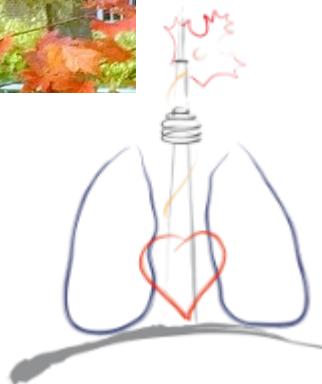




Mechanisms of Patient-Ventilator Dyssynchrony

Laurent Brochard
Toronto



Conflicts of interest

- Our clinical research laboratory has received equipment or research grants for clinical research projects from the following companies:
 - Covidien (PAV+)
 - Air Liquide (CPR)
 - Sentec (tcPCO2)
 - Philips (Sleep)
 - Fisher Paykel (Optiflow)



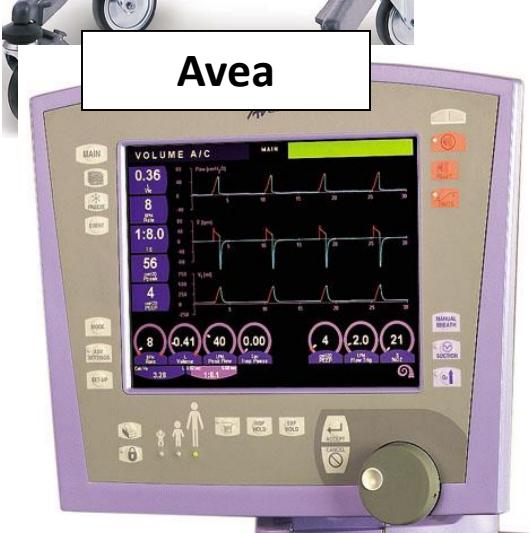
ICU ventilators...



...ICU ventilators



Medtronic
PB



Avea



Hamilton



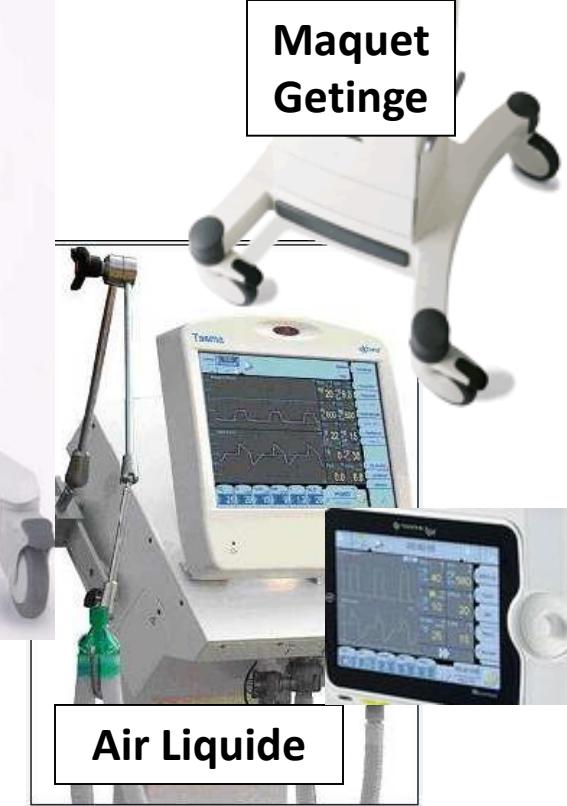
Engström



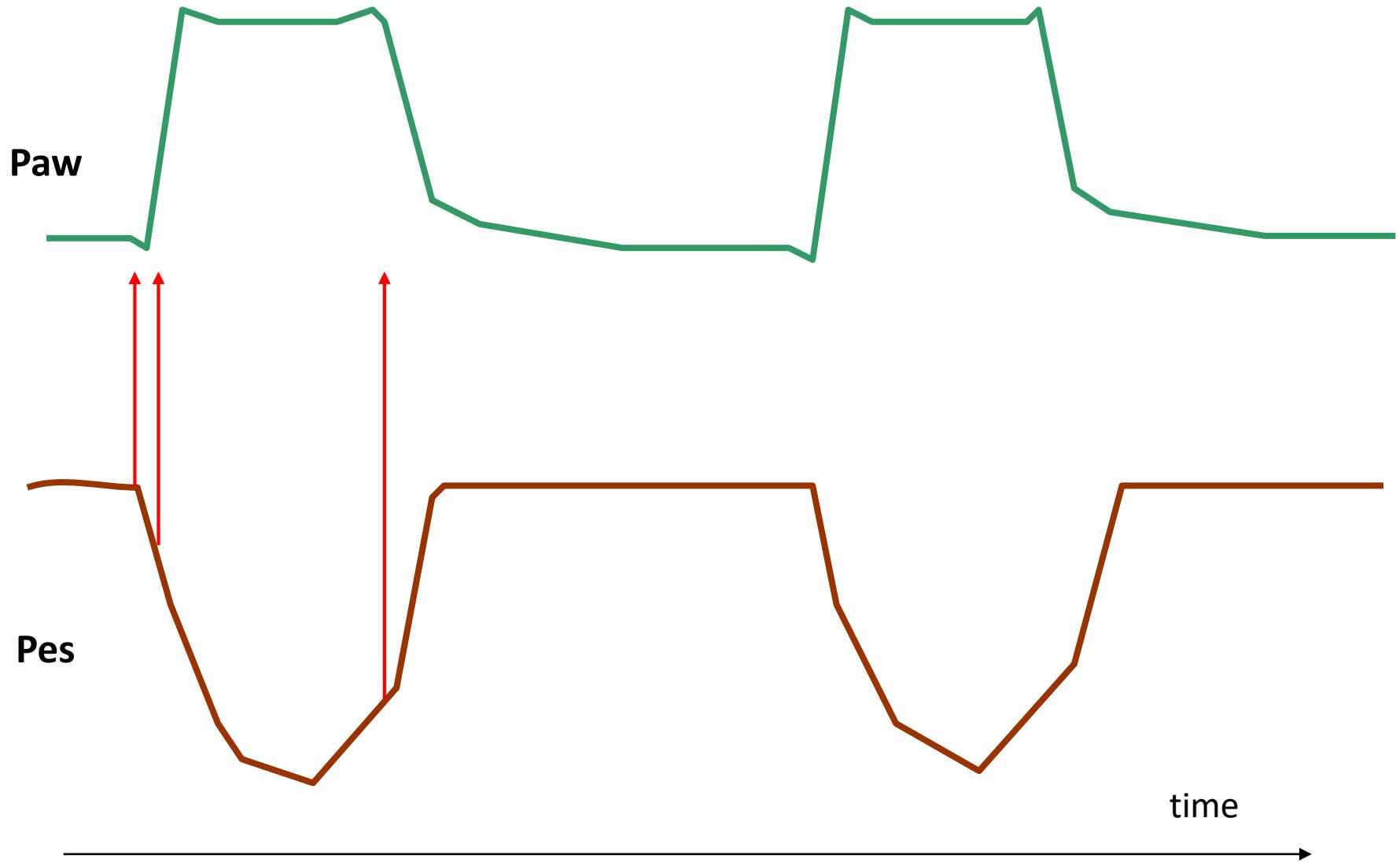
Maquet
Getinge



Draeger



Air Liquide



Good Synchrony: Paw follows Pes

Arnaud W. Thille
Pablo Rodriguez
Belen Cabello
François Lellouche
Laurent Brochard

Patient-ventilator asynchrony during assisted mechanical ventilation

DOI 10.1007/s00134-015-3692-6

ORIGINAL

Asynchronies during mechanical ventilation are associated with mortality

Lluís Blanch
Ana Villagra
Bernat Sales
Jaume Montanya
Umberto Lucangelo
Manel Luján
Oscar García-Esquirol

ORIGINAL

Clusters of ineffective efforts during mechanical ventilation: impact on outcome

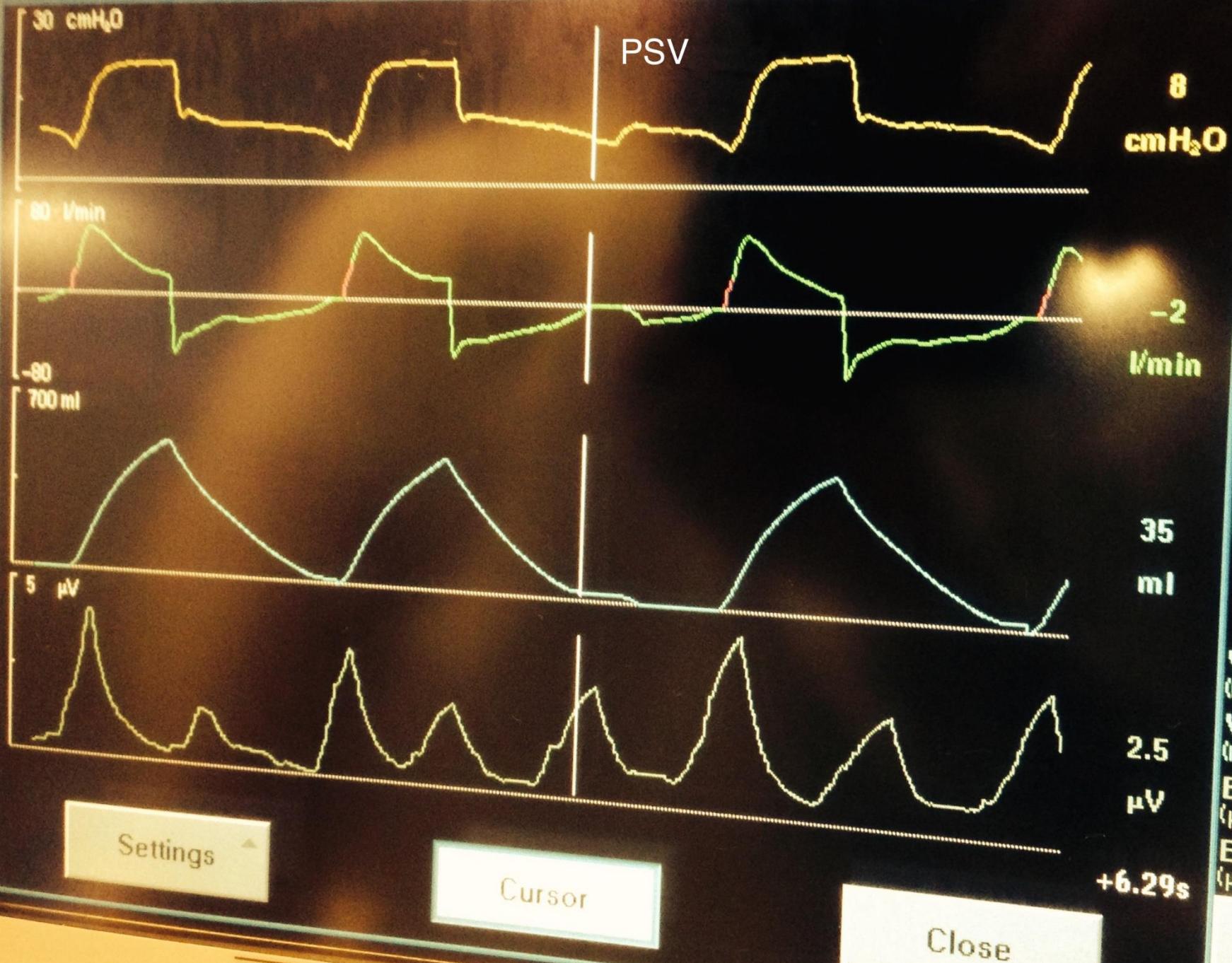


Katerina Vaporidi¹, Dimitris Babalis¹, Achilleas Chytas^{2,3}, Emmanuel Lilitsis¹, Eumorfia Kondili¹, Vasilis Amargianitakis¹, Ioanna Chouvarda^{2,3}, Nicos Maglaveras^{2,3} and Dimitris Georgopoulos^{1*}

