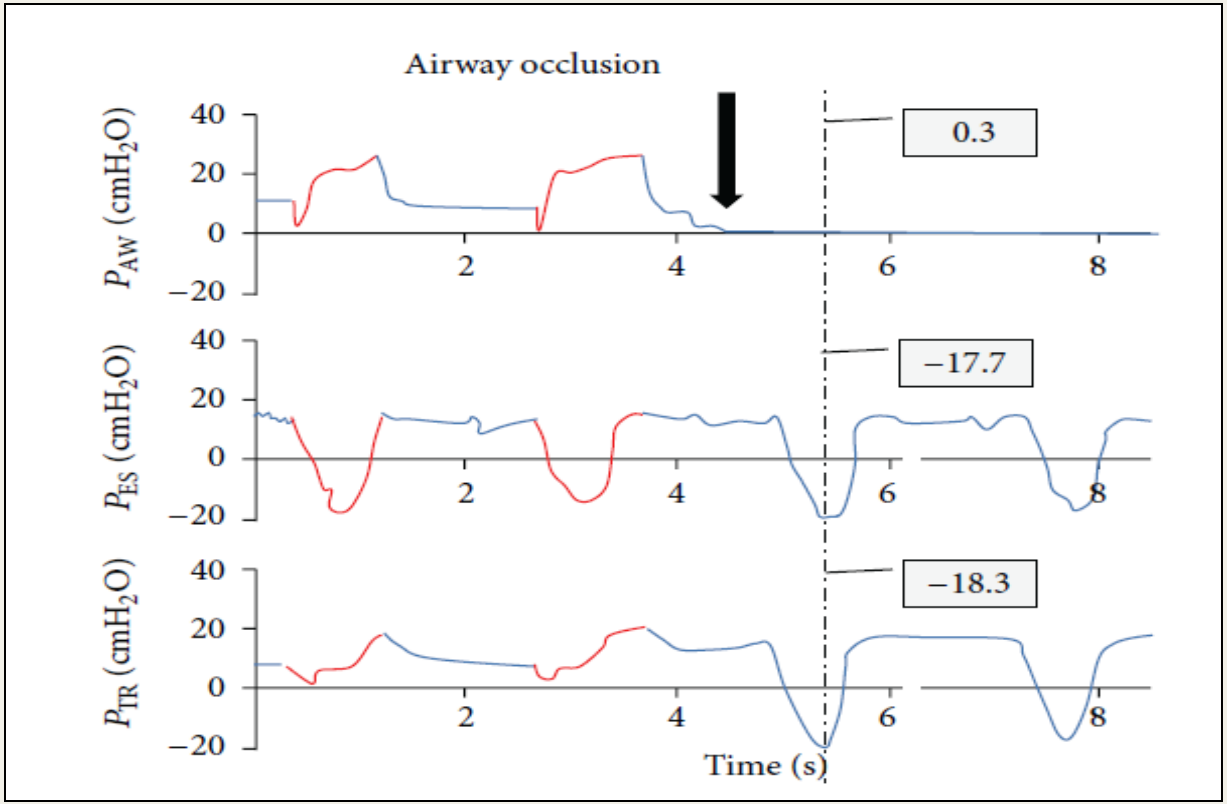


From Mojoli et al. 2014

TP

Occlusion Test

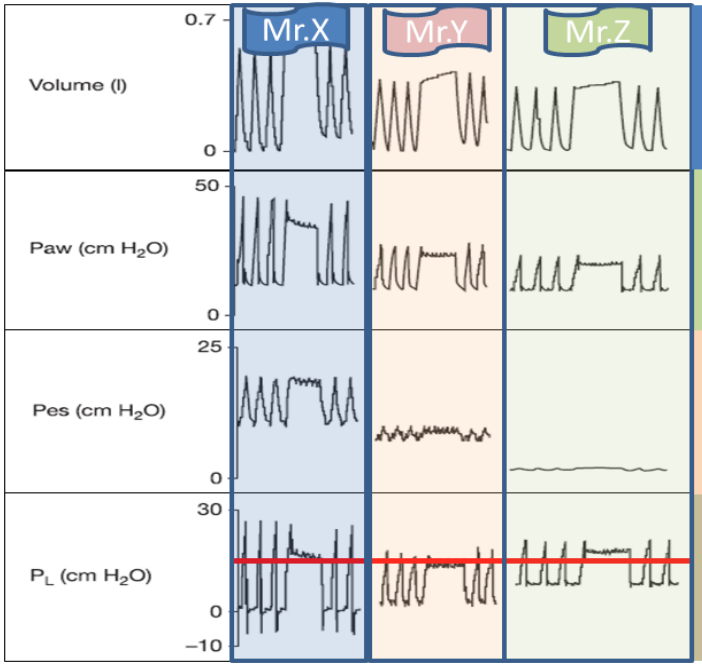
Confirm position



TP

Understanding

Differences



Nearly same Tidal Volume – 400 cc

Nearly same PEEP = 9 cm

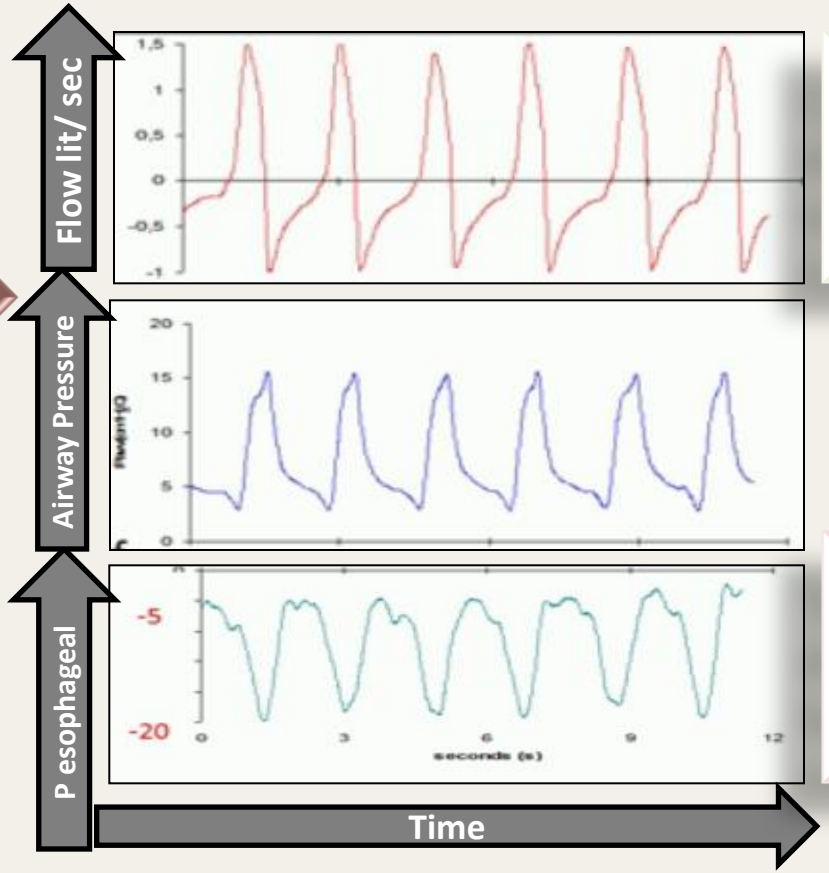
Peak and Pplat – X $_{35}$> Y $_{25}$> Z_{23}

Pes – X(20cm) > Y (8cm) > Z (1cm)

Transpulmonary Pressure- X = 18cm
- Y = 16 cm
- Z = 20 cm

TP

Case Scenario



COPD exacerbation
Weaning with PEEP 5 and PS 15 cm
Vt generated ~ 550 ml RR 22
Gases well acceptable

