Monitorage de la pression oesophagienne
Pourquoi ? Comment ?

Alain Mercat
alain.mercat@univ-angers.fr

Liens d’intérêts

- Financement de travaux de recherche
  - Covidien (PAV+)
  - General Electric (CRF/SDRA)
  - Maquet (NAVA)
  - Fisher-Paykel (Optiflow)
- Brevet
  - General Electric (EELV/PEEP/recrutement)
- Exposés lors de congrès
  - Covidien
  - Alung technologies
- Activité d’expertise
  - Faron Pharmaceuticals
  - Air Liquide Medical Systems

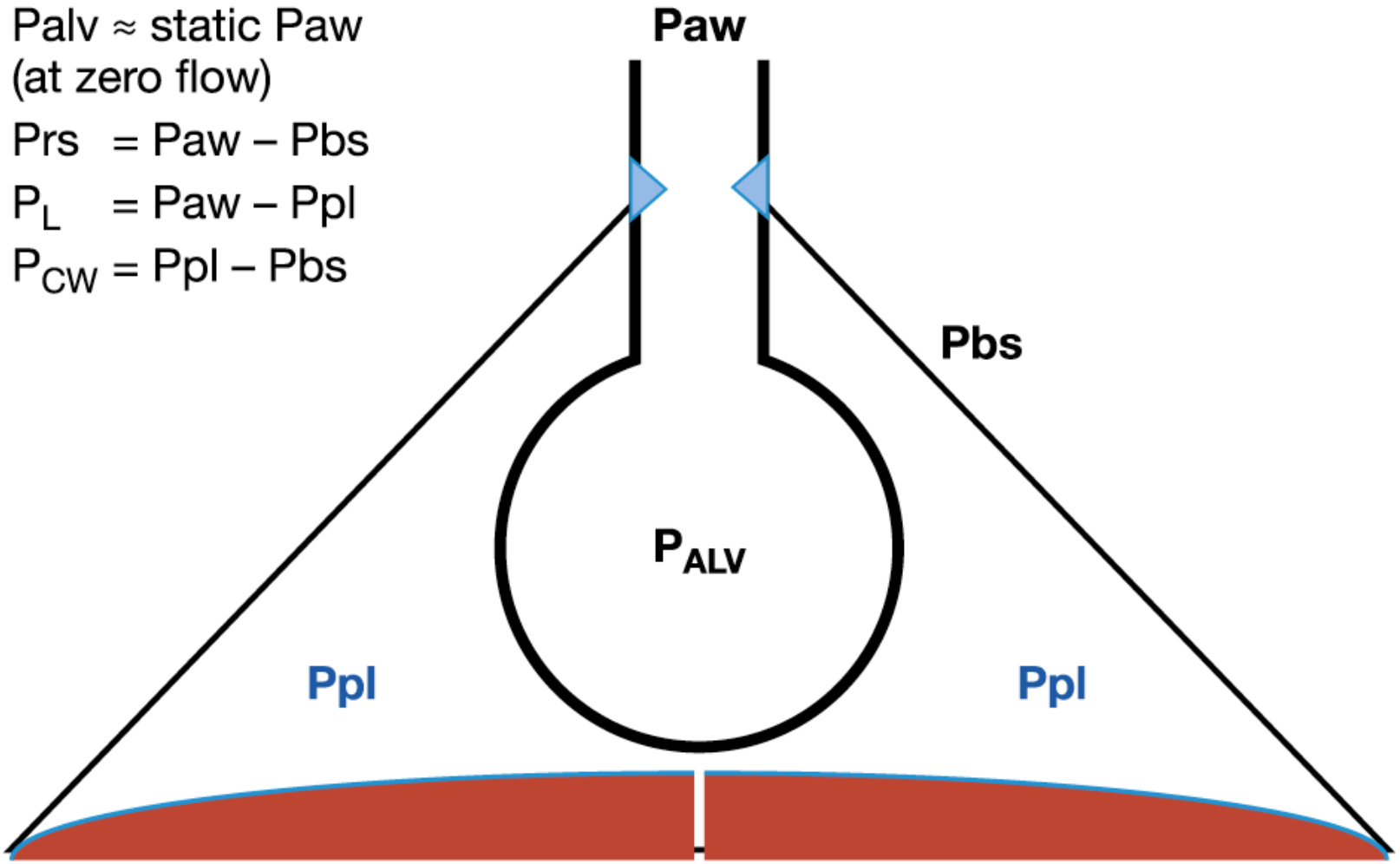
Système respiratoire = Poumon + Paroi

Palv ≈ static Paw
(at zero flow)