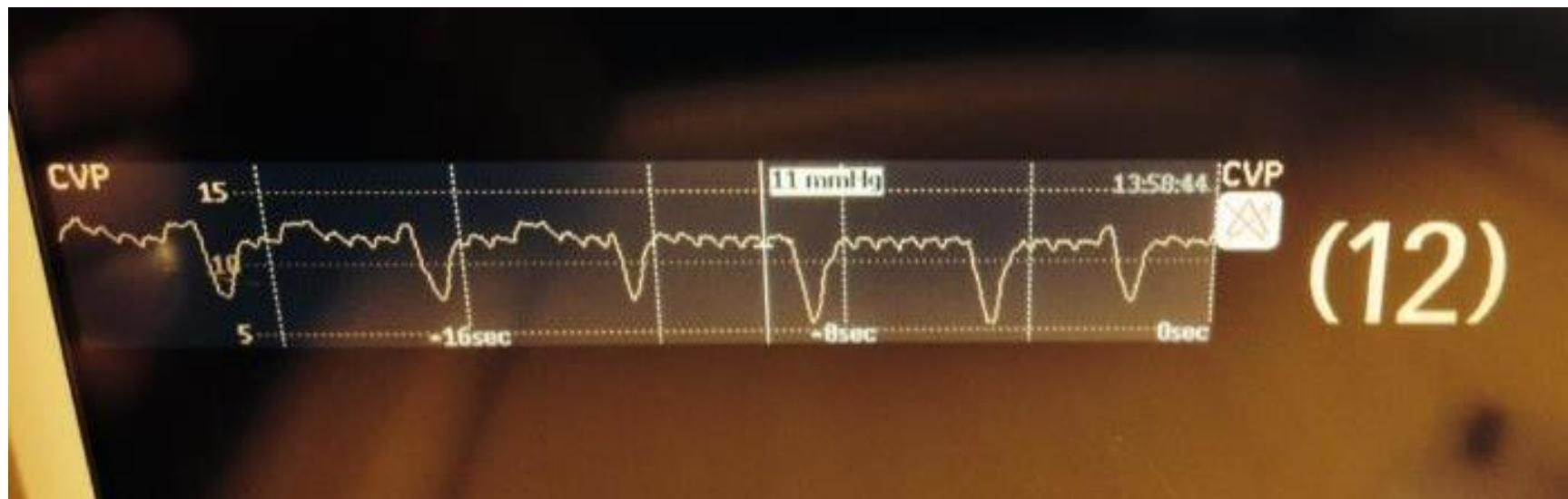
Clinical consequences of asynchronies

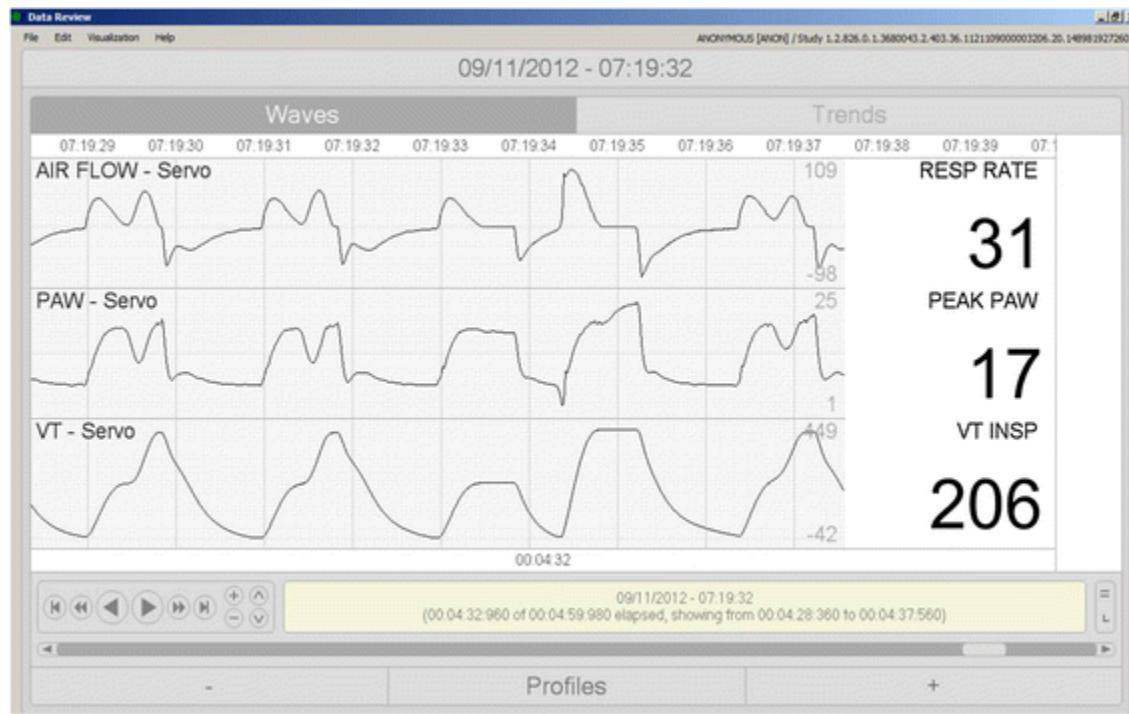
- 1) •Excessive or insufficient ventilatory assistance
- 2) •Dynamic hyperinflation
- 3) •Sedation
- 4) •Sleep fragmentation
- 5) •Errors in assessing weaning readiness
- 6) •Prolonged duration of ventilation
- 7) •Respiratory sequelae...

Recorded waveforms 2014-10-01 15:48:36

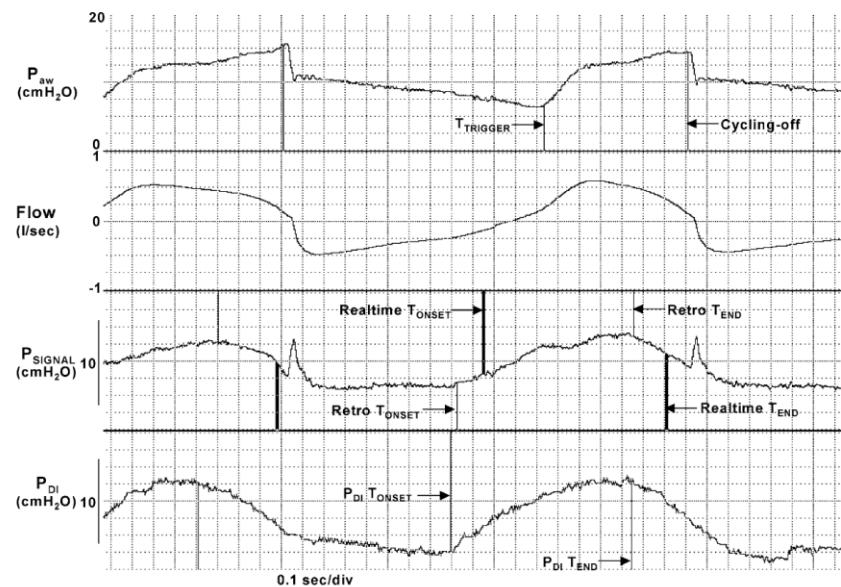


Pes during controlled ventilation Vs. spontaneous breathing





From Murias G... Blanch L
Crit Care 2016



From Younes M, Brochard L...
ICM 2007

Assistance in excess

- Auto-triggering
- Apneas
- Ineffective Efforts or Missed Cycles

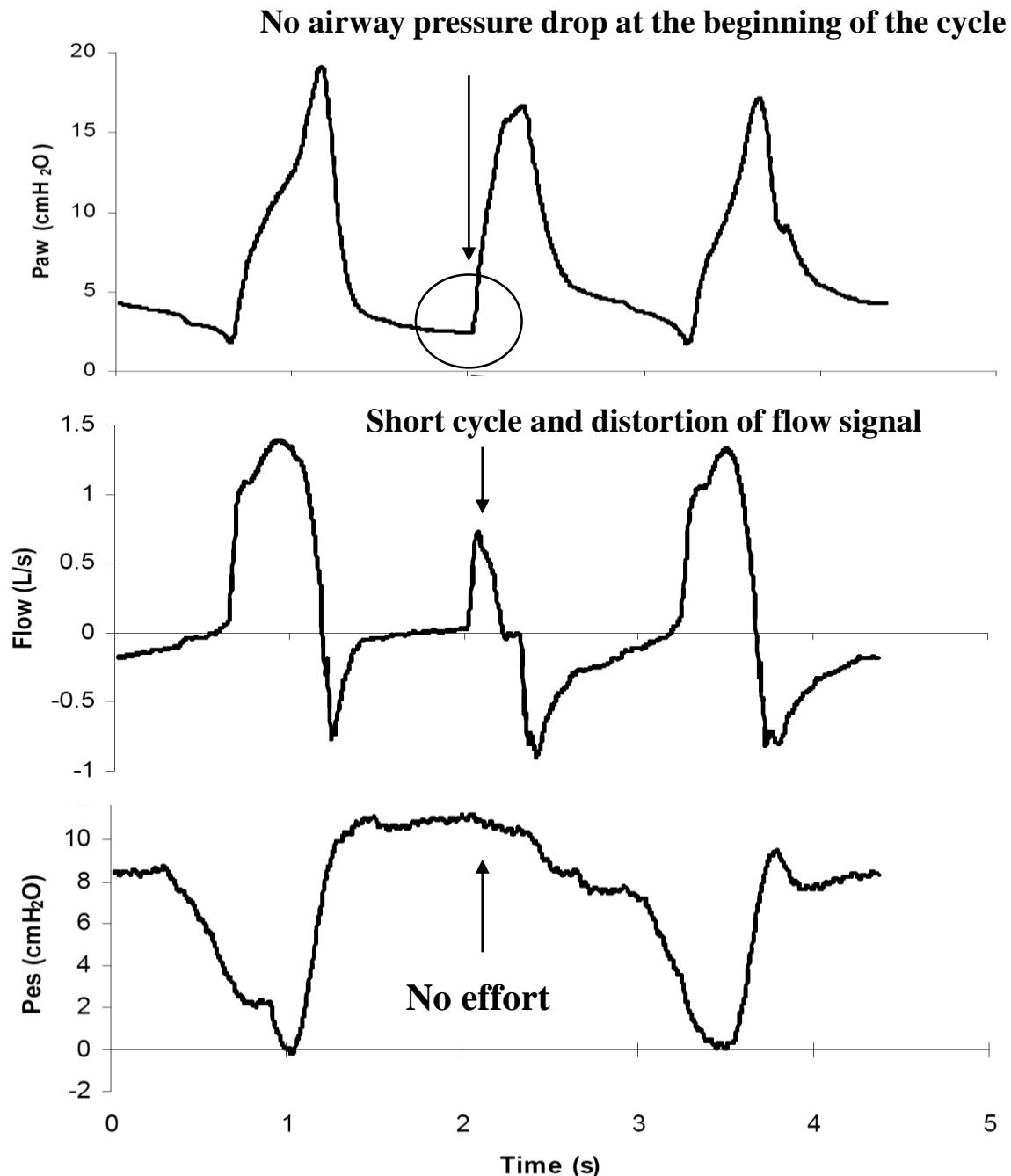
When to suspect auto-triggering ?

During controlled ventilation:

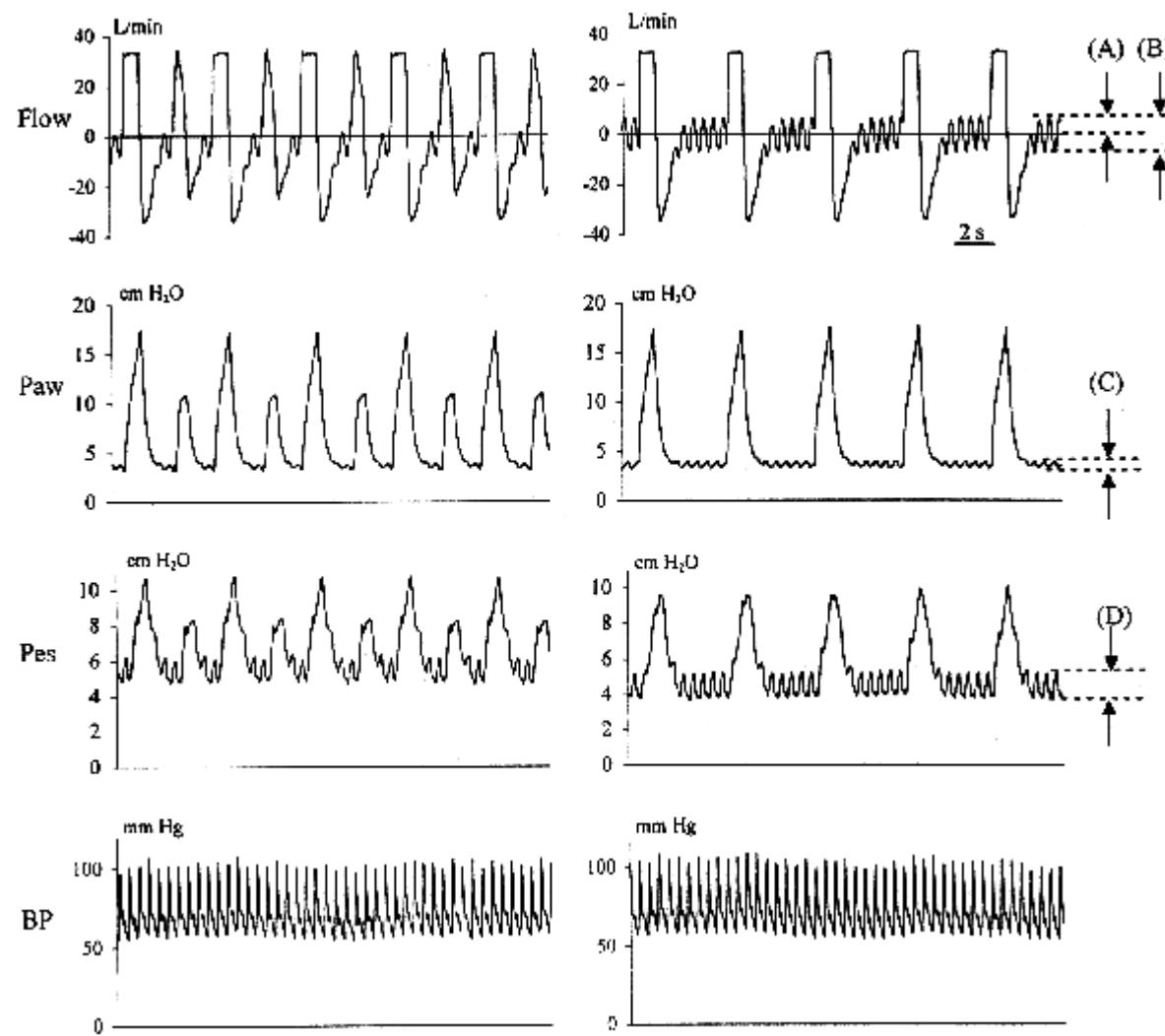
- $RR > adjusted\ RR$
- Respiratory alkalosis

During assisted ventilation:

- Sudden increase or persistently high respiratory rate
- Absence of an airway pressure drop at beginning of the cycle
- PSV: short cycle with a flow signal distortion
- ACV: abrupt airway pressure increase



Imanaka H, et al. Crit Care Med 2000; 28:402-407



Both High Level Pressure Support Ventilation and Controlled Mechanical Ventilation Induce Diaphragm Dysfunction and Atrophy

Matthew B. Hudson¹, Ashley J. Smuder¹, W. Bradley Nelson¹, Christian S. Bruells², Sanford Levine³, and Scott K. Powers¹

Accuracy of Invasive and Noninvasive Parameters for Diagnosing Ventilatory Overassistance During Pressure Support Ventilation

Renata Pletsch-Assuncao, RT, PhD¹; Mayra Caleffi Pereira, RT, MSc¹; Jeferson George Ferreira, RT^{1,2}; Letícia Zumpano Cardenas, RT, PhD^{1,2}; André Luis Pereira de Albuquerque, MD, PhD^{1,3}; Carlos Roberto Ribeiro de Carvalho, MD, PhD¹; Pedro Caruso, MD, PhD^{1,2}