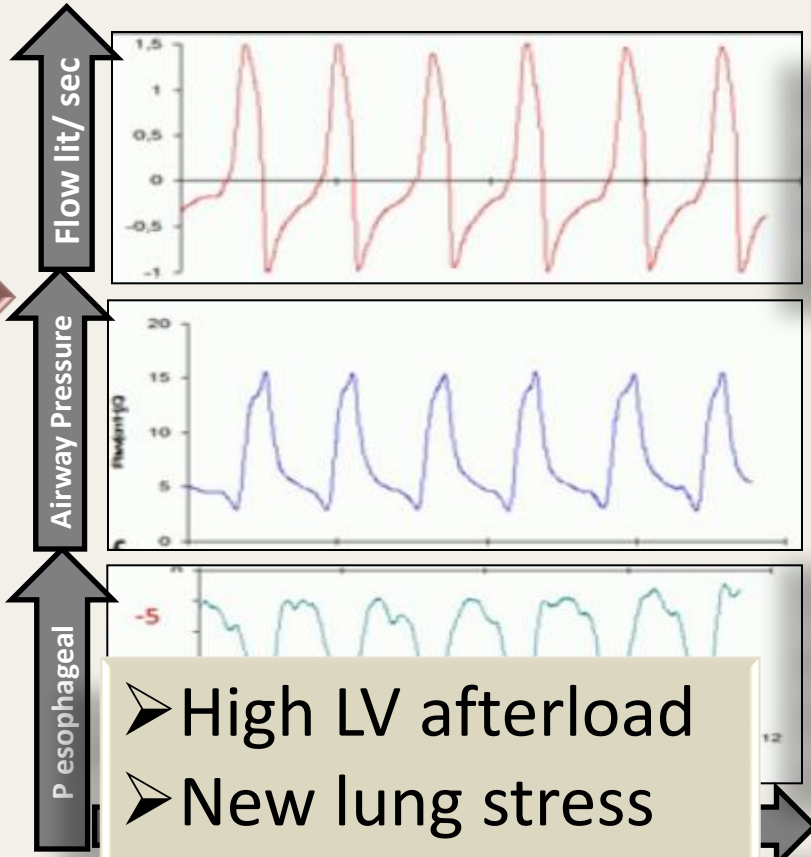
After 2 hours

Tachypnoea, tachycardia, desaturation, distress
Sedated and returned to volume controlled

What happened ?
What went wrong ?

TP

Case Scenario



COPD exacerbation
Weaning with PEEP 5 and PS 15 cm
Vt generated ~ 550 ml RR 22
Gases well acceptable

After 2 hours

Tachypnoea, tachycardia, desaturation, distress
Sedated and returned to volume controlled

- High LV afterload
- New lung stress
- VILI started

P_{eso} is - 15 cm
Transpulmonary pressure is 30 cm !!
(Upper limit of normalcy ~ 25 cm)

TP

Research

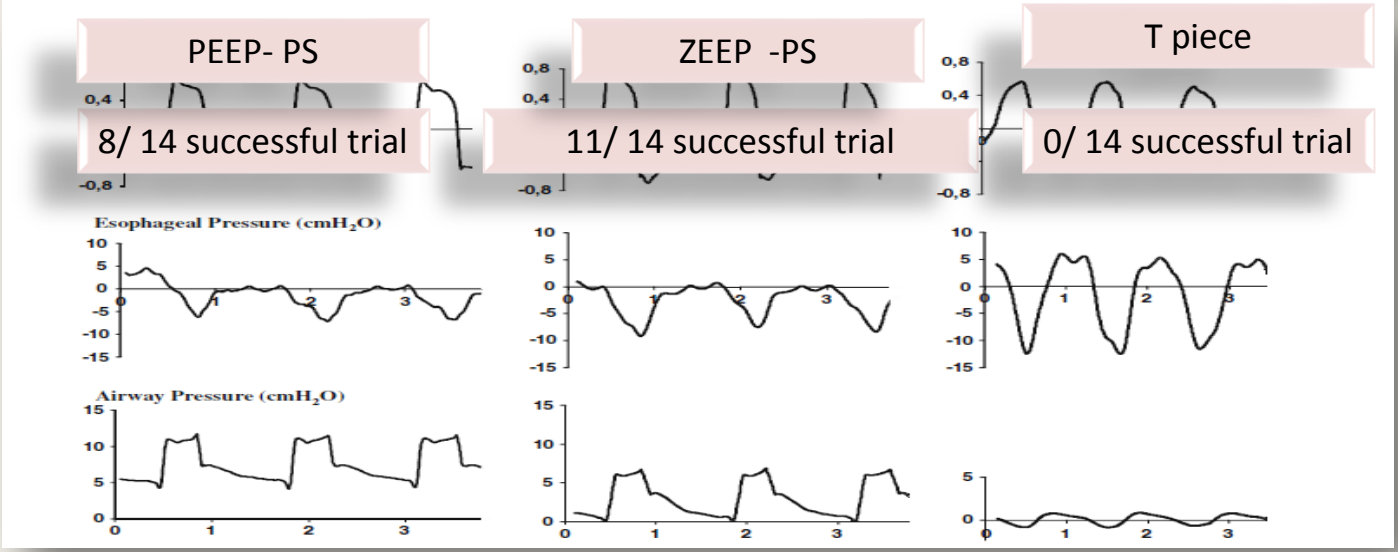
Data

Intensive Care Med (2010) 36:1171–1179
DOI 10.1007/s00134-010-1870-0

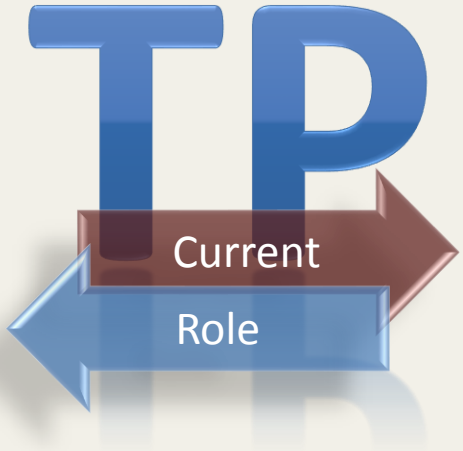
ORIGINAL

Belén Cabello
Arnaud W. Thille
Ferran Roche-Campo
Laurent Brochard
Francisco J. Gómez
Jordi Mancebo