Prs = Paw – Pbs

P_L = Paw – Ppl

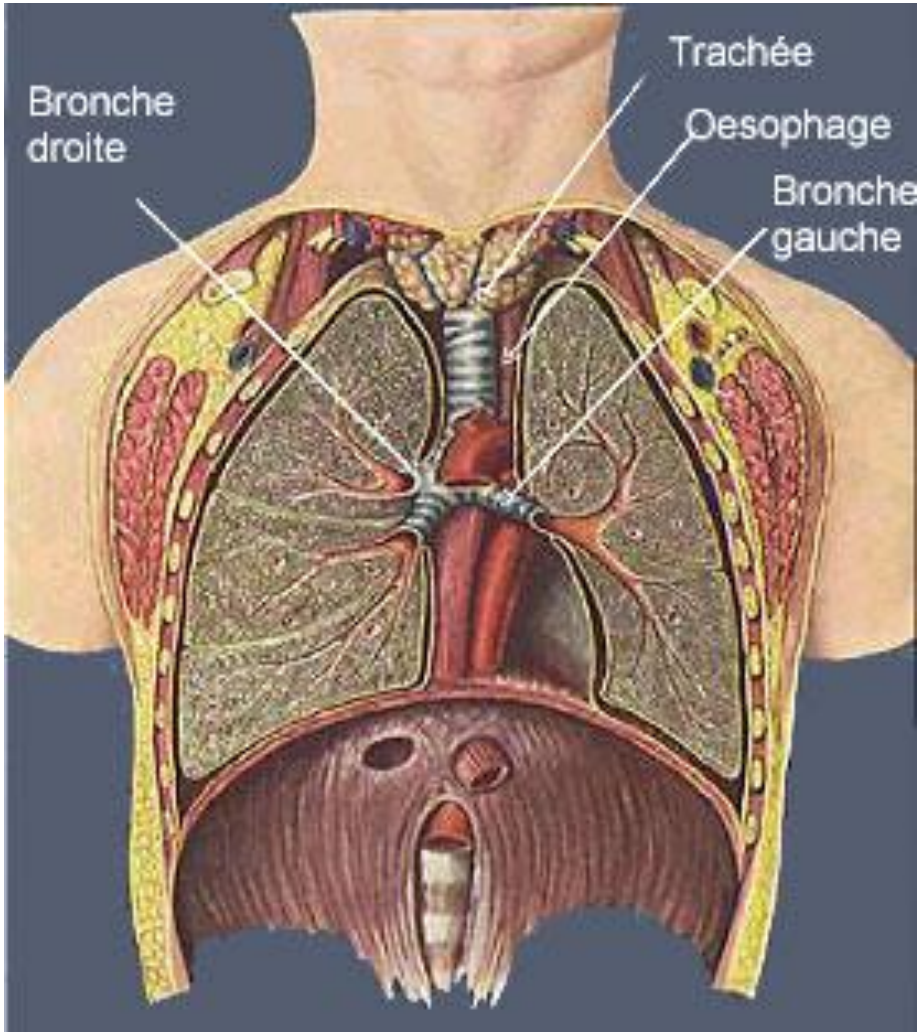
P_{CW} = Ppl – Pbs



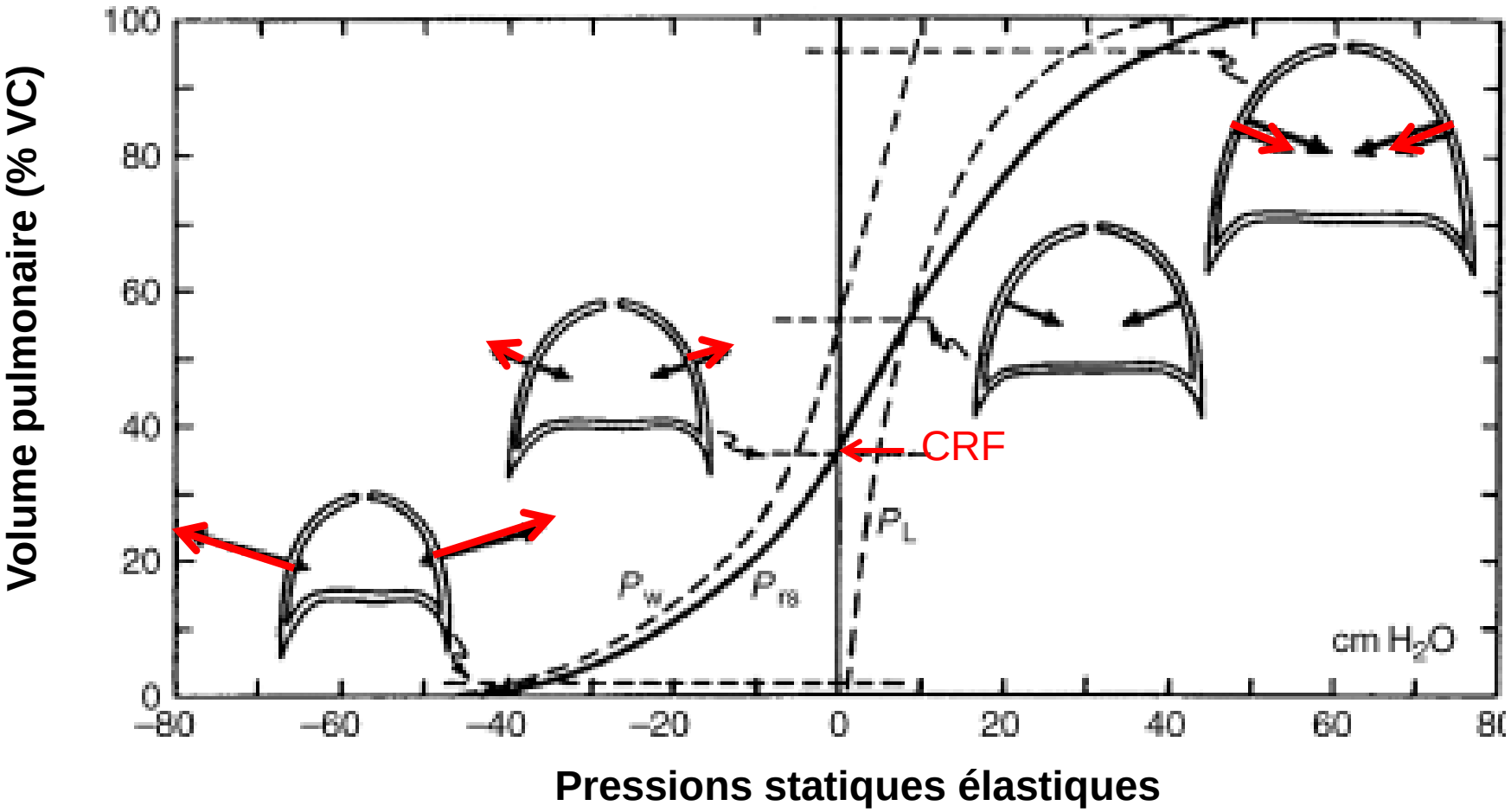
Akoumianaki et al. AJRCCM 2014

the PLG

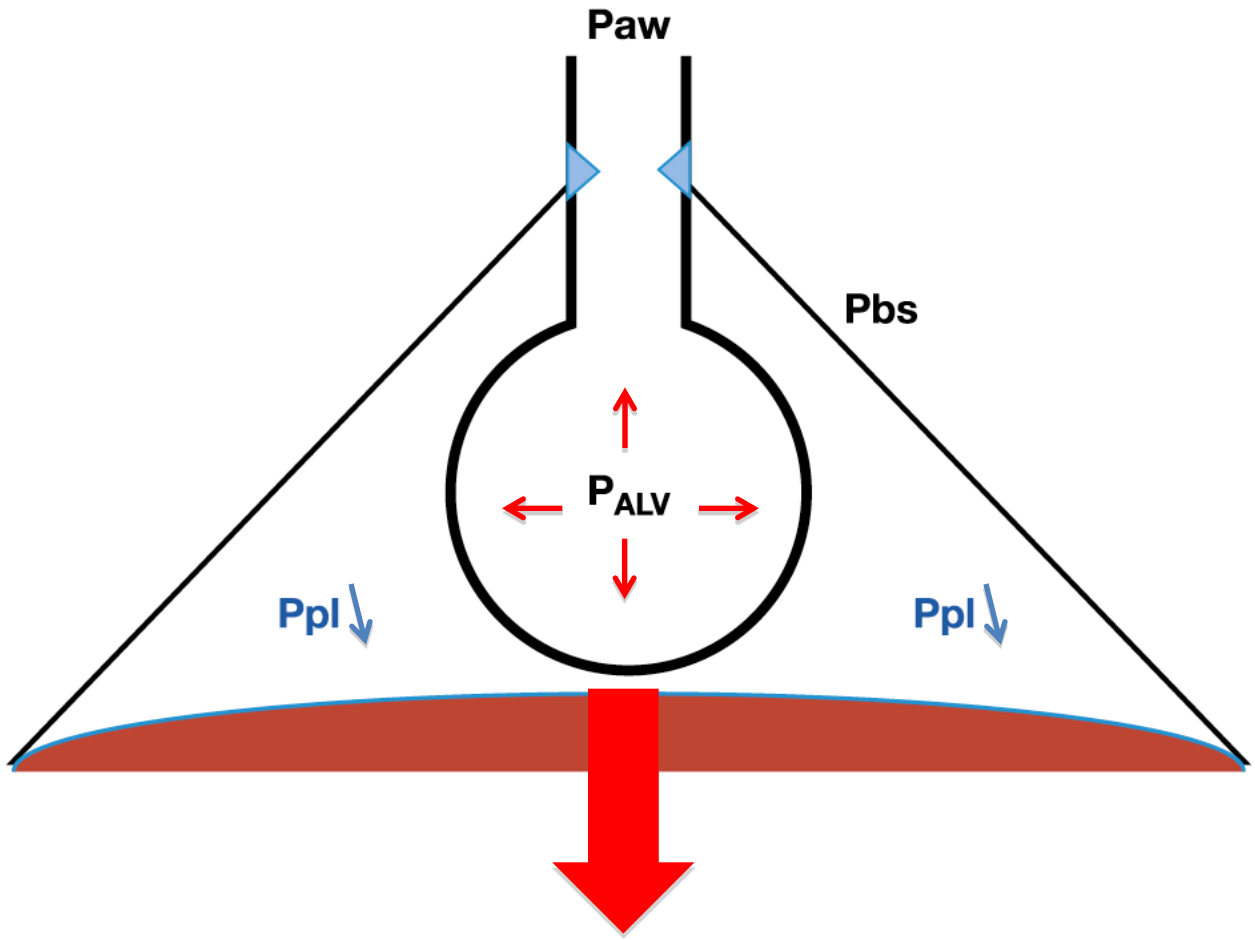
Paroi thoracique (Chest wall)



Mécanique passive du système respiratoire



Efforts inspiratoires → Diminution Ppleurale



Akoumianaki et al. AJRCCM 2014

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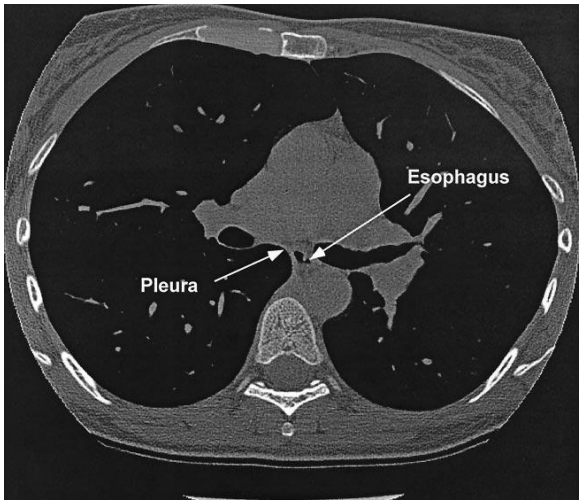
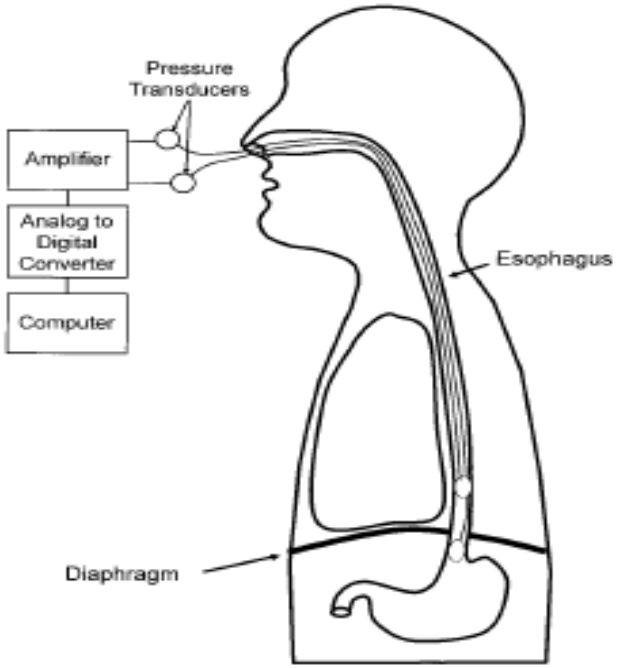
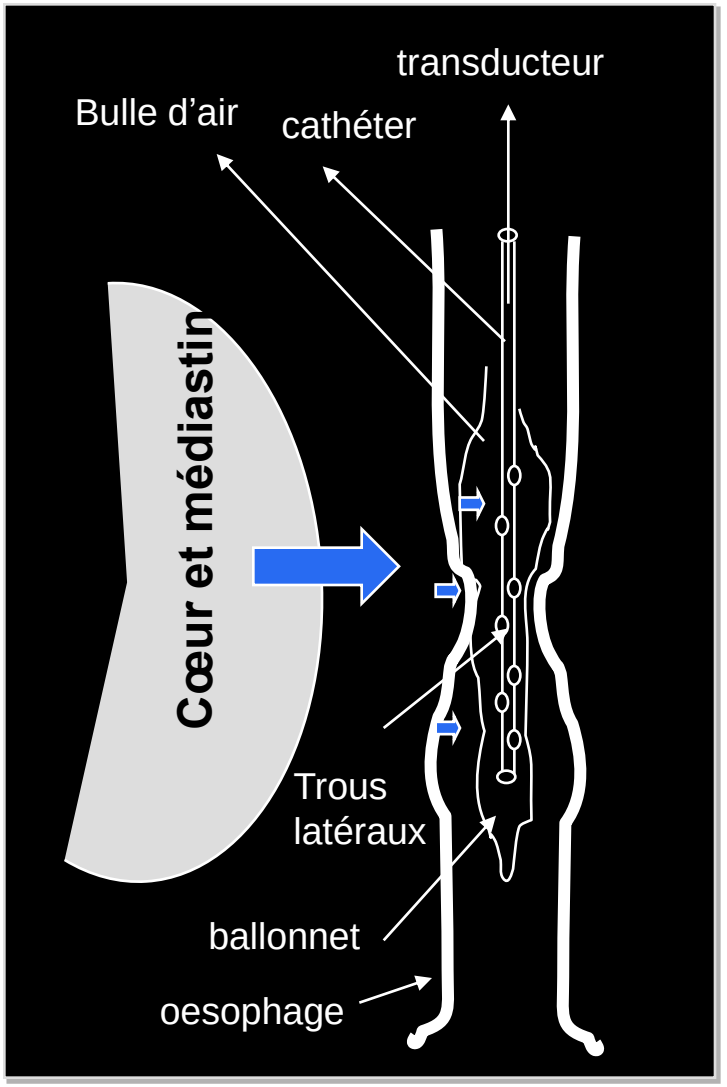
Pression pleurale ? → Pression oesophagienne