Bedside Detection of Overassistance During Pressure Support Ventilation*

Laurent Brochard, MD

Interdepartmental Division of Critical Care Medicine
University of Toronto; and
Keenan Centre for Biomedical Research
Li Ka Shing Knowledge Institute
St. Michael's Hospital
Toronto, ON, Canada

Irene Telias, MD

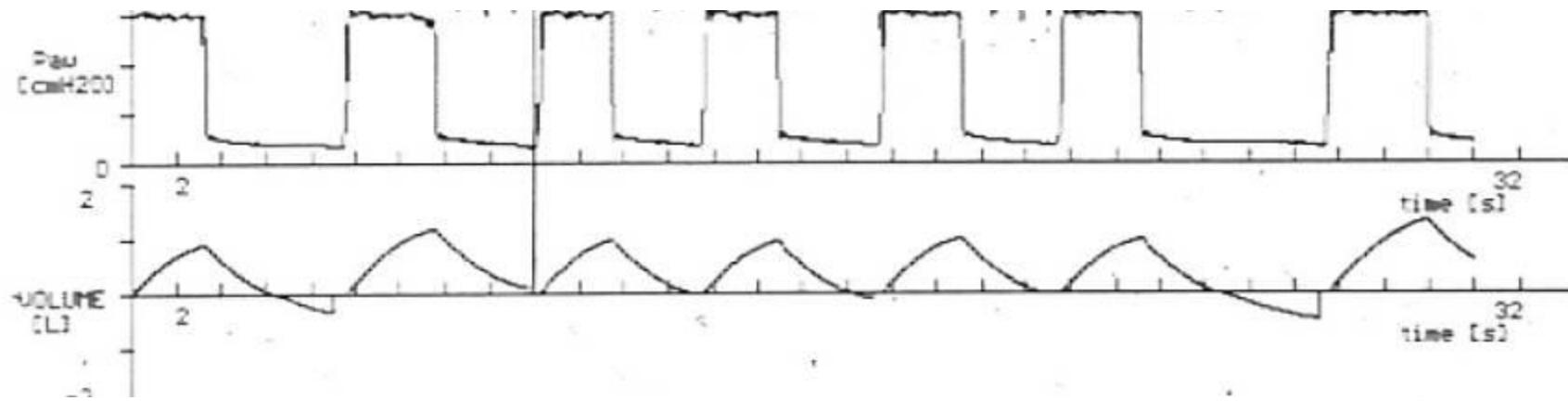
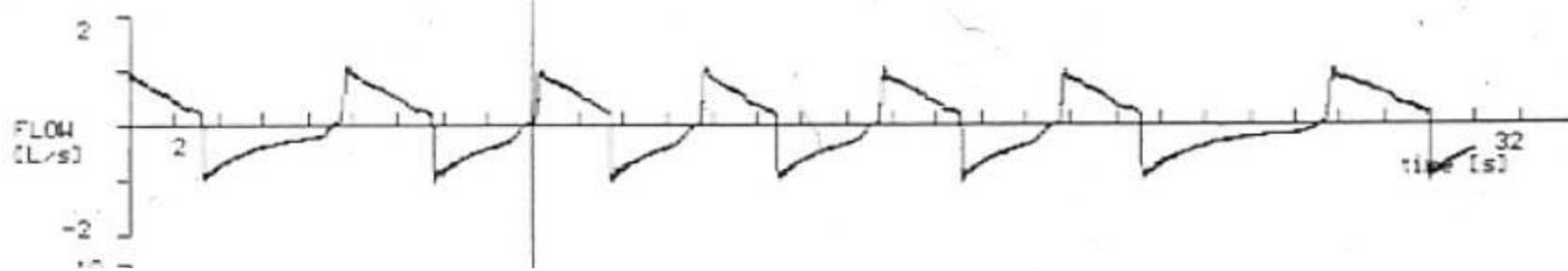
Interdepartmental Division of Critical Care Medicine
University of Toronto

respiratory rate less than or equal to 12 confirmed overassistance with 100% specificity, whereas a respiratory rate greater than or equal to 30 excluded overassistance with 100% sensitivity.

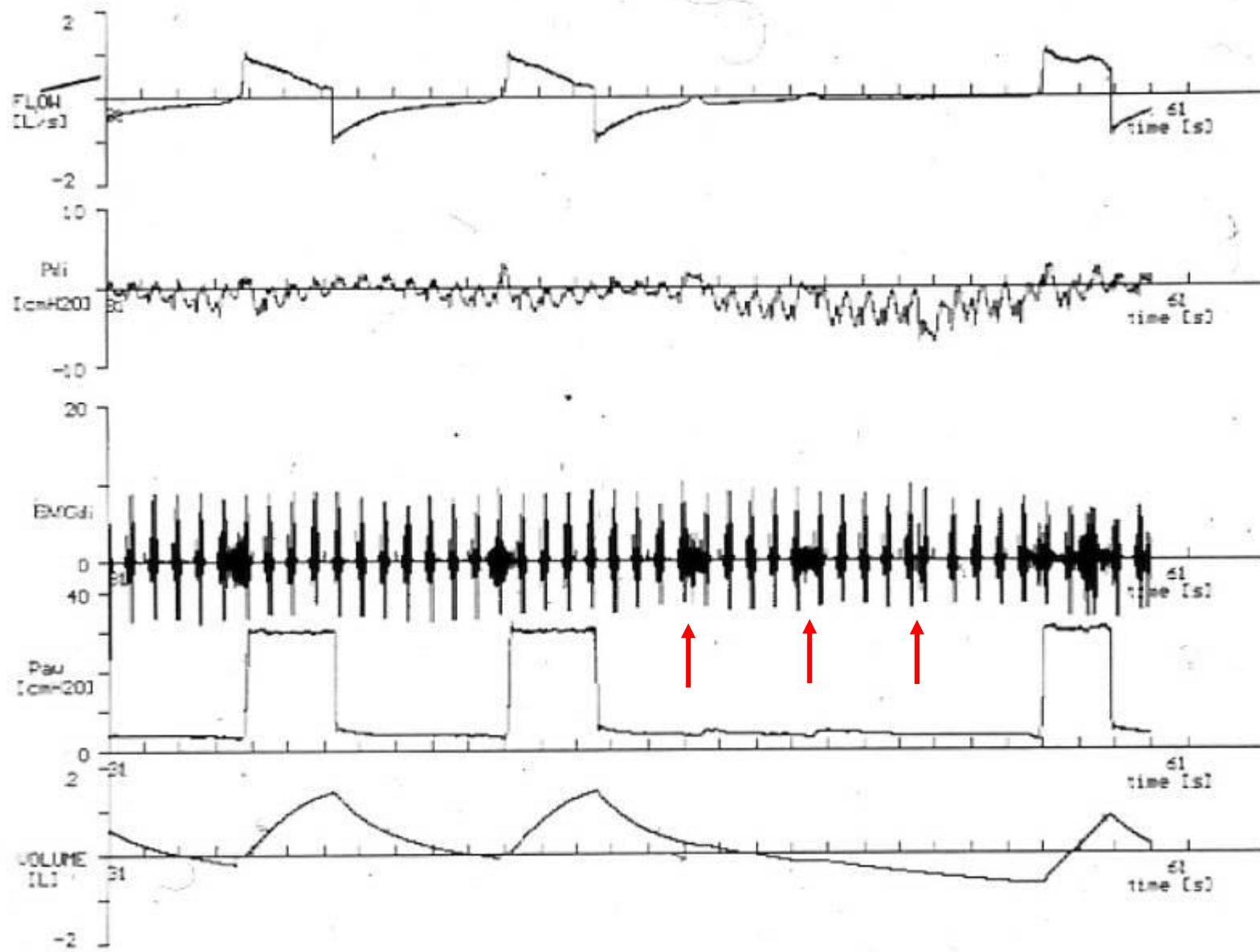
STUDY LIMITATIONS

One limitation of the study is the definition of overassistance. As they discuss it, an ideal definition should be based on clinical outcomes like mortality, duration of ventilation, and hospital length of stay or on direct diaphragm atrophy as a surrogate. They based their definition on a respiratory rate greater than or equal to 30 breaths/min.