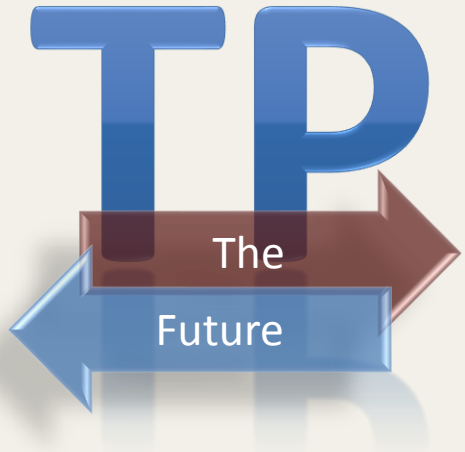
Physiological comparison of three spontaneous breathing trials in difficult-to-wean patients



Should I routinely use?

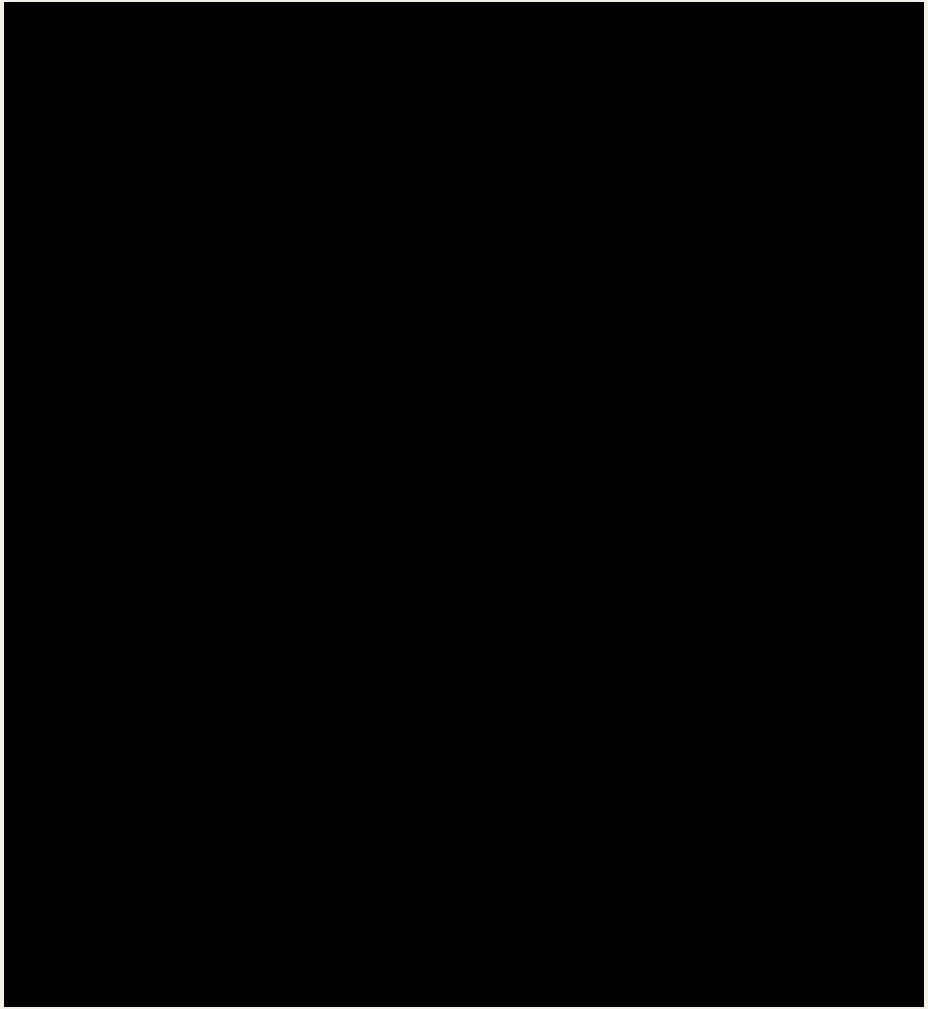


- Today not advisable in all.
- Select cases of Severe ARDS needing PEEP > 16 -18 cm and P_{plat} is around 30cm
- ARDS with IAH/ ACS or morbid obesity
- Difficult weaning



Multicenter trial is currently testing ventilation strategy in which PEEP is adjusted to achieve End Expiratory Trans Pulmonary pressure between 0 and 6 cm H_2O compared to a gas exchange-based strategy (PEEP/FIO_2 table)

Fish E, Novack V, Banner-Goodspeed VM, Sarge T, Loring S, Talmor D



Thank You