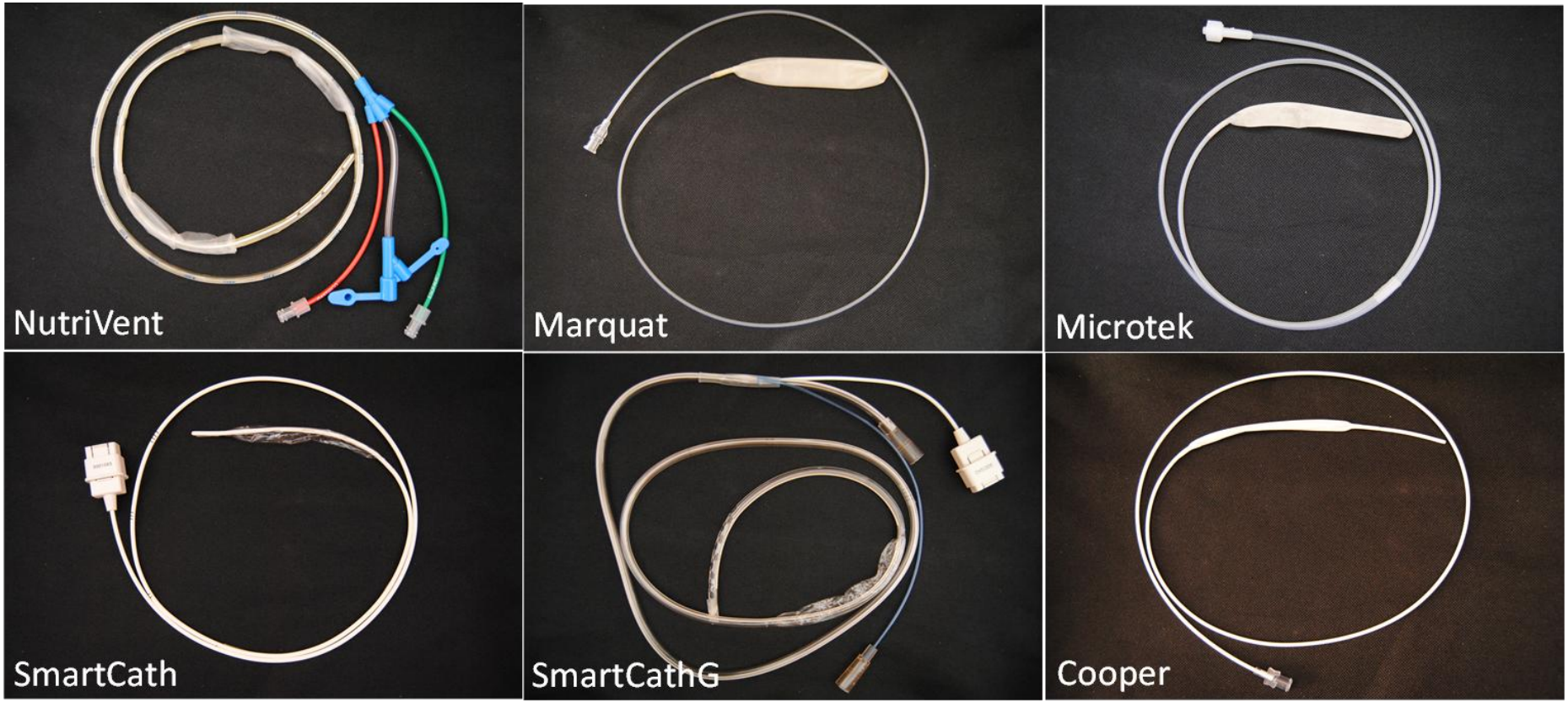




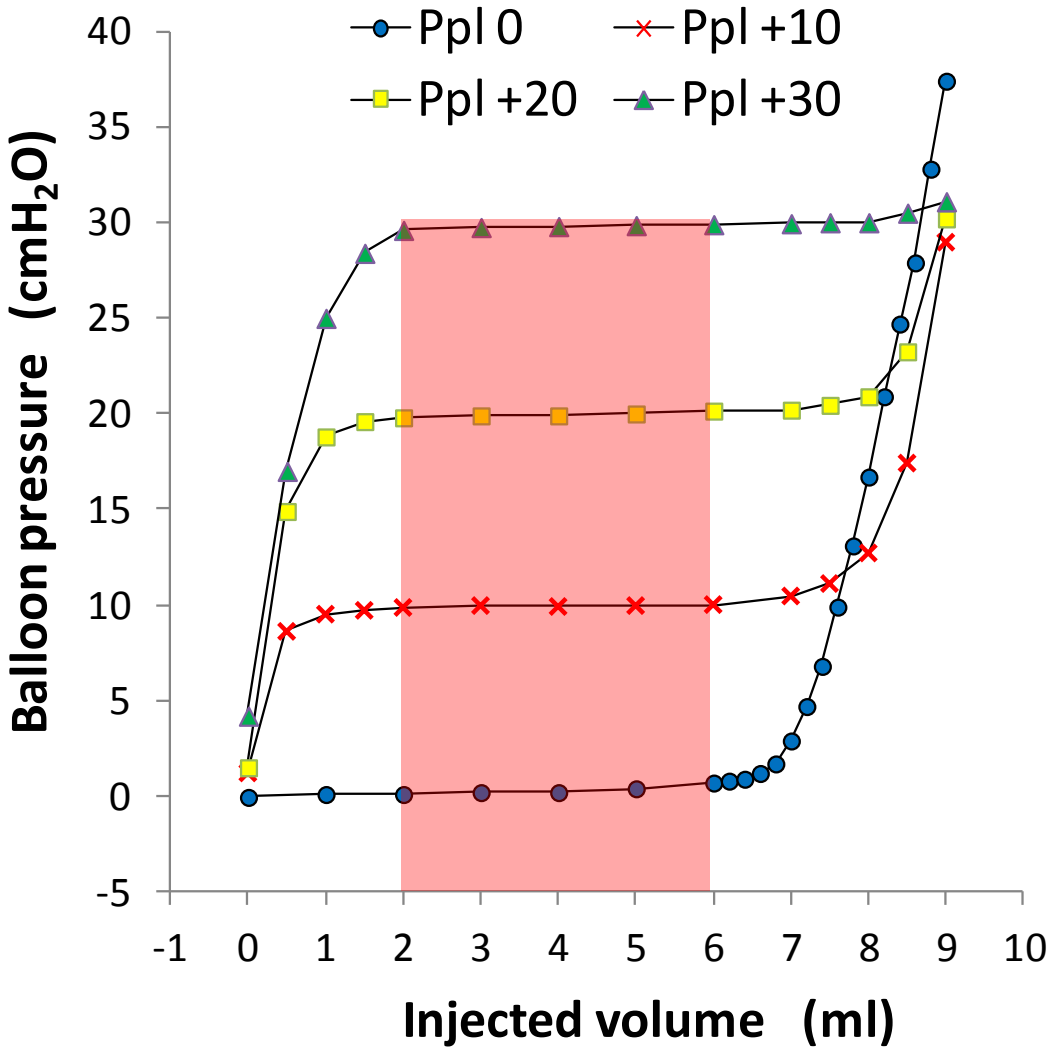


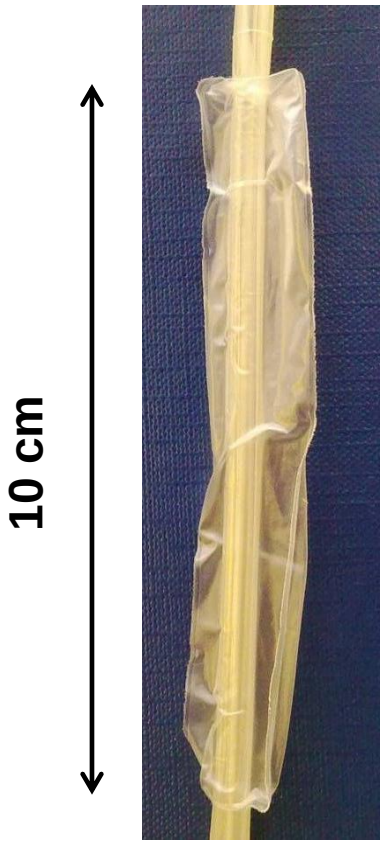
the PLG

Ballonnets oesophagiens



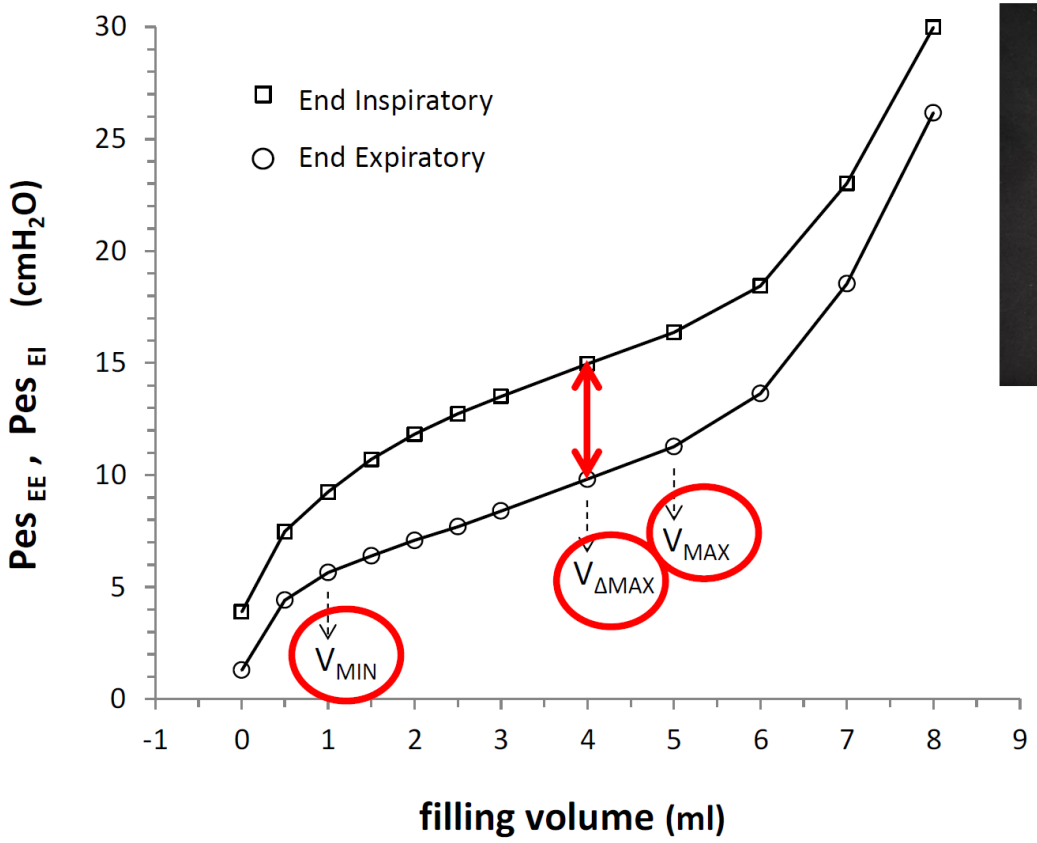
PV curve of the balloon in a positive pressure environment

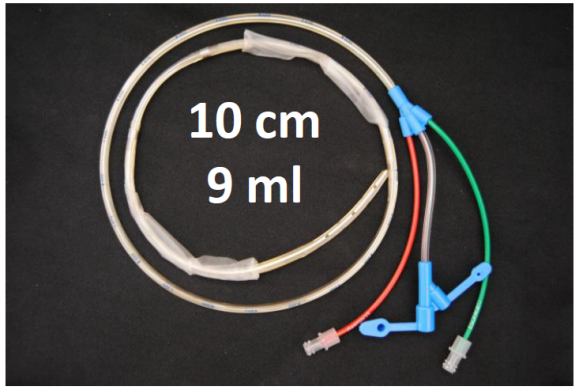




the PLUG

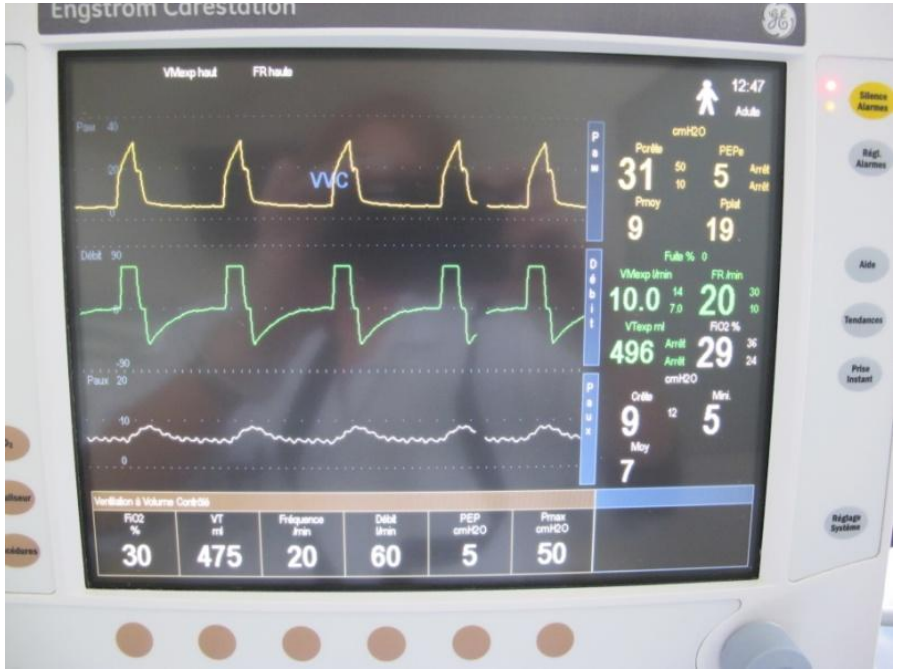
Esophageal balloon PV curves in ARF patients