Pressure support ventilation



Pressure support ventilation



Assist-Control

Pressure Support

Arousal

C₄-A₁

O₃-A₂

ROC

LOC

Chin

Leg

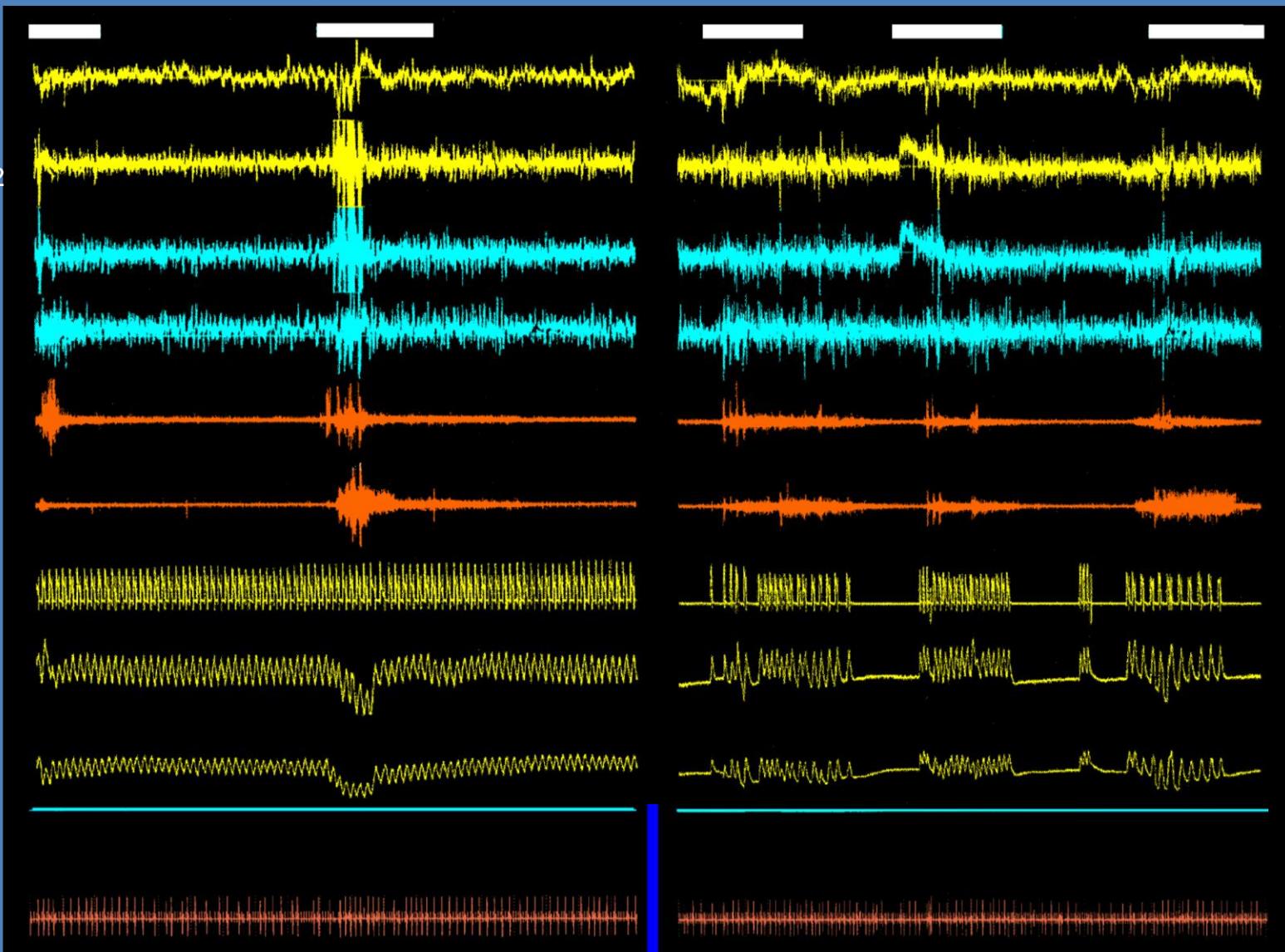
V_T

RC

AB

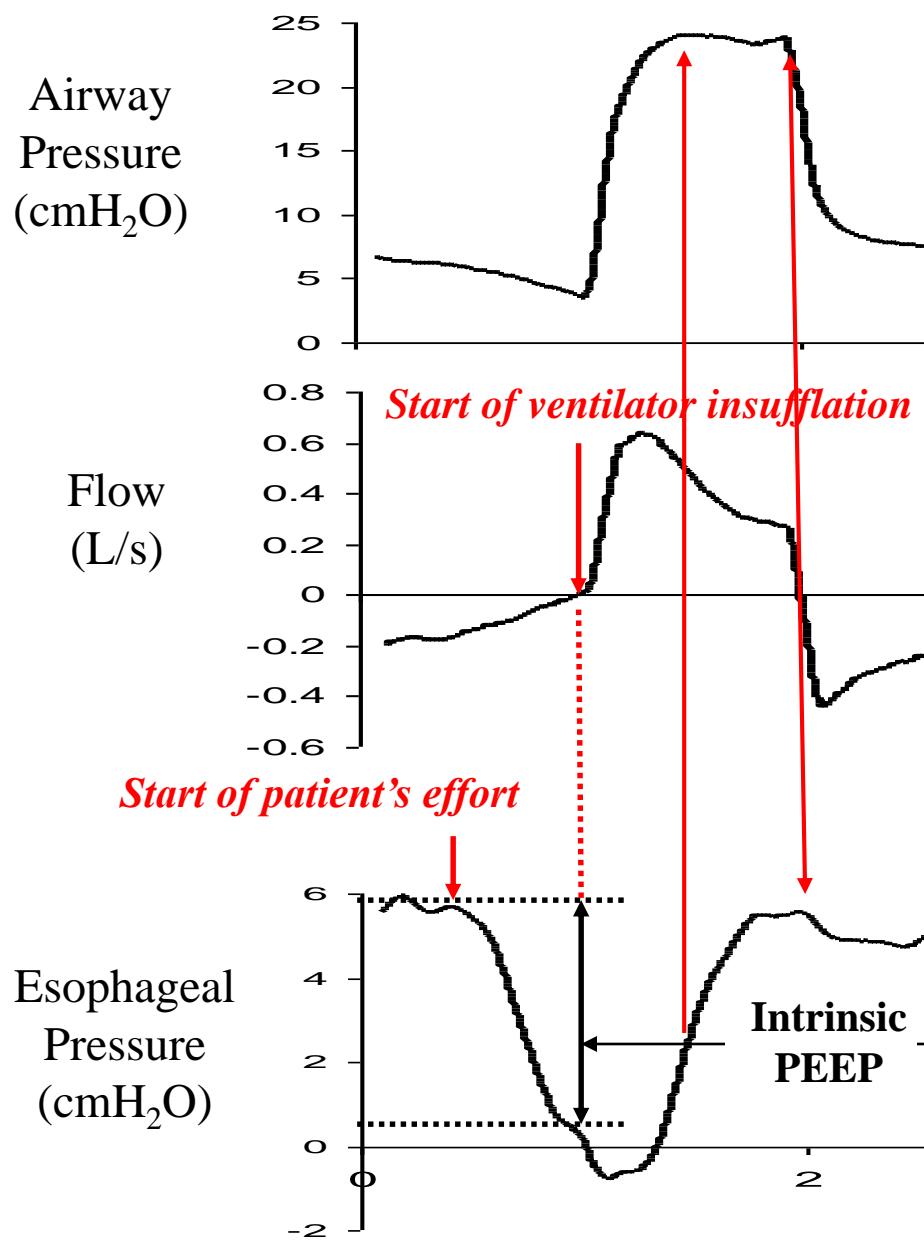
SpO₂

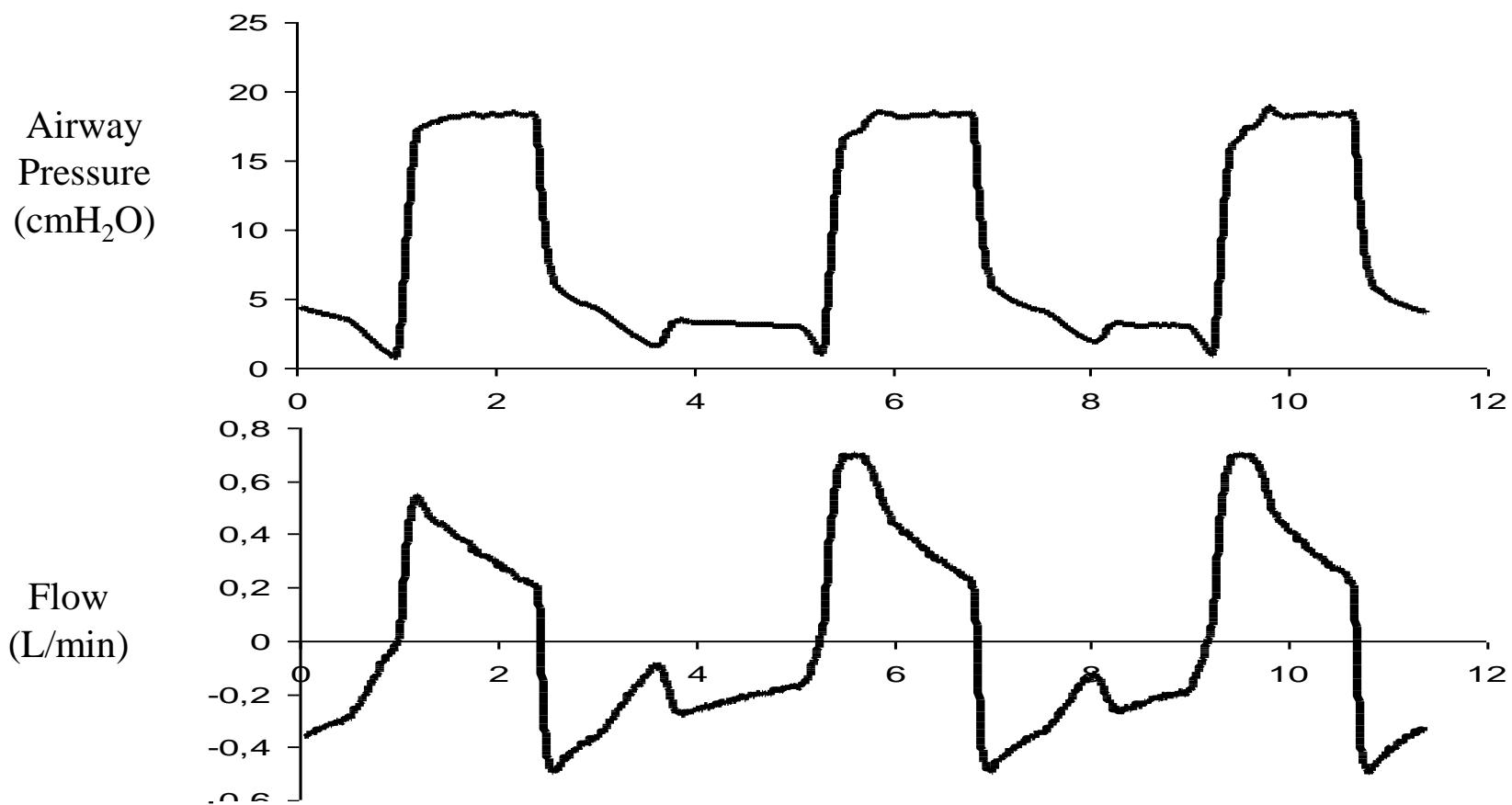
EKG



1 min

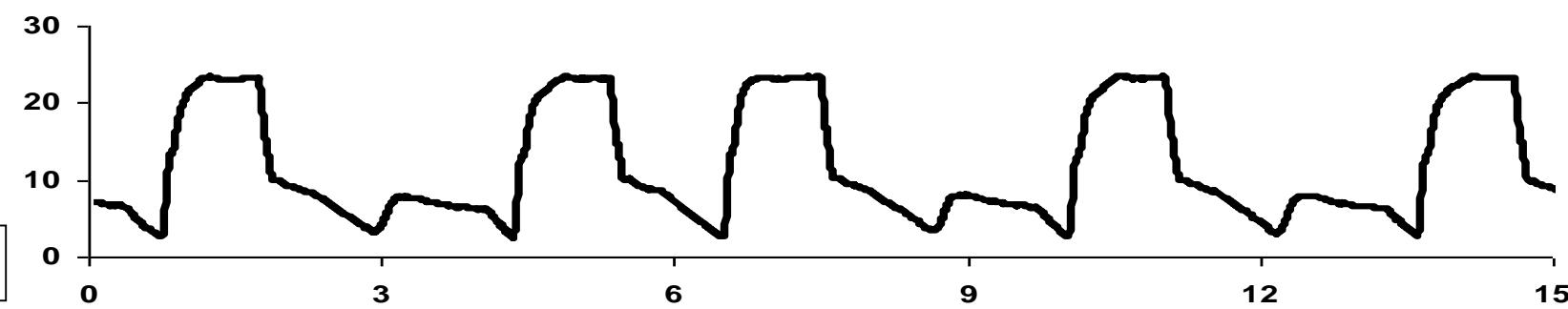
Parthasarathy. AJRCCM 2002;166:1423



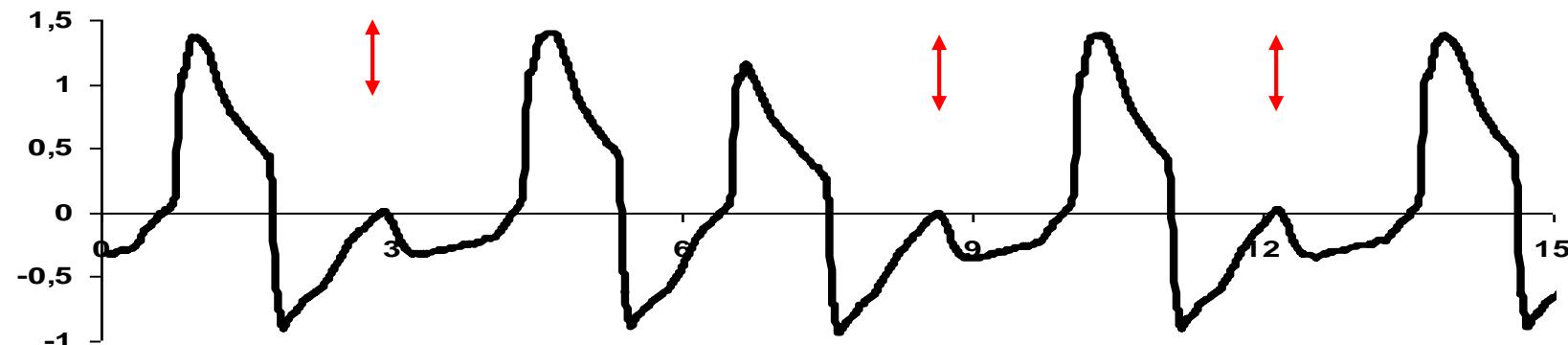


Airway
Pressure

PSV



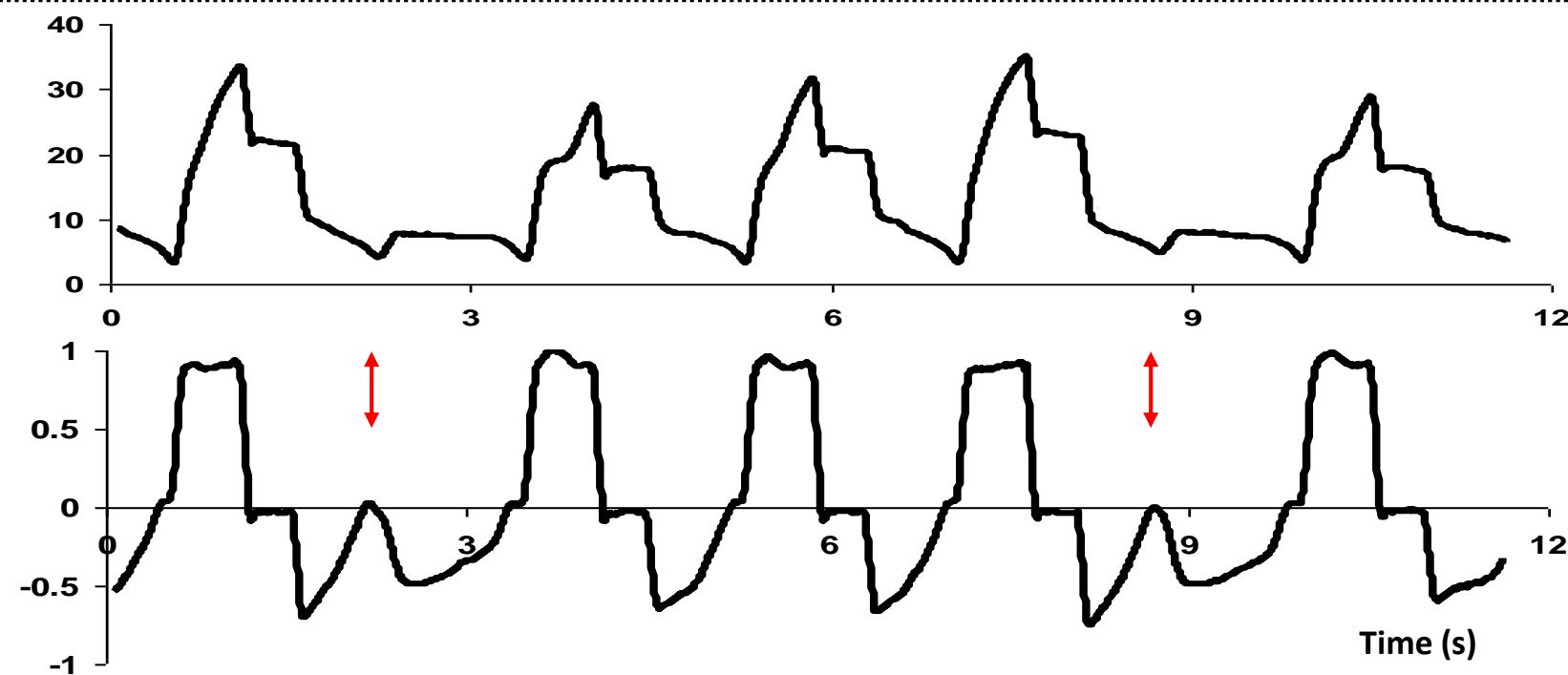
Flow



Airway
Pressure

ACV

Flow





Aide inspiratoire/VS PEP

Admettre
patient

Nébuliseur

Etat
d

1:14

Pcrète (cmH₂O)

25

Pmoyen.
(cmH₂O)

10

PEP
(cmH₂O)

5

F resp. (resp./min)

18

O₂
(%)

50

Ti/Ttot

0.26

VMe (l/min)

C 7.0

400
4.0Vc insp.
(ml)

471

Vc exp.
(ml)

405

Edi max
(µV)

5.7

Edi min
(µV)

0.2

Conc. d'O₂

50

%

100

0

PEP

5

cmH₂O

50

Niv. Al sur PEP

20

cmH₂O

120

Autres
réglages

21

Autres
valeurs



Aide inspiratoire/VS PEP

Admettre
patient

Nébuliseur

Etat
d

1:14

Pcrète (cmH₂O)**25**Pmoyen.
(cmH₂O)**10**PEP
(cmH₂O)**5**

F resp. (resp./min)

18O₂
(%)**50**

Ti/Ttot

0.26

VMe (l/min)

C 7.0**400**Vc insp.
(ml)**471**Vc exp.
(ml)**405**Edi max
(µV)**5.7**Edi min
(µV)**0.2**Conc. d'O₂**50**