Mojoli F et al Crit Care 2016

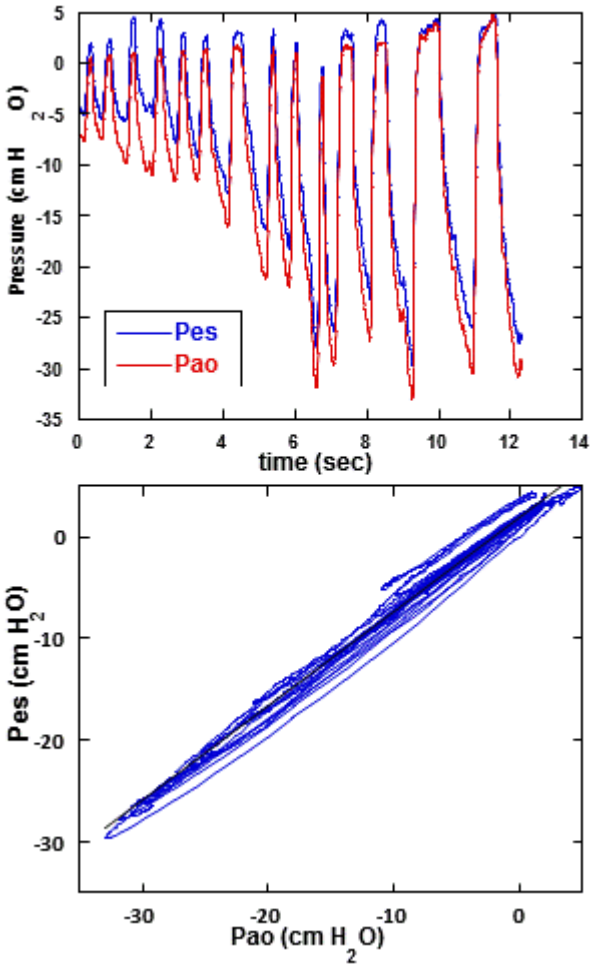

SIEMENS SC 9000XL
Pression statique PA
30-Sep 13:37
FC 118
Stimulateur NON
Adulte
PA 140 67
PG1 90 11
SpO2 96
FP 119
Ta 37,3
Tb
FR 20
Chargeur batterie


Engstrom Carestation
VMexp haut
FR haute
12:47
Adulte
cmH2O
Pcrête 31
PEPe 5
Pmoy 9
Pplat 19
Fuite % 0
VMexp l/min 10.0
FR /min 20
VTexp ml 496
FiO2 % 29
Crête 9
Moy 7
Mini. 5
Ventilation à Volume Contrôlé
FiO2 % 30
VT ml 475
Fréquence /min 20
Débit l/min 60
PEP cmH2O 5
Pmax cmH2O 50


Flux Med
Respiratory Mechanics Monitor
Autocalibration
Successfull calibration


RR 19
PEEP 5,0
VT 448
Cdyn 19
DELL
LATITUDE

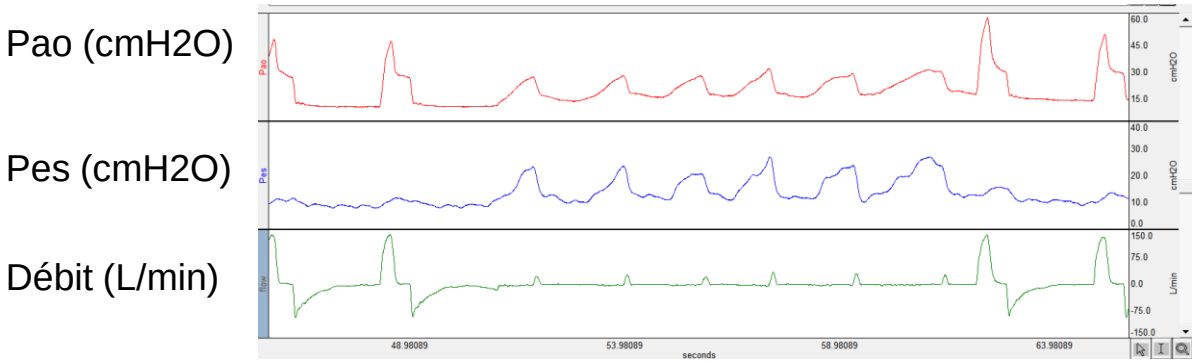
A. Patient intubé, sédaté, avec effort inspiratoire présent



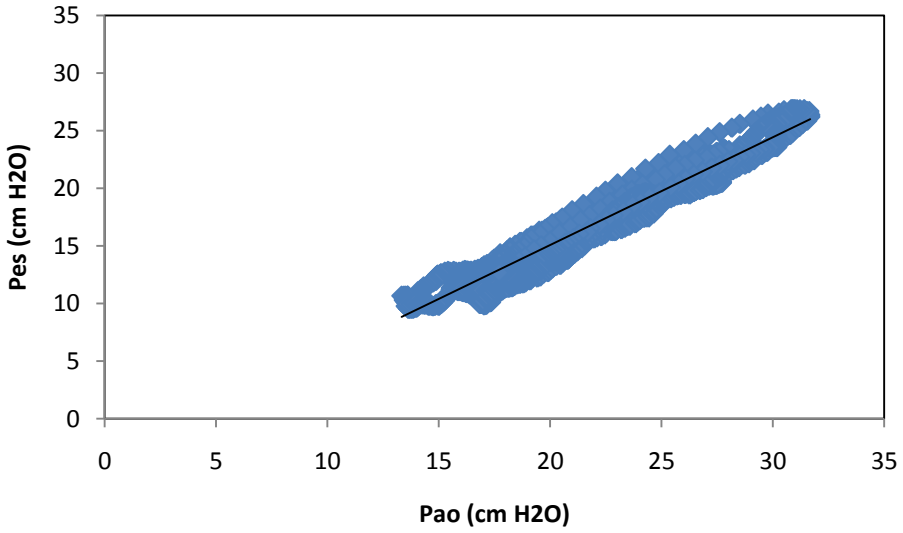
$\Delta Pes = 1,92 + 0,92\ \Delta Pao$

$R^2 = 0,99 \quad P < 0,0001$

B. Patient intubé, sédaté sans effort inspiratoire présent



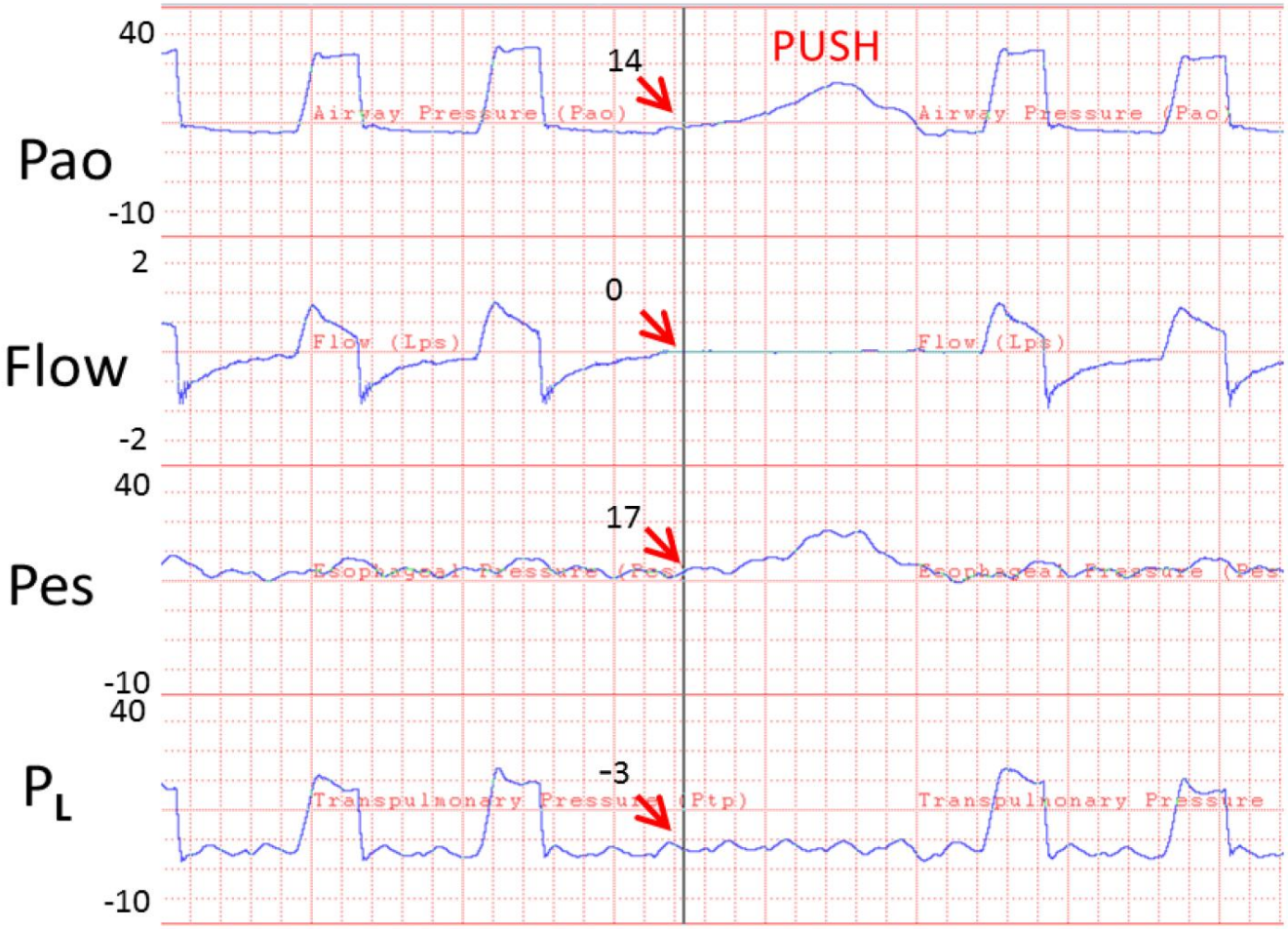
Occlusion télé-expiratoire



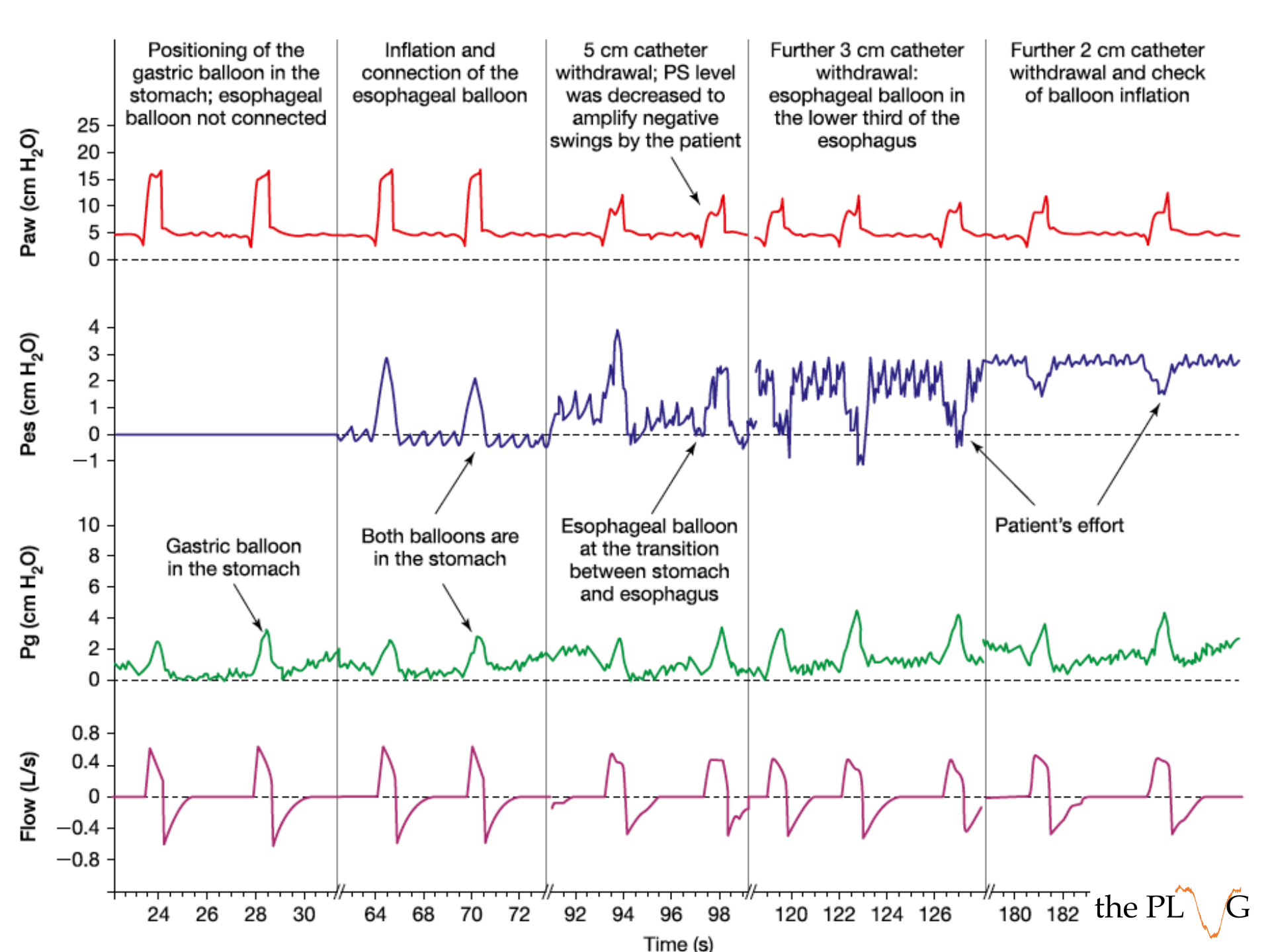
$\Delta Pes = -3.62 + 0,94\ \Delta Pao$

$R^2 = 0,95 \quad P < 0,0001$

Test d’occlusion patient passif



Mauri T, and the PLUG. ICM 2016

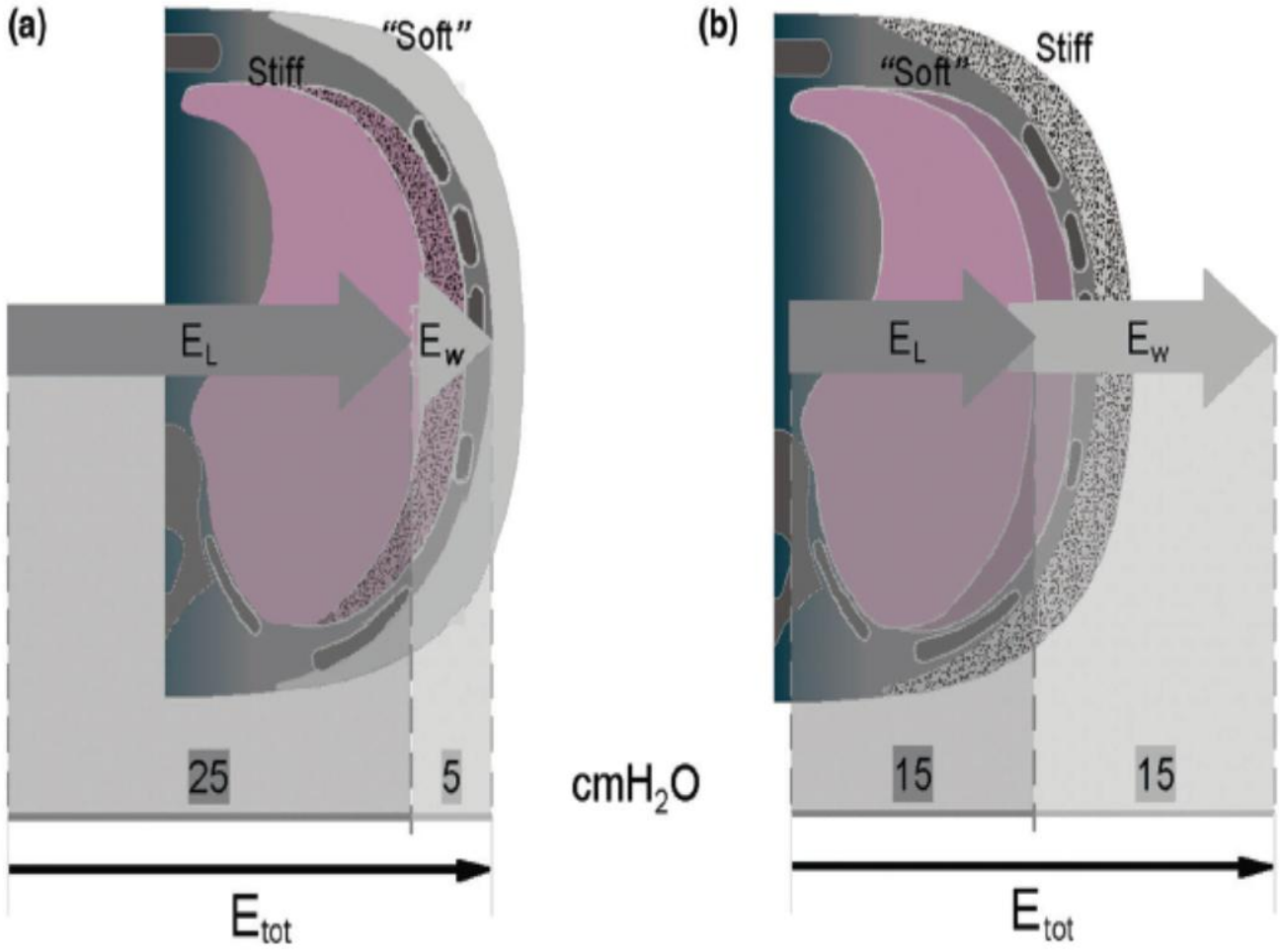

Positioning of the gastric balloon in the stomach; esophageal balloon not connected
Inflation and connection of the esophageal balloon
5 cm catheter withdrawal; PS level was decreased to amplify negative swings by the patient
Further 3 cm catheter withdrawal: esophageal balloon in the lower third of the esophagus
Further 2 cm catheter withdrawal and check of balloon inflation
Paw (cm H2O)
Pes (cm H2O)
Pg (cm H2O)
Flow (L/s)
Gastric balloon in the stomach
Both balloons are in the stomach
Esophageal balloon at the transition between stomach and esophagus
Patient's effort
Time (s)
the PLG

Pression oesophagienne : Applications cliniques

- Mécanique respiratoire passive (SDRA)
  - Mesure de l'élastance de la paroi
  - Calcul de la pression transpulmonaire
  - Réglage de la PEEP / Ptp télé-expiratoire
- Ventilation assistée
  - Intensité des efforts inspiratoire (PTPeso, PTPdi, WOB)
  - Asynchronie patient-ventilateur
  - Pression transpulmonaire
- Hémodynamique
  - Pressions transmurales (OD, PAPO)

Respiratory system vs Lung

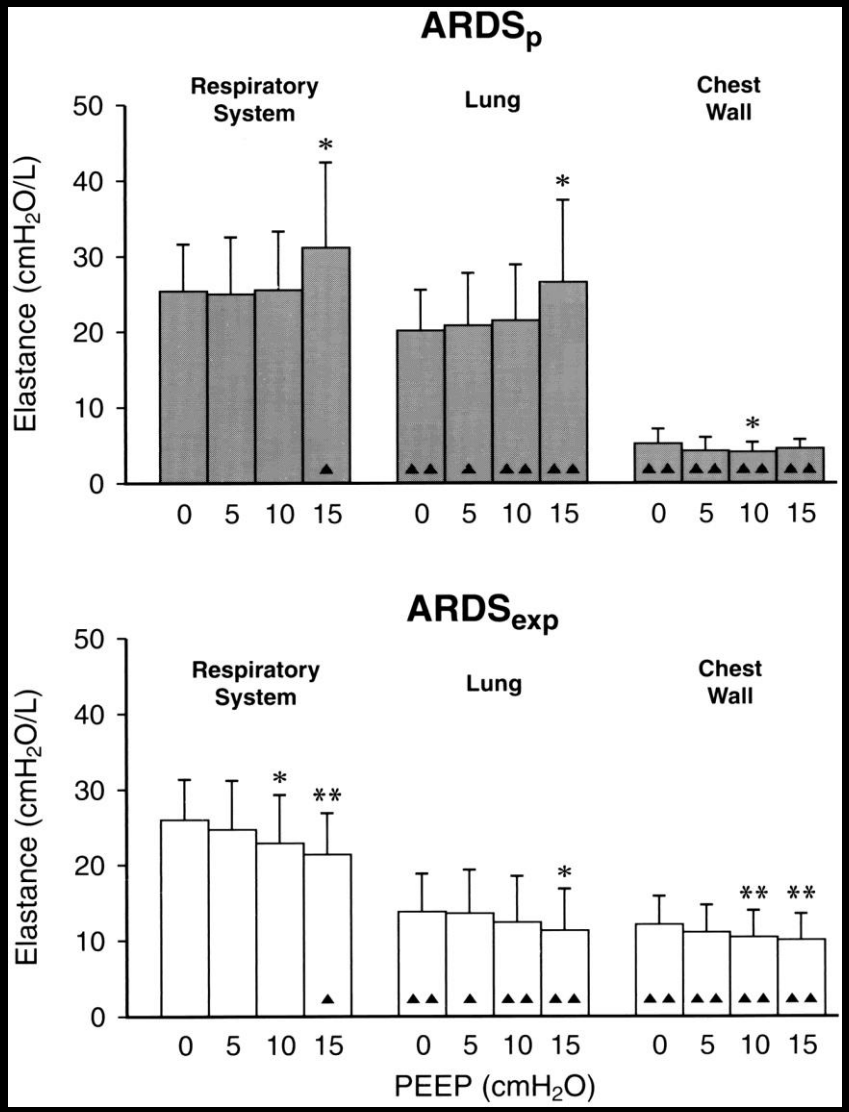
$$E_{RS} = E_L + E_{CW} \rightarrow P_{RS} = P_L + P_{CW}$$

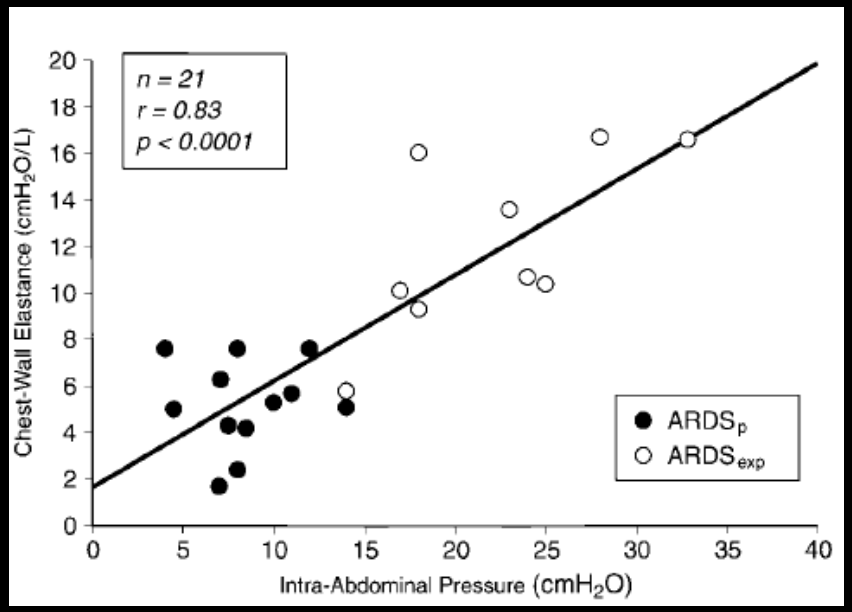


Acute Respiratory Distress Syndrome Caused by Pulmonary and Extrapulmonary Disease

Different Syndromes?