%

21

PEP

5cmH₂OAutres
réglages

Niv. Al sur PEP

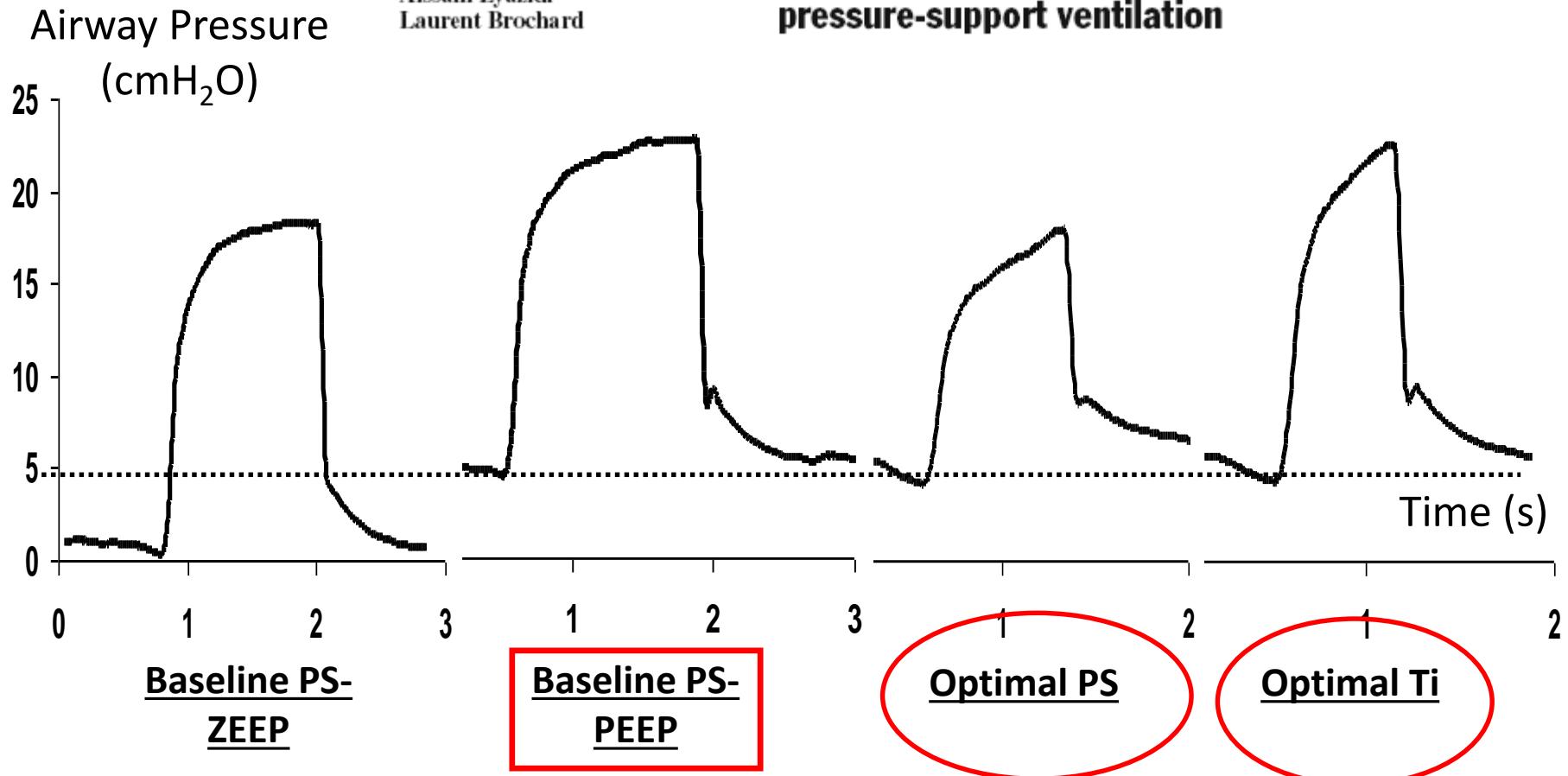
20cmH₂O

0

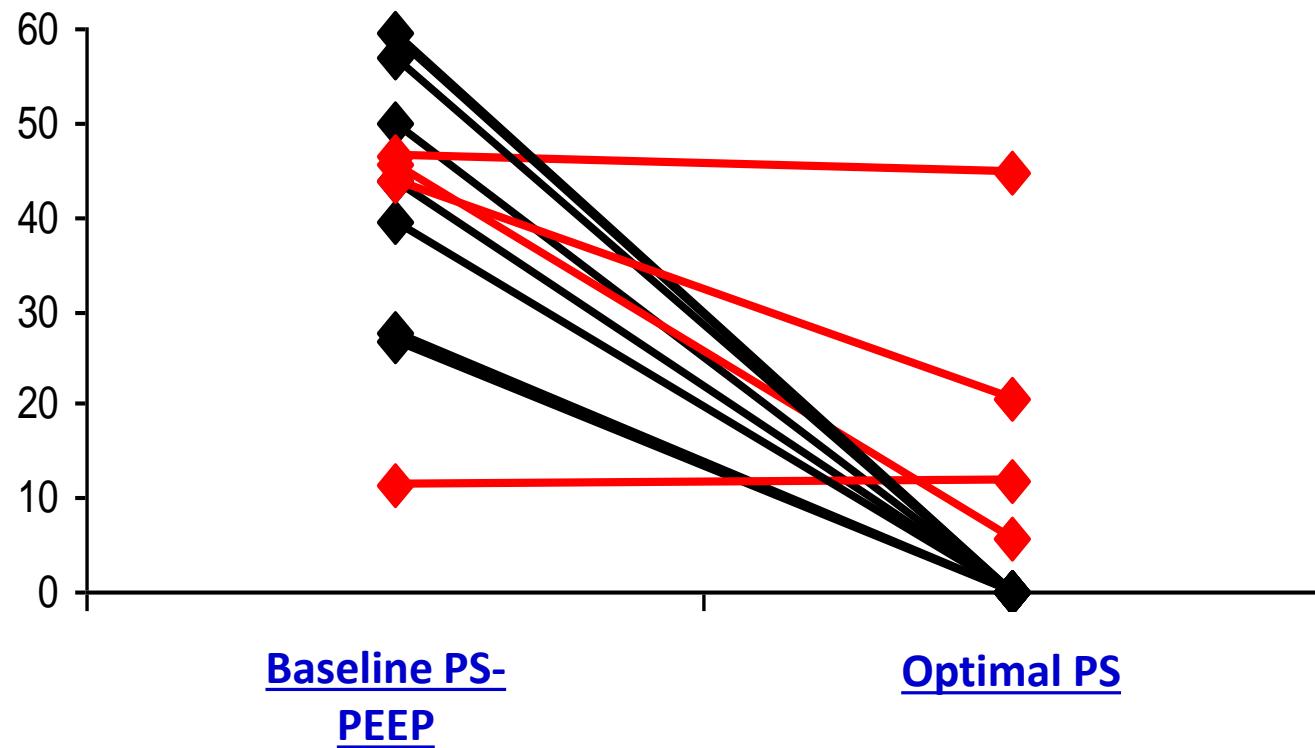
Autres
valeurs

Arnaud W. Thille
Belen Cabello
Fabrice Galia
Aissam Lyazidi
Laurent Brochard

Reduction of patient-ventilator asynchrony by reducing tidal volume during pressure-support ventilation



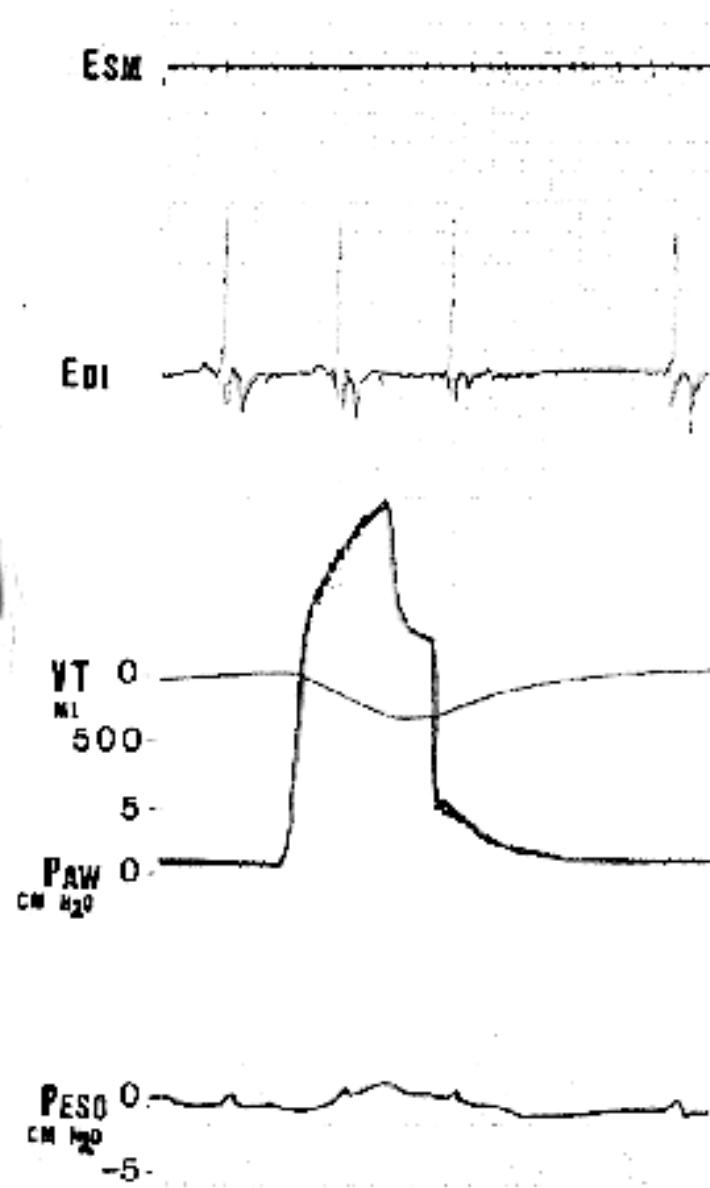
Asynchrony
Index (%)



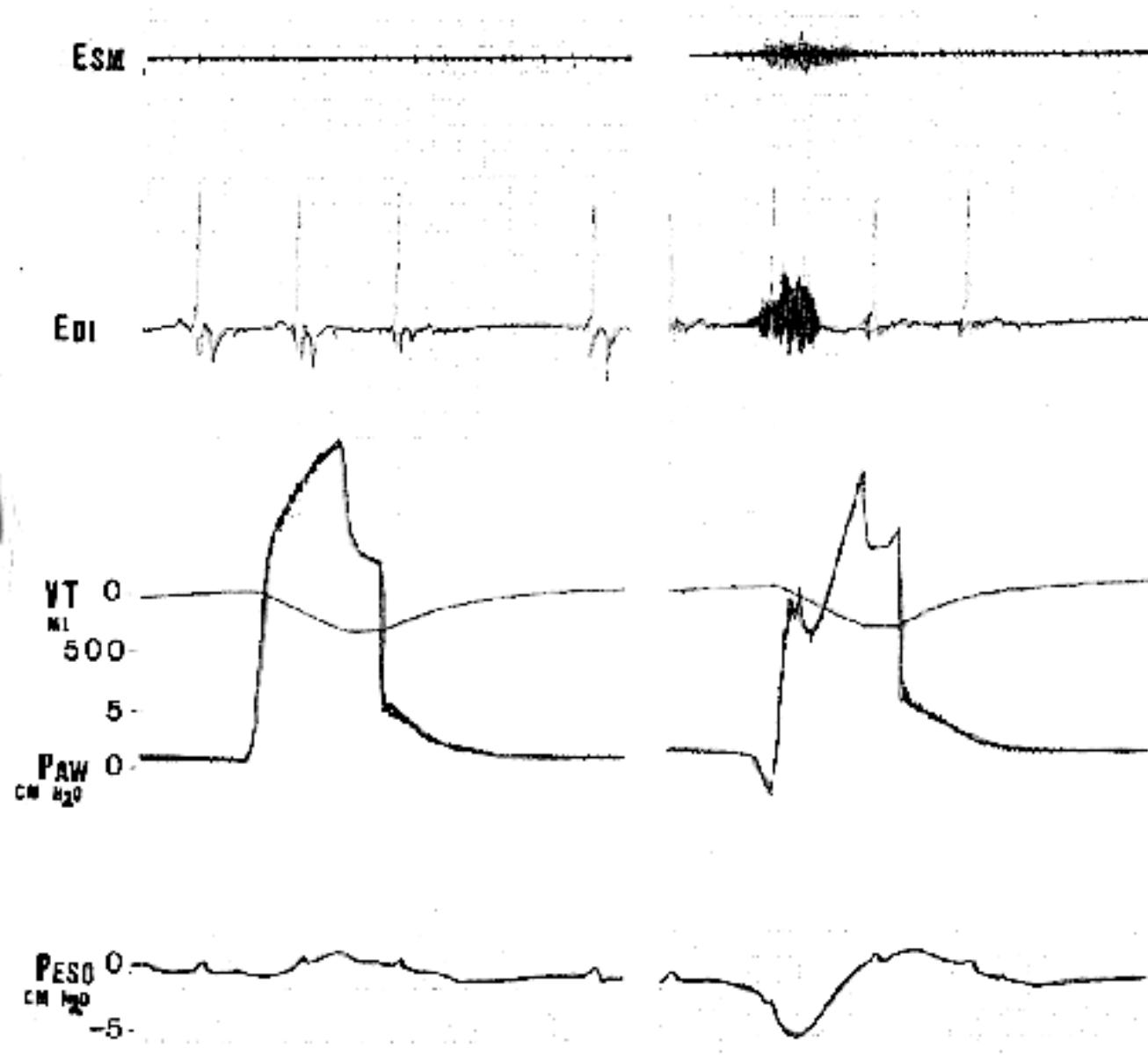
Insufficient Assistance

- Air hunger or flow starvation
- Double triggering, breath stacking and short cycles