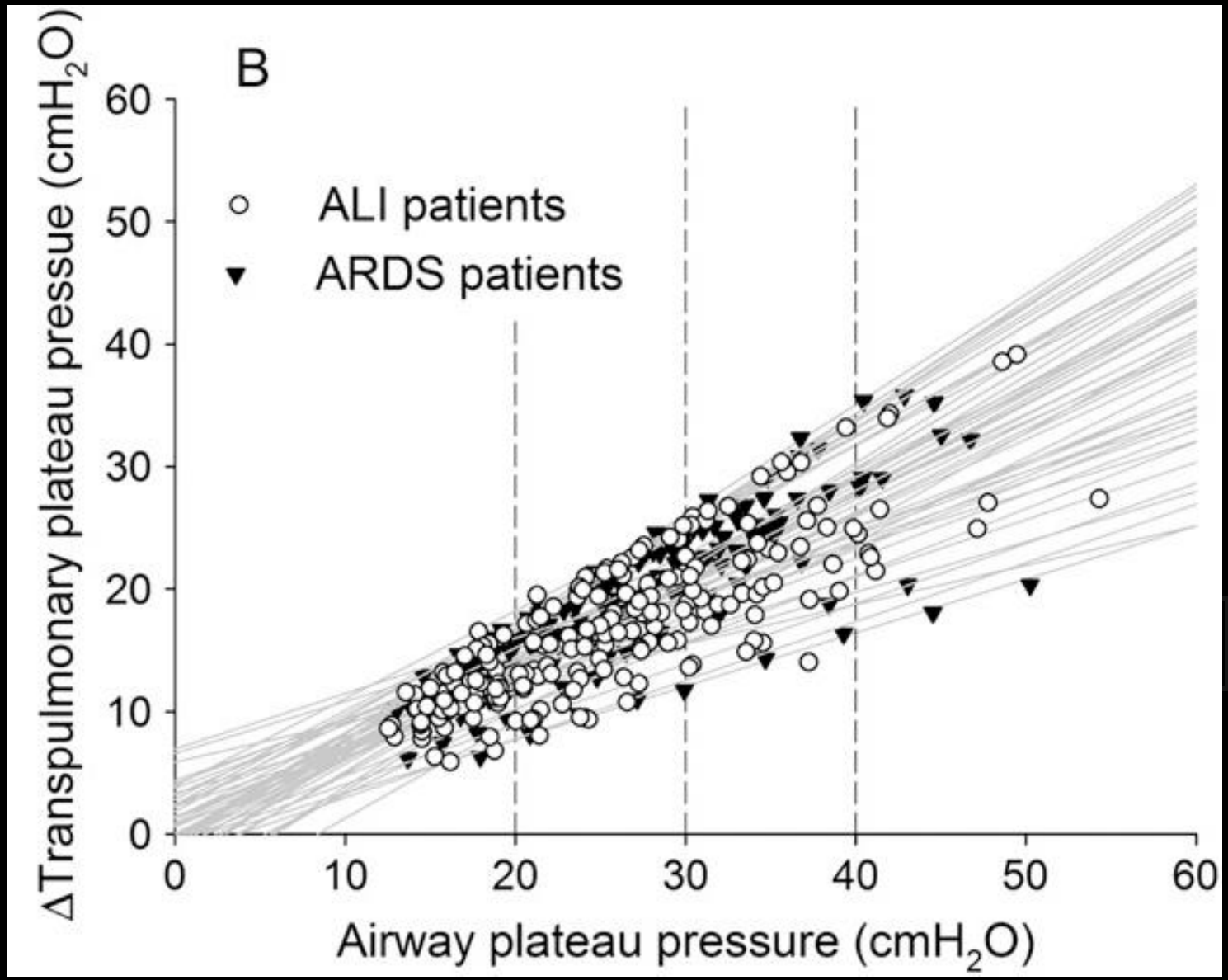
LUCIANO GATTINONI, PAOLO PELOSI, PETER M. SUTER, ALESSIA PEDOTO, PAOLA VERCESI, and ALFREDO LISSONI





AM J RESPIR CRIT CARE MED 1998;158:3–11.

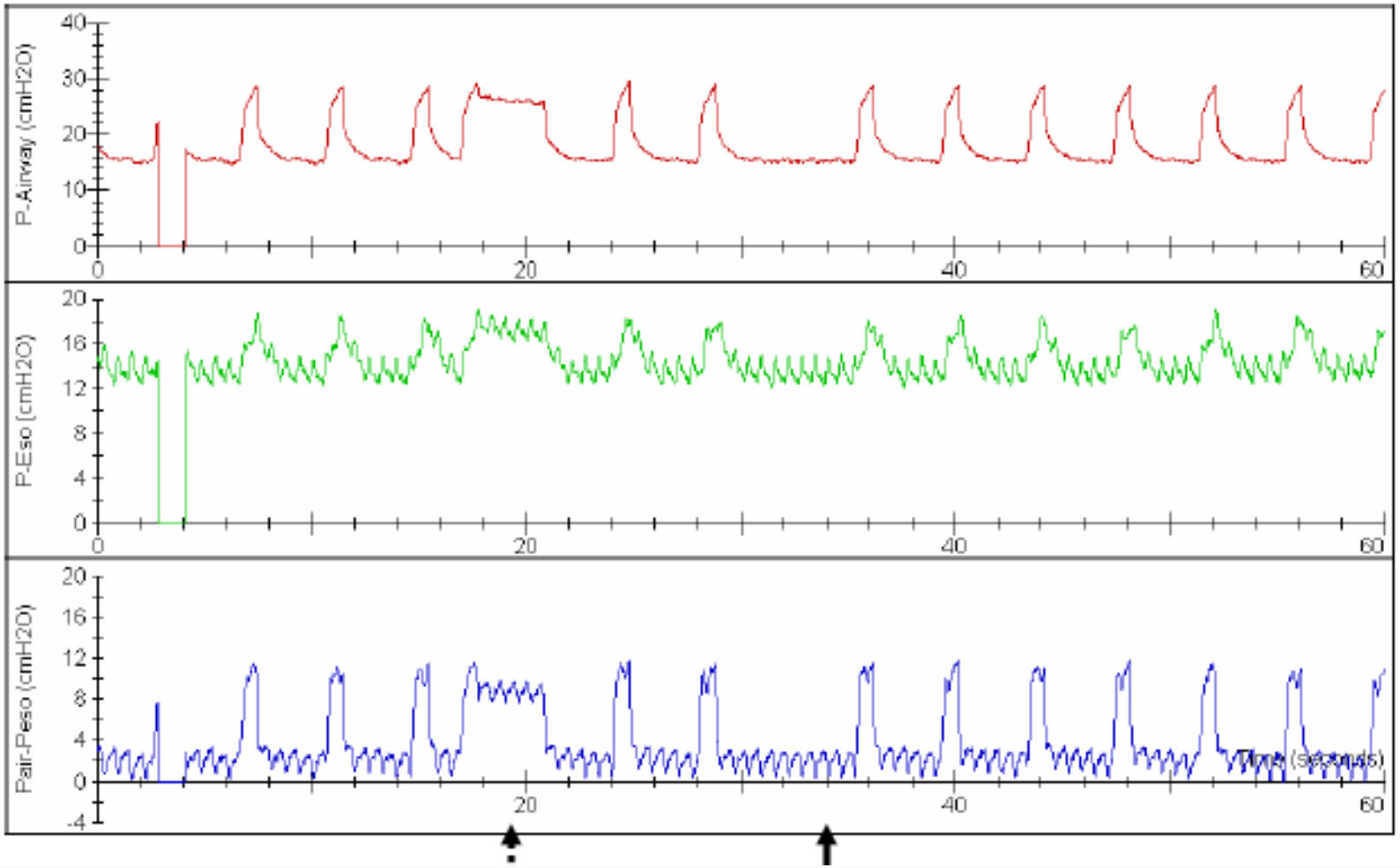
Lung Stress and Strain during Mechanical Ventilation for Acute Respiratory Distress Syndrome



Chiumello et al. AJRCCM 2008

Mechanical Ventilation Guided by Esophageal Pressure in Acute Lung Injury

N ENGL J MED 359;20 WWW.NEJM.ORG NOVEMBER 13, 2008



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

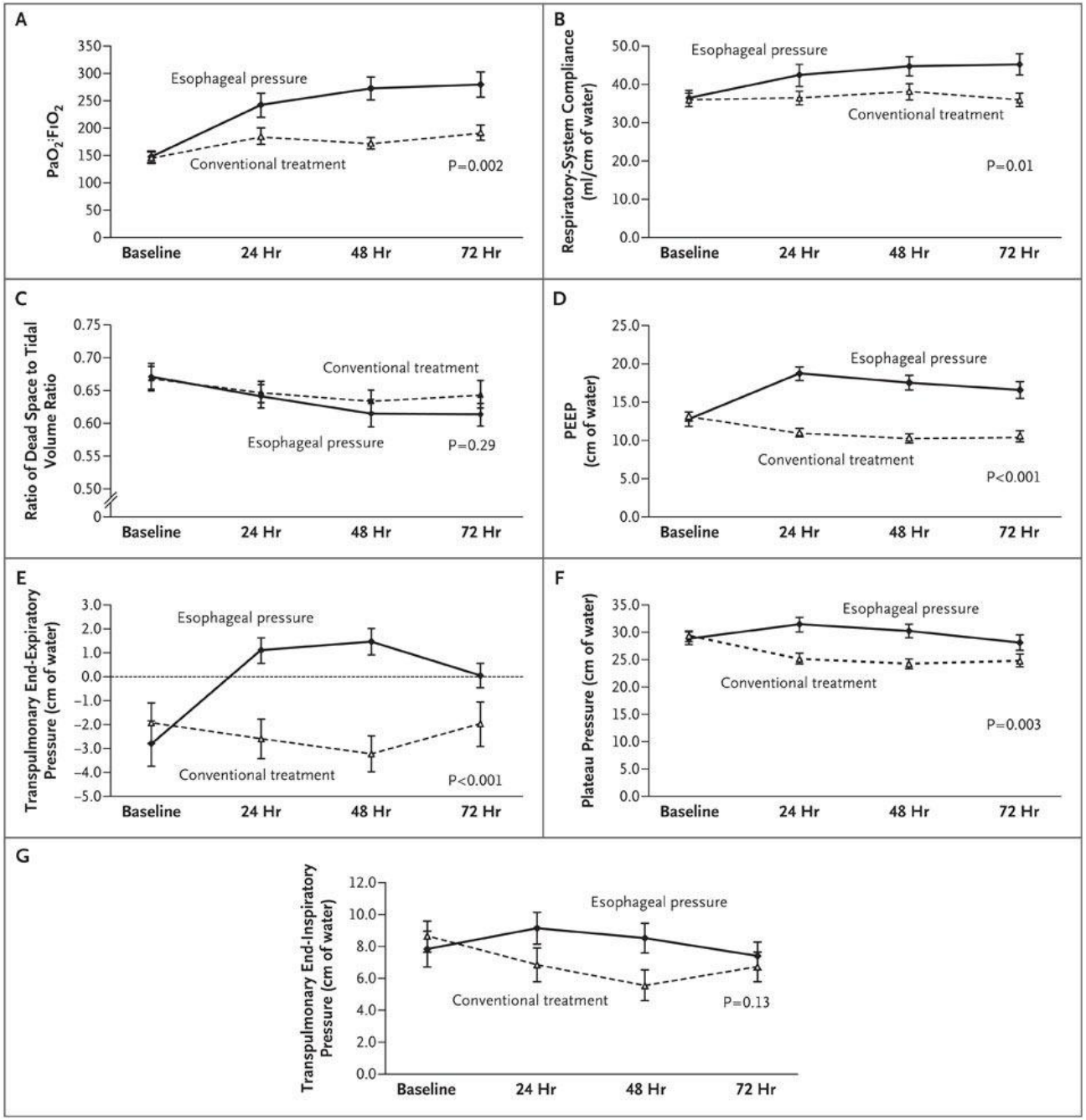
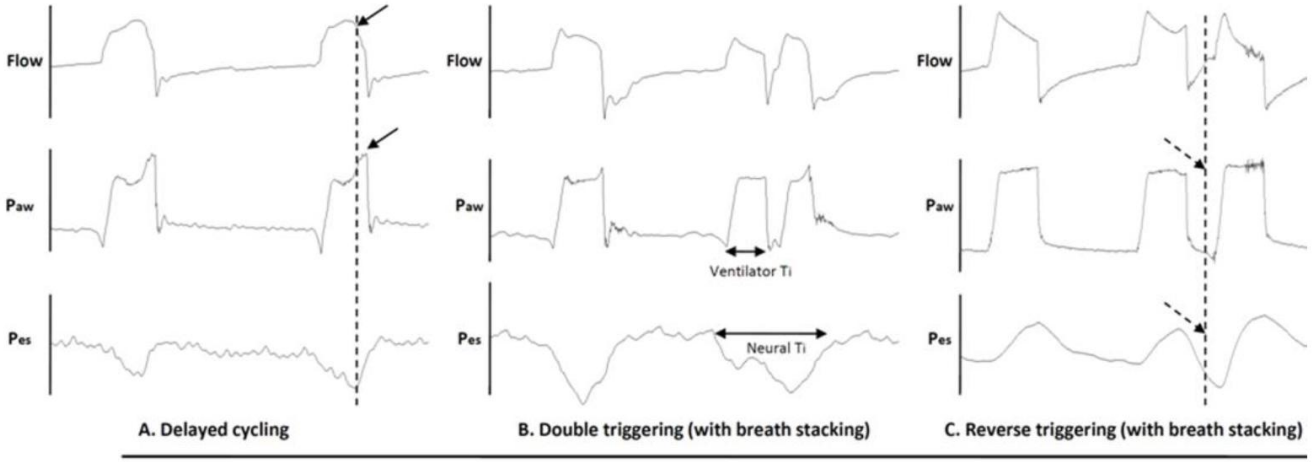

A
$PaO_2:FiO_2$
Esophageal pressure
Conventional treatment
P=0.002
Baseline
24 Hr
48 Hr
72 Hr
B
Respiratory-System Compliance (ml/cm of water)
Esophageal pressure
Conventional treatment
P=0.01
C
Ratio of Dead Space to Tidal Volume Ratio
Conventional treatment
Esophageal pressure
P=0.29
D
PEEP (cm of water)
Esophageal pressure
Conventional treatment
P<0.001
E
Transpulmonary End-Expiratory Pressure (cm of water)
Esophageal pressure
Conventional treatment
P<0.001
F
Plateau Pressure (cm of water)
Esophageal pressure
Conventional treatment
P=0.003
G
Transpulmonary End-Inspiratory Pressure (cm of water)
Esophageal pressure
Conventional treatment
P=0.13

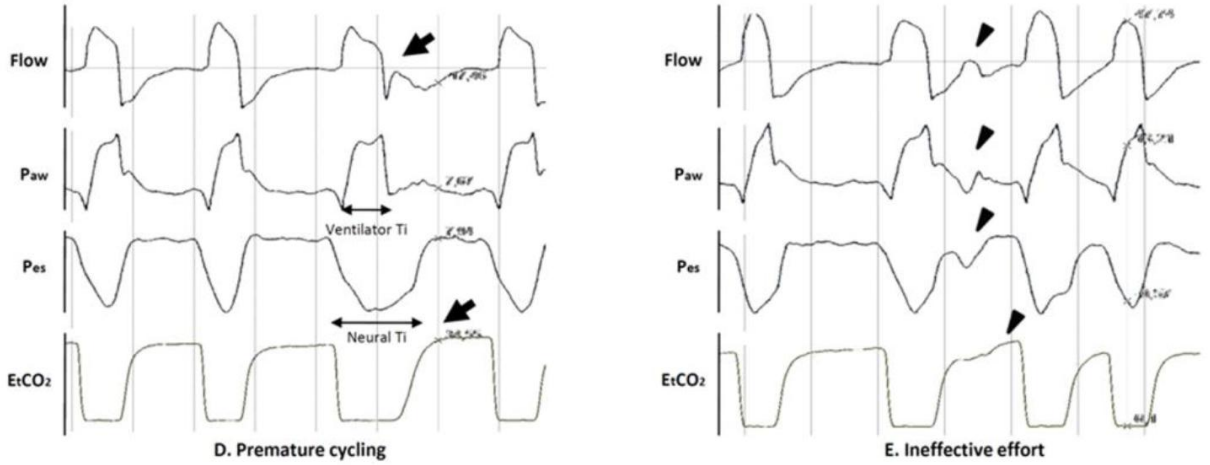
Table 4. Clinical Outcomes.*

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	
No. of ICU-free days at 28 days			0.96
Median	5.0	4.0	
Interquartile range	0.0–14.0	0.0–16.0	
No. of ventilator-free days at 28 days			0.50
Median	11.5	7.0	
Interquartile range	0.0–20.3	0.0–17.0	
No. of days of ventilation among survivors			0.71
Median	12.0	16.0	
Interquartile range	7.0–27.5	7.0-20.0	

* For patients who were deceased at day 28, a value of 0 days was assigned. ICU denotes intensive care unit.

Pression oesophagienne et asynchronies



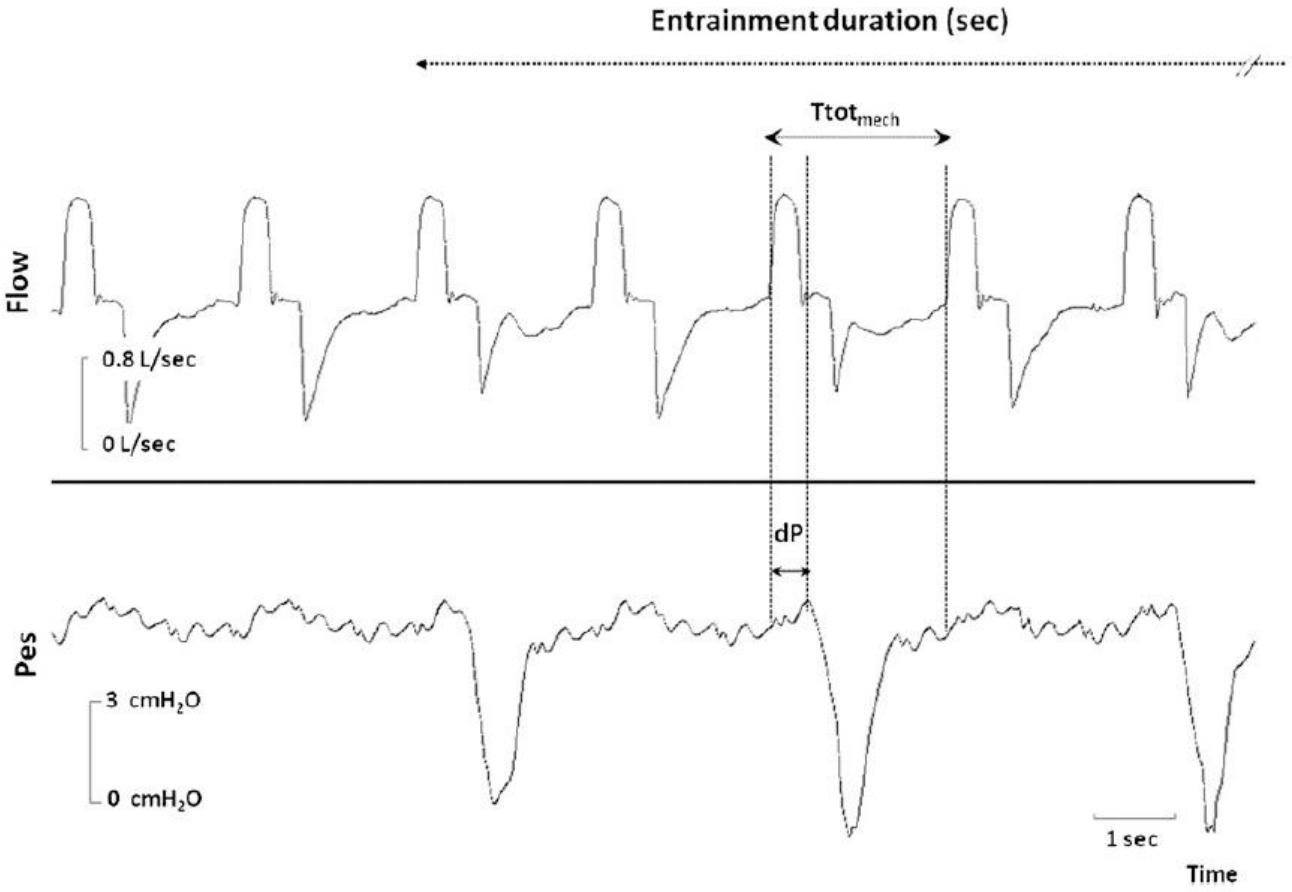


Mauri T, and the PLUG. ICM 2016

Mechanical Ventilation-Induced Reverse-Triggered Breaths

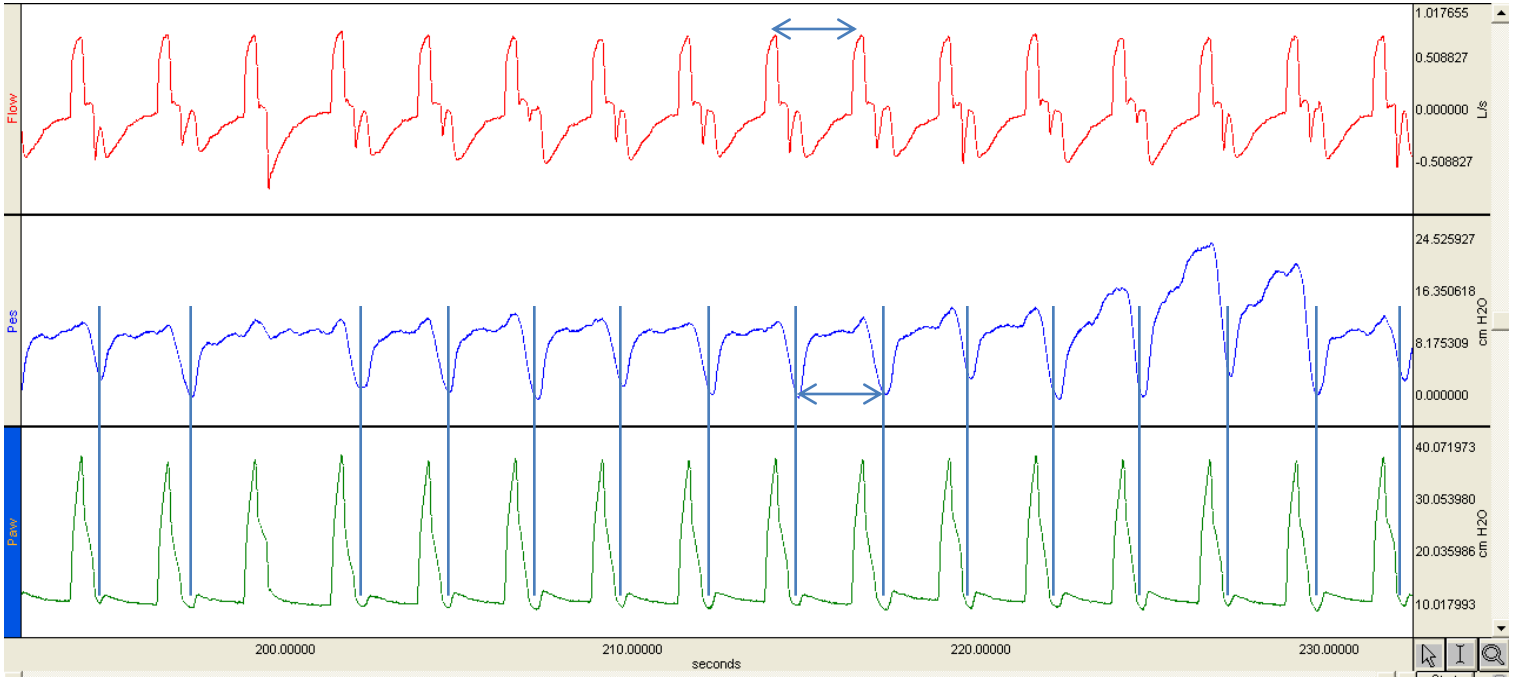
A Frequently Unrecognized Form of Neuromechanical Coupling