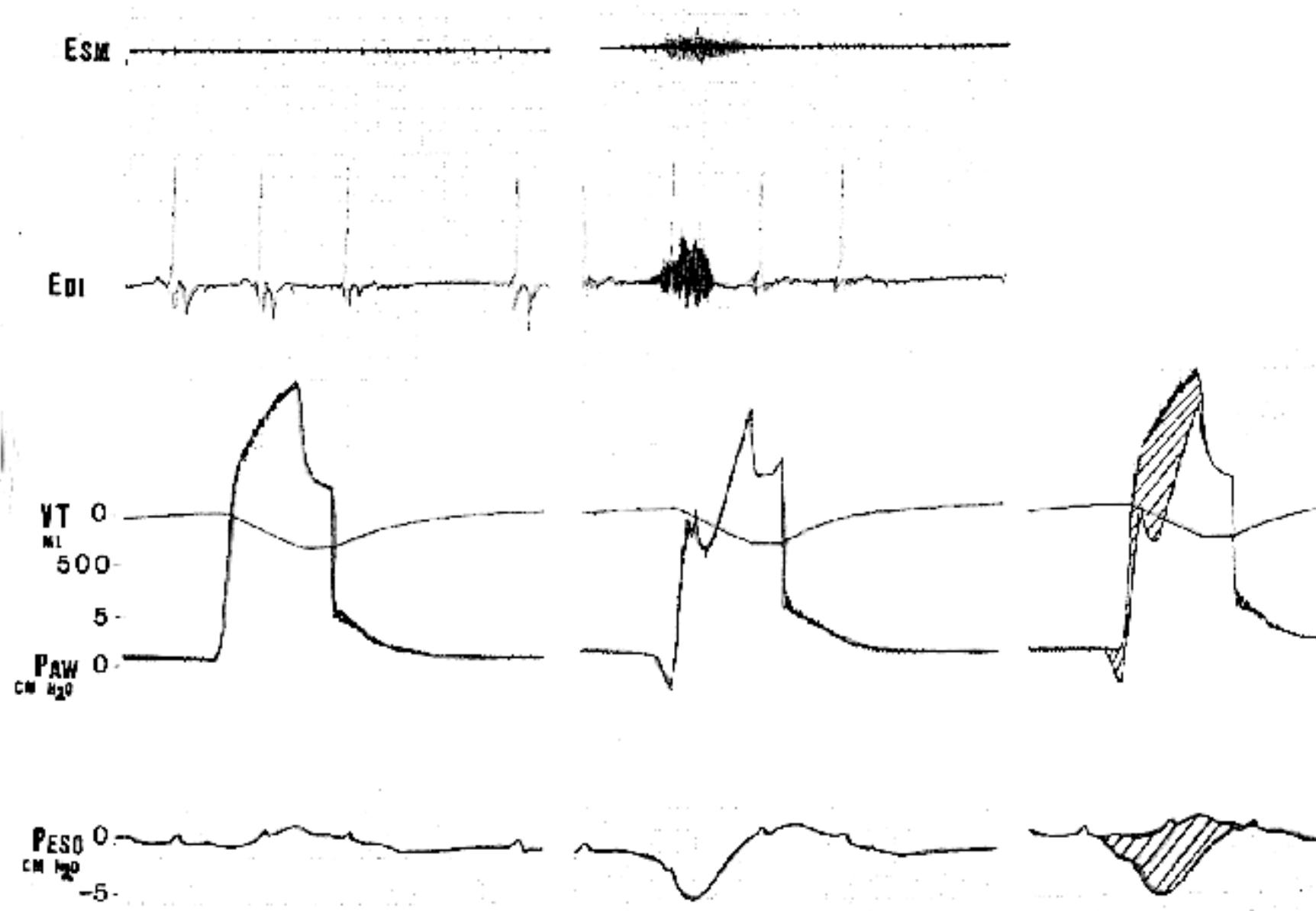
Ventilation assistée-contrôlée



Ventilation assistée-contrôlée

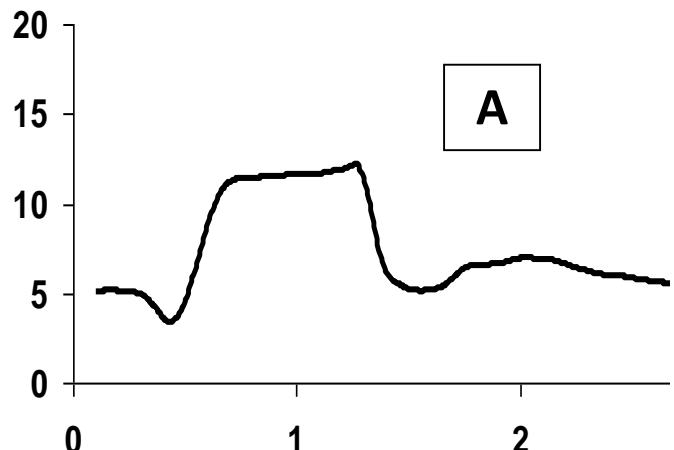


Ventilation assistée-contrôlée

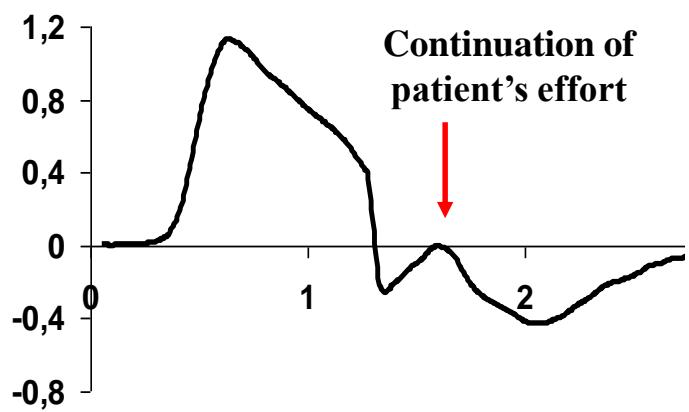


Under Assistance

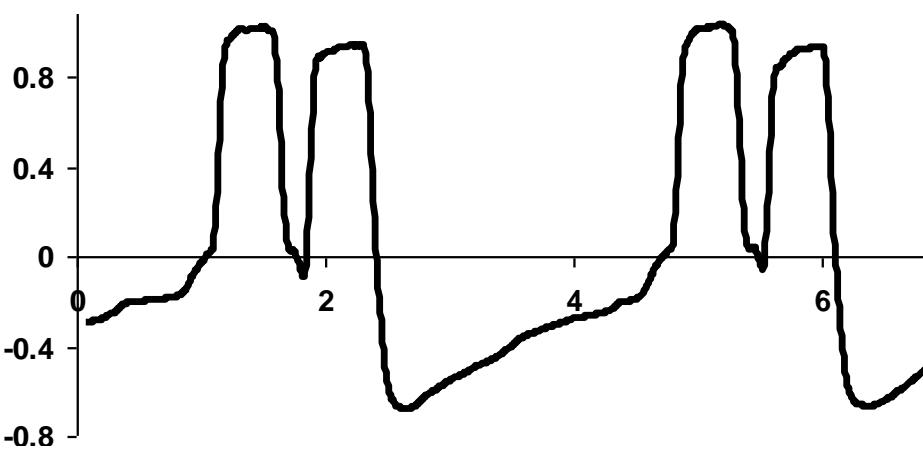
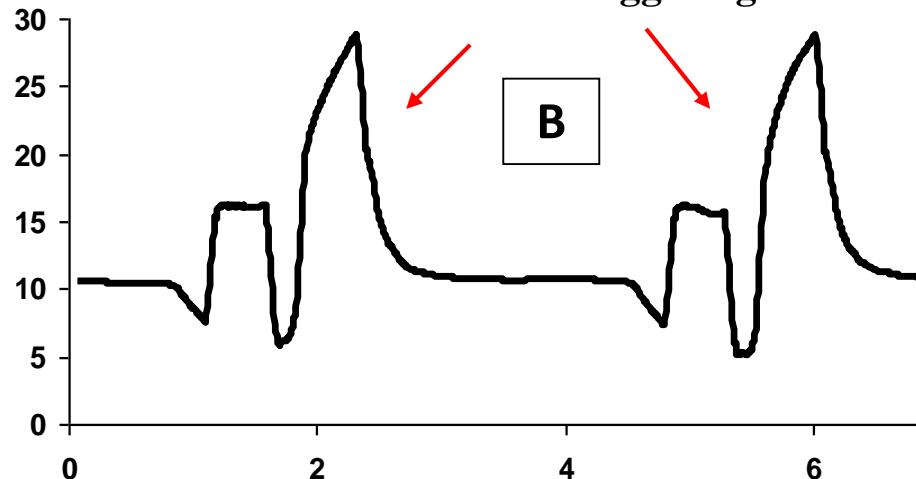
Airway
Pressure
(cmH₂O)



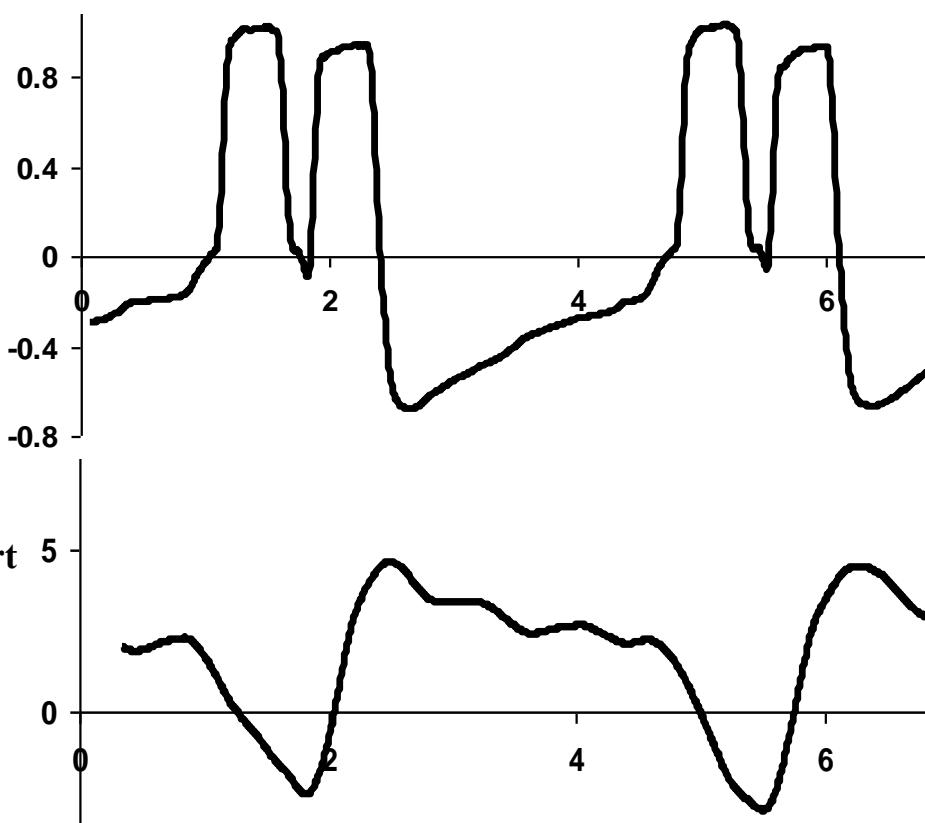
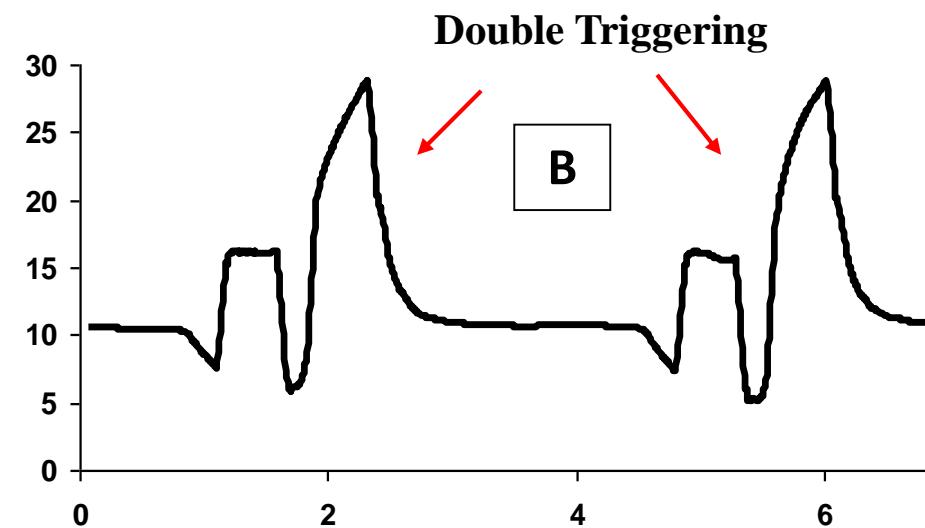
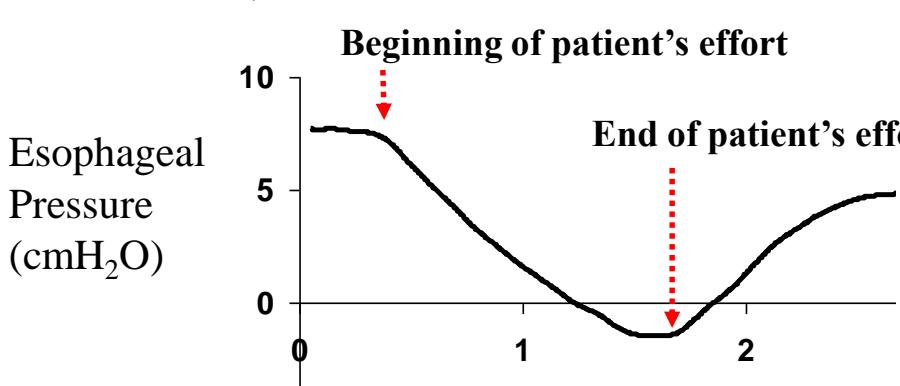
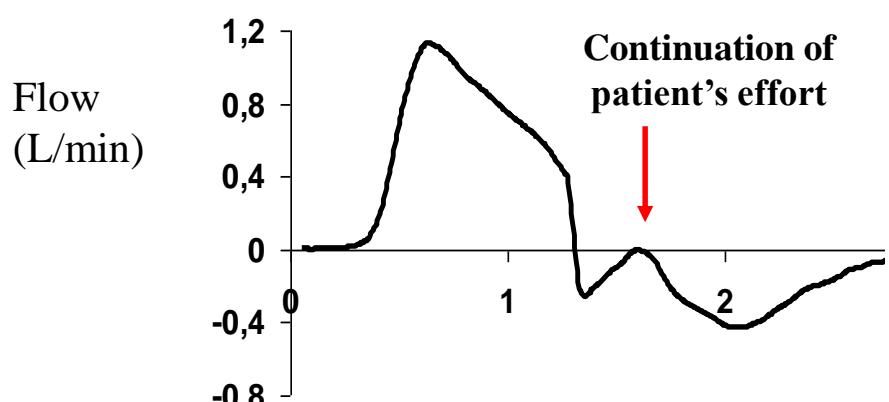
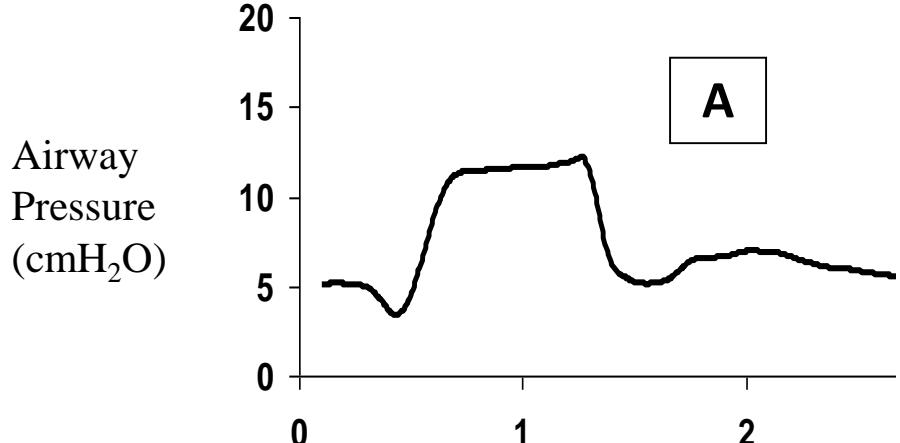
Flow
(L/min)



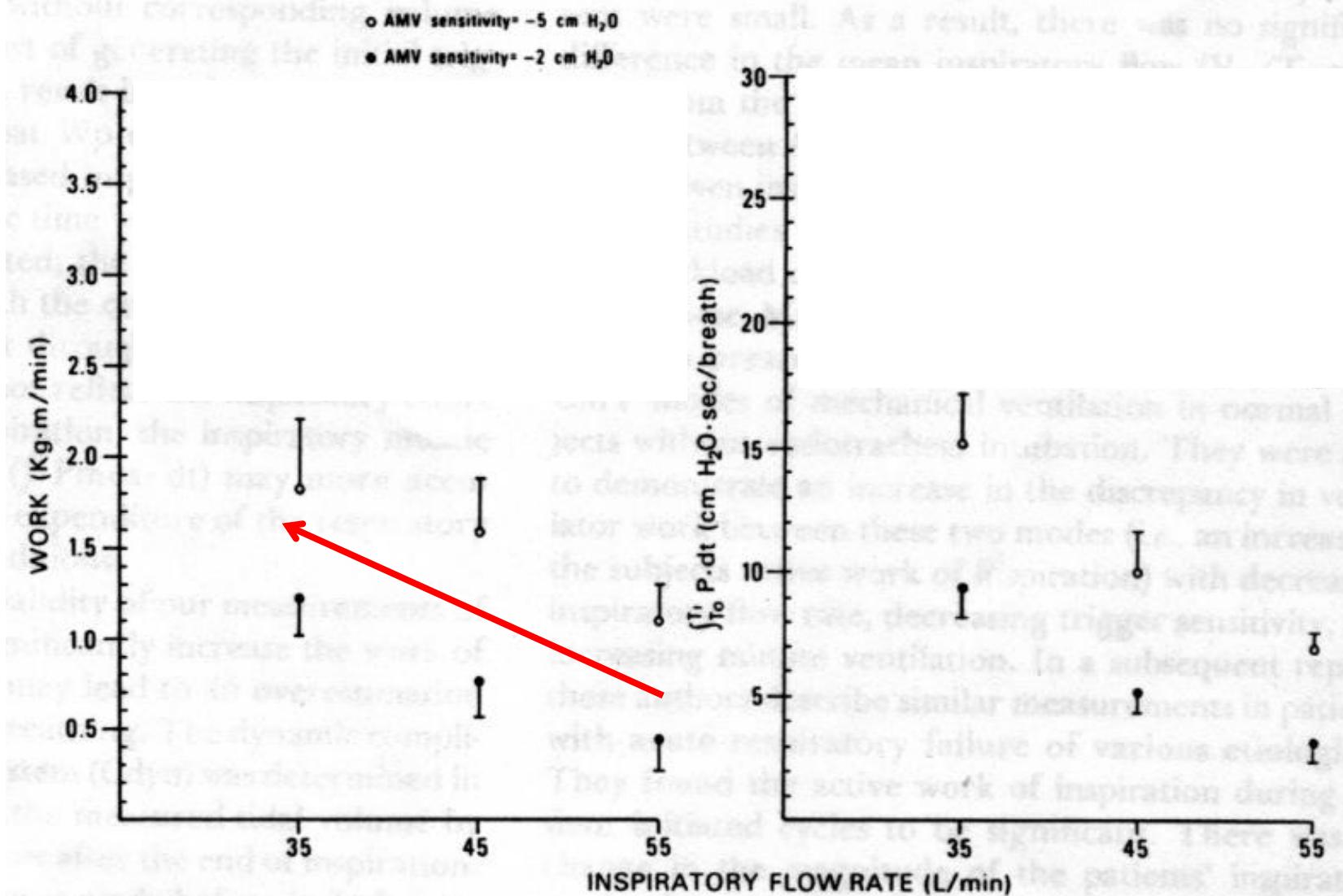
Double Triggering



Under Assistance



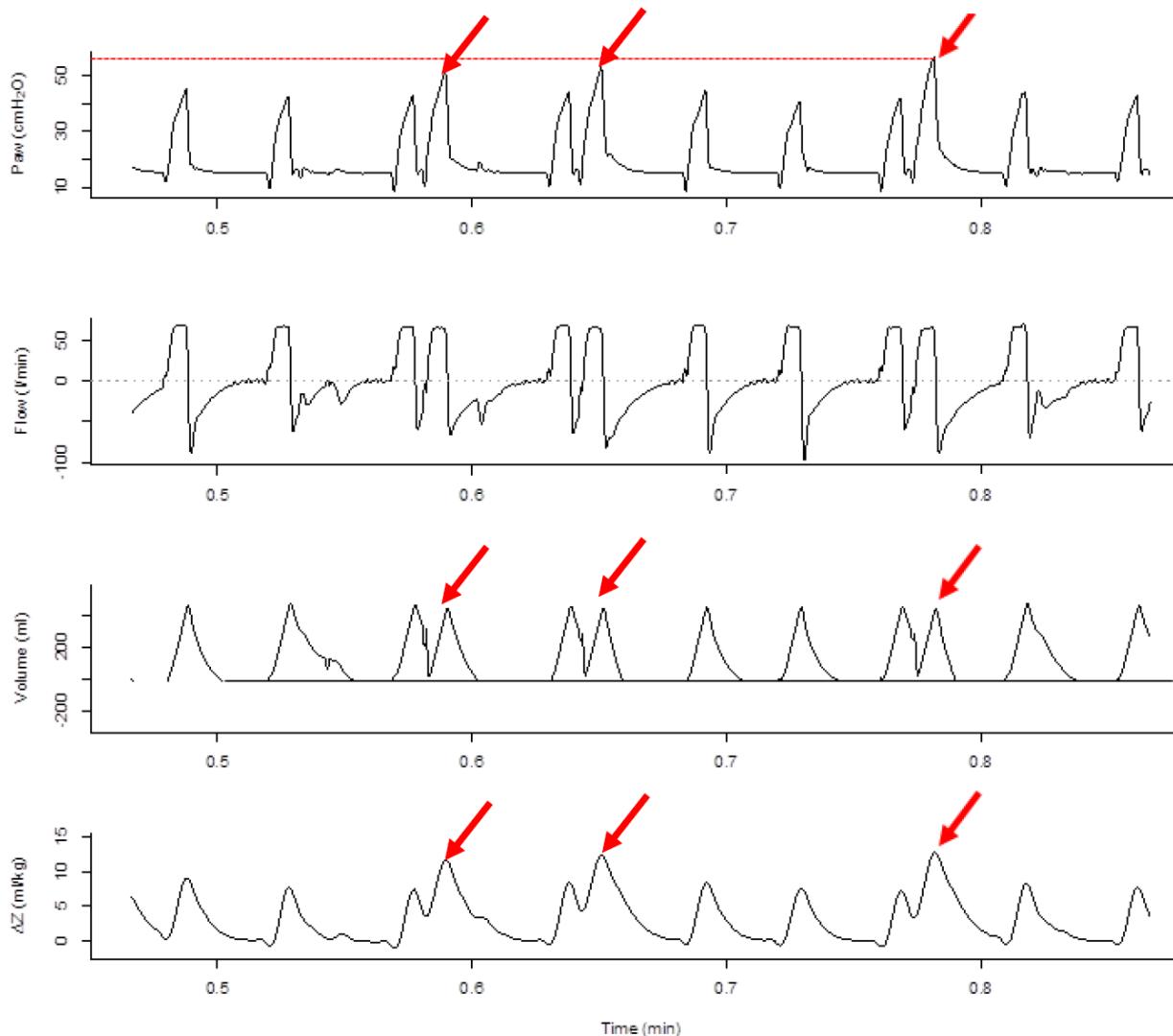
Peak Flow and Work of Breathing



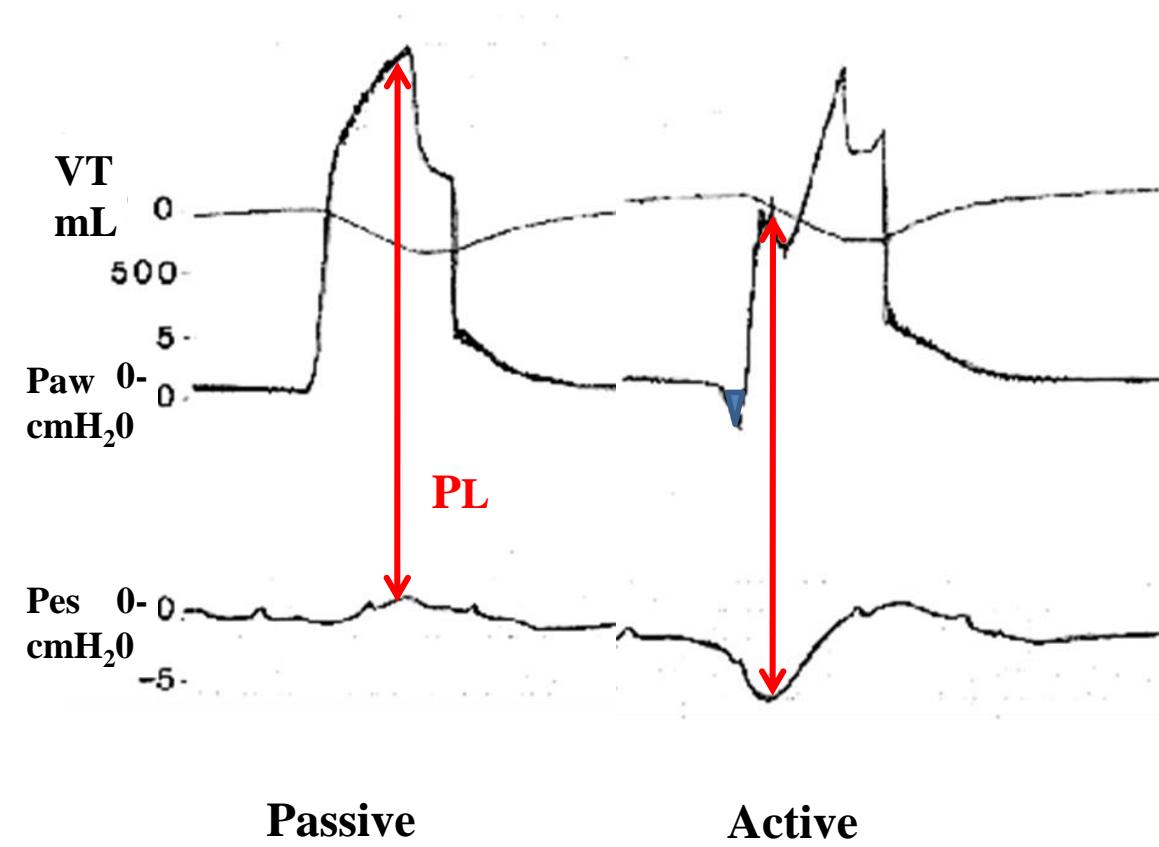
Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome

A Randomized Clinical Trial

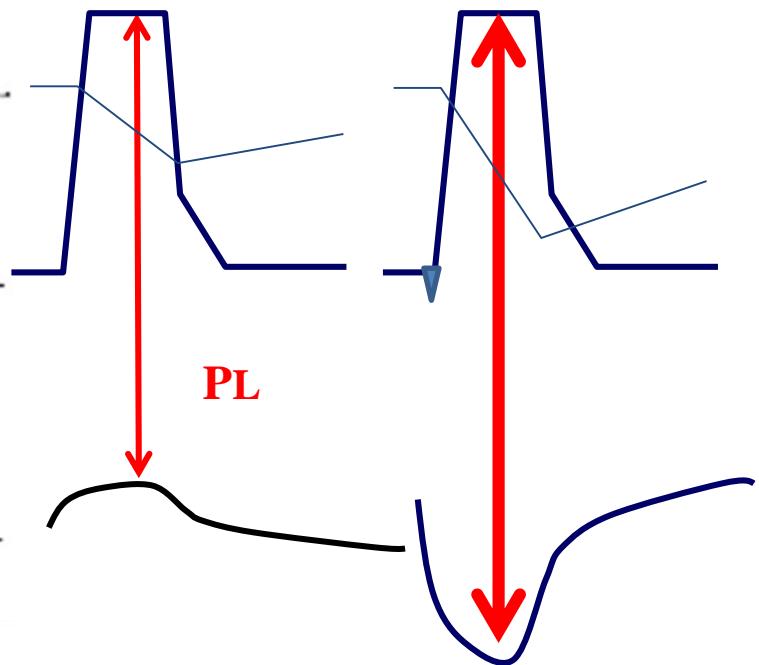
Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators



Volume Assist-Control



Pressure Assist-Control



Passive

Active

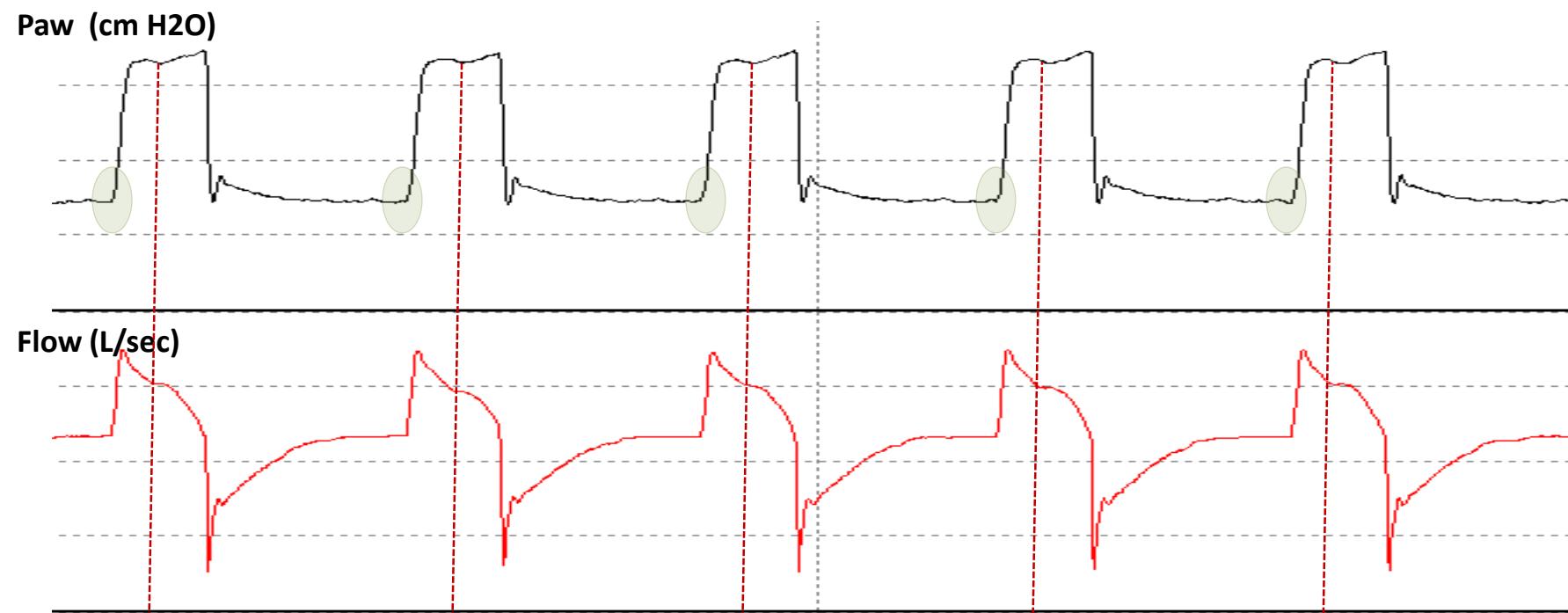
Passive

Active

Excessive Sedation?

- Respiratory Entrainement or Reverse Triggering

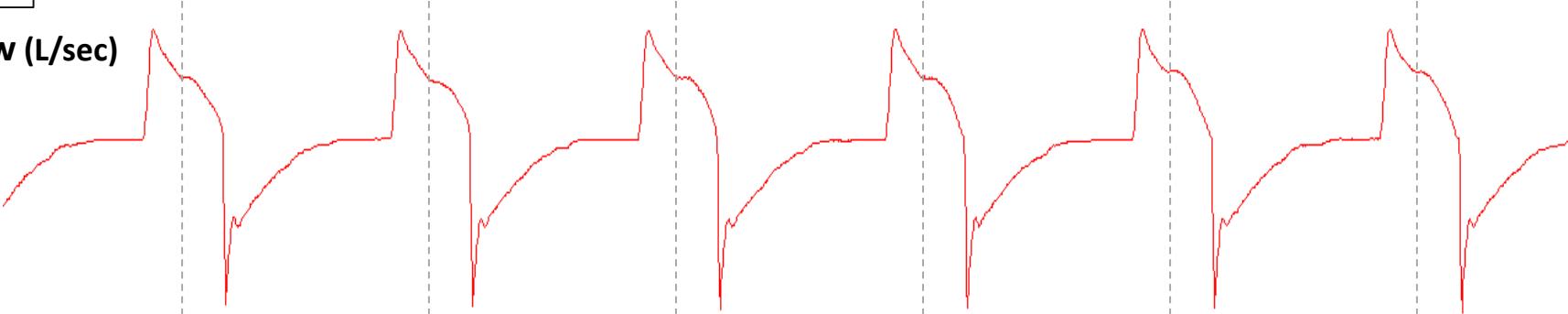
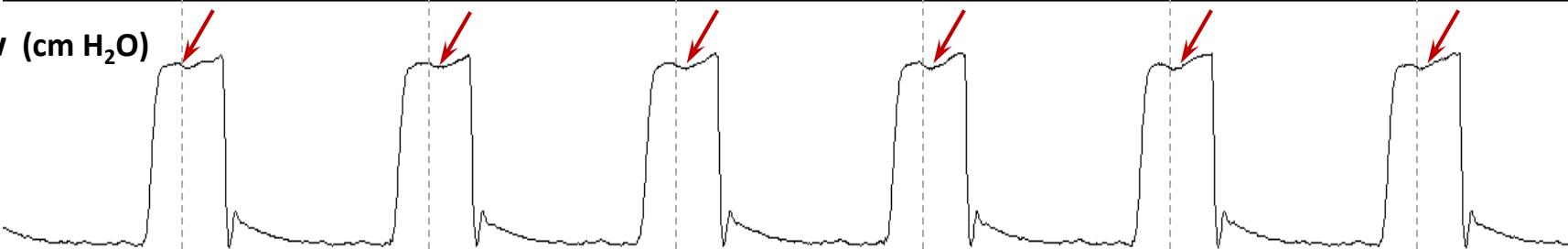
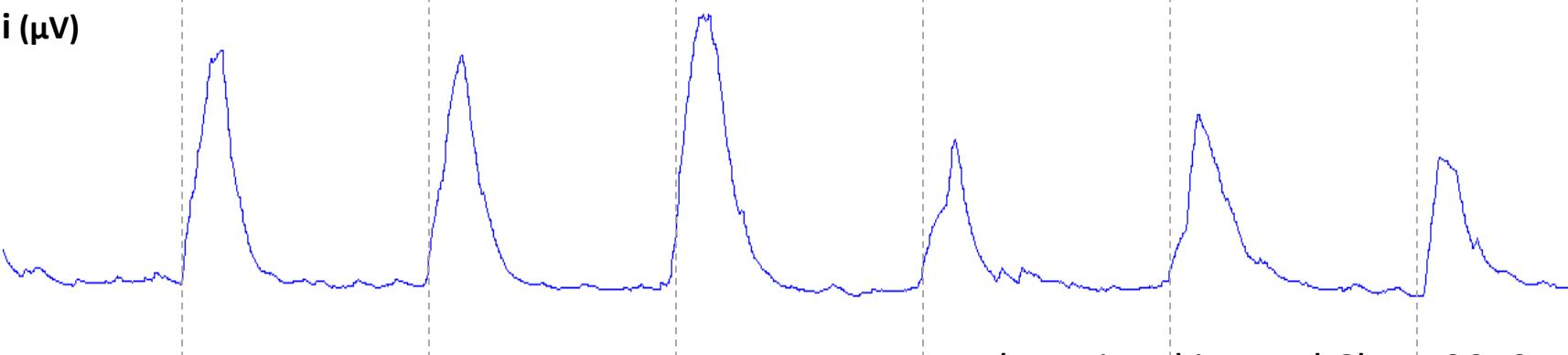
Accidental observation...



A

Respiratory Entrainment

Flow (L/sec)

Paw (cm H₂O)EAdi (μ V)

Akoumianaki E et al Chest 2012

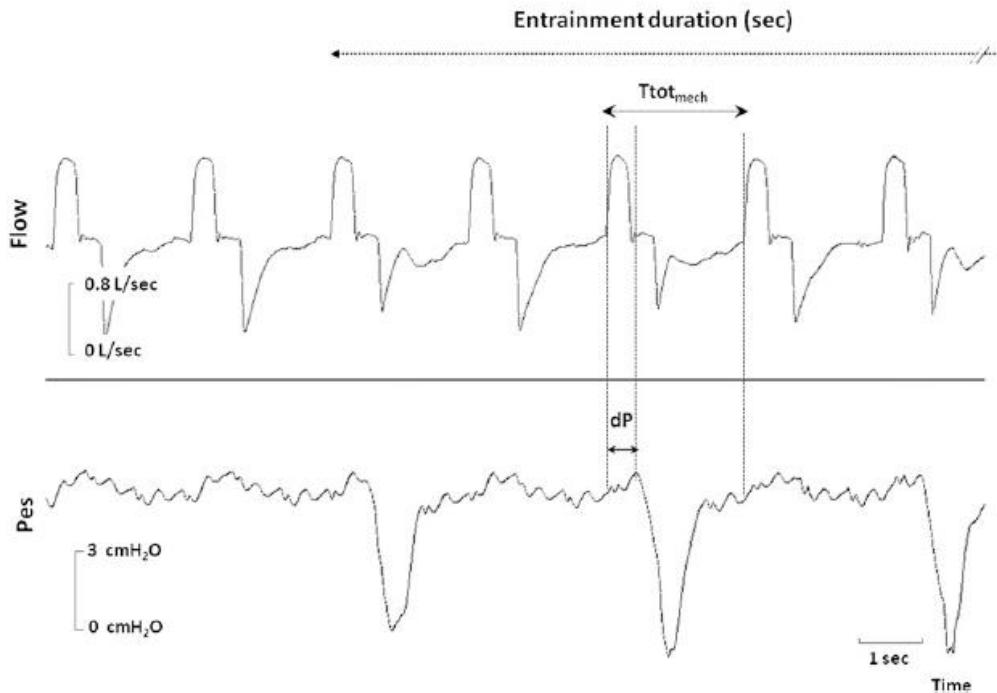


Mechanical Ventilation-Induced Reverse-Triggered Breaths

A Frequently Unrecognized Form of Neuromechanical Coupling

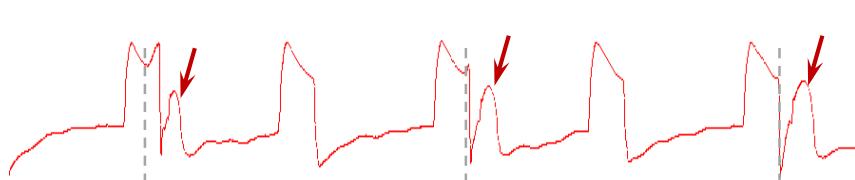
CHEST 2013; 143(4):927–938

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



Clinical consequences: VT increase

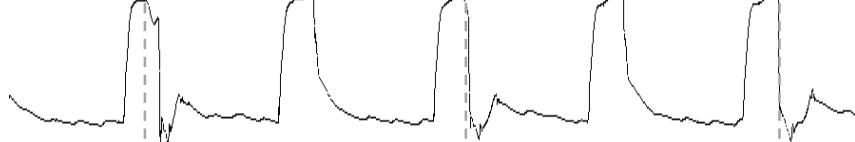
Flow



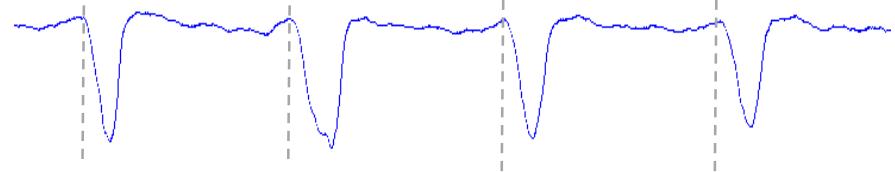
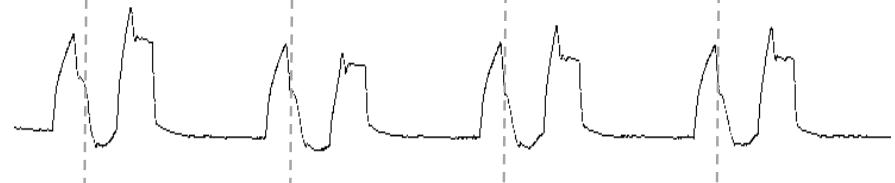
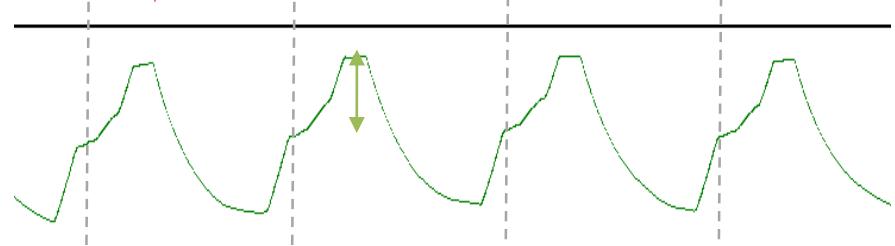
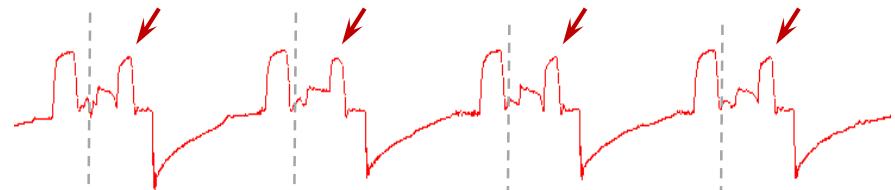