Evangelia Akoumianaki, MD; Aissam Lyazidi, PhD; Nathalie Rey, MD; Dimitrios Matamis, MD; Nelly Perez-Martinez, MD; Raphael Giraud, MD; Jordi Mancebo, MD; Laurent Brochard, MD; and Jean-Christophe Marie Richard, MD, PhD

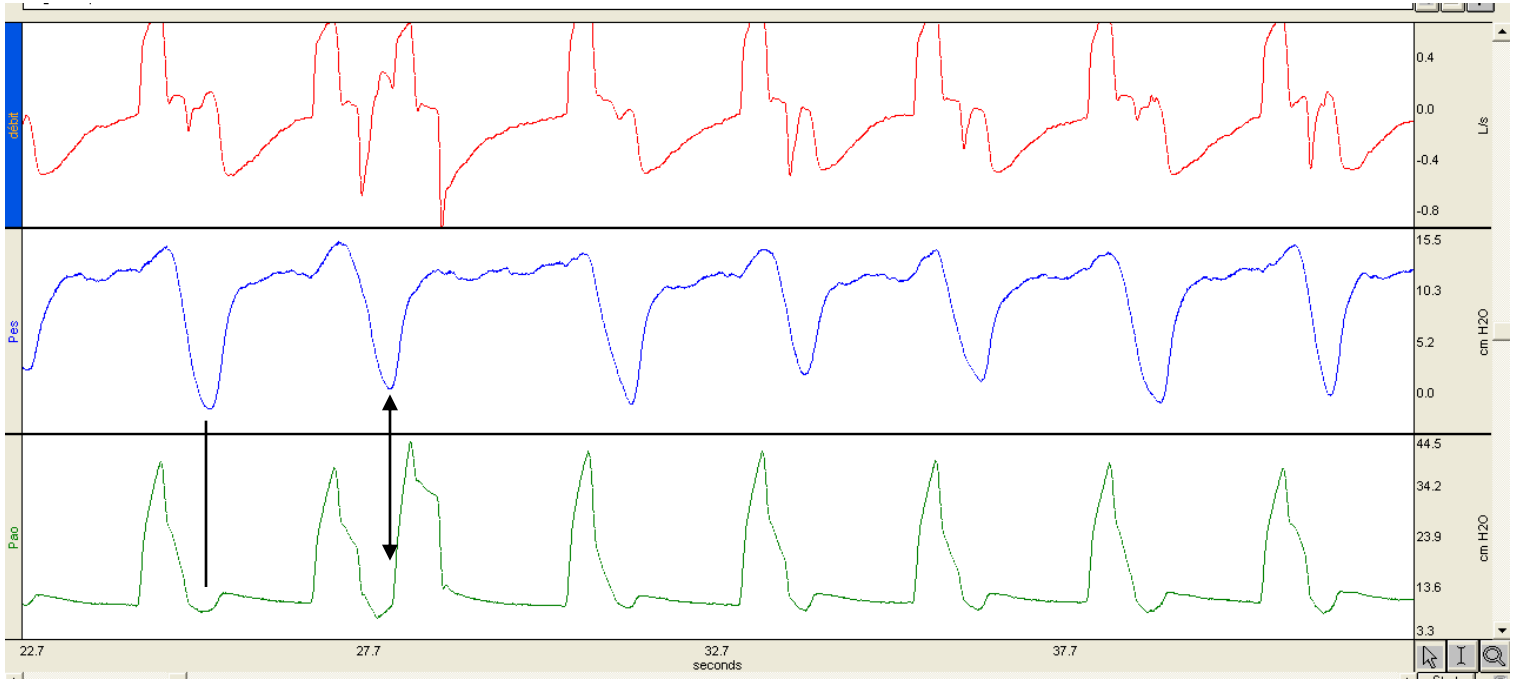


CHEST 2013; 143(4):927–938

A


Flow
1.017655
0.508827
0.000000
-0.508827
L/s
Pes
24.525927
16.350618
8.175309
0.000000
cm H2O
Paw
40.071973
30.053980
20.035986
10.017993
cm H2O
200.00000
210.00000
220.00000
230.00000
seconds

B


débit
0.4
0.0
-0.4
-0.8
L/s
Pes
15.5
10.3
5.2
0.0
cm H2O
Pao
44.5
34.2
23.9
13.6
3.3
cm H2O
22.7
27.7
32.7
37.7
seconds

Poeso et modes assistés

- AI 15/5 cmH2O
- Vt ≈ 600 ML

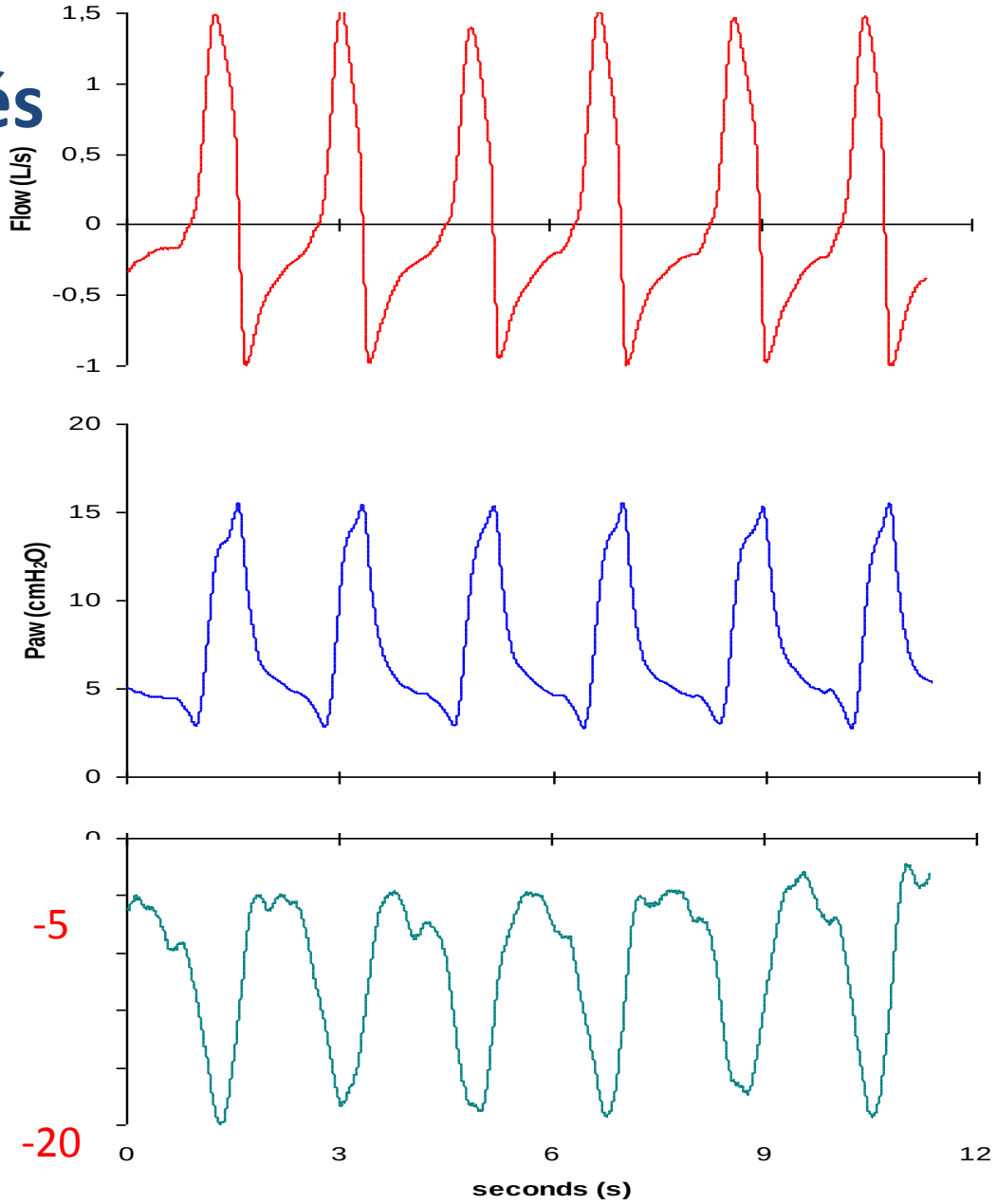
- Delta Peso 15 cmH20

- Delta Ptp élevé

→Risque de VILI ?

- Poeso négative ++

→ Postcharge VG ++



The Application of Esophageal Pressure Measurement in Patients with Respiratory Failure

Evangelia Akoumianaki[1], Salvatore M. Maggiore[2], Franco Valenza[3], Giacomo Bellani[4], Amal Jubran[5], Stephen H. Loring[6], Paolo Pelosi[7], Daniel Talmor[6], Salvatore Grasso[8], Davide Chiumello[9], Claude Guérin[10], Nicolo Patroniti[4], V. Marco Ranieri[11], Luciano Gattinoni[12], Stefano Nava[13], Pietro-Paolo Terragni[11], Antonio Pesenti[4], Martin Tobin[5], Jordi Mancebo[14], and Laurent Brochard[15]

American Journal of Respiratory and Critical Care Medicine Volume 189 Number 5 | March 1 2014

REVIEW

Esophageal and transpulmonary pressure in the clinical setting: meaning, usefulness and perspectives

Tommaso Mauri[1], Takeshi Yoshida[2,3,4], Giacomo Bellani[5], Ewan C. Goligher[6,7,12], Guillaume Carteaux[8,9], Nuttapol Rittayamai[10,11,12], Francesco Mojoli[13], Davide Chiumello[1,14], Lise Piquilloud[15,16], Salvatore Grasso[17], Amal Jubran[18], Franco Laghi[18], Sheldon Magder[19], Antonio Pesenti[1,14], Stephen Loring[20], Luciano Gattinoni[1,14], Daniel Talmor[20], Lluis Blanch[21], Marcelo Amato[22], Lu Chen[11,12], Laurent Brochard[11,12*], Jordi Mancebo[23] and the PLeUral pressure working Group (PLUG—Acute Respiratory Failure section of the European Society of Intensive Care Medicine)

Intensive Care Med (2016) 42:1360–1373

the PLUG

http://www.edge-cdn.net/video_1059118?playerskin=37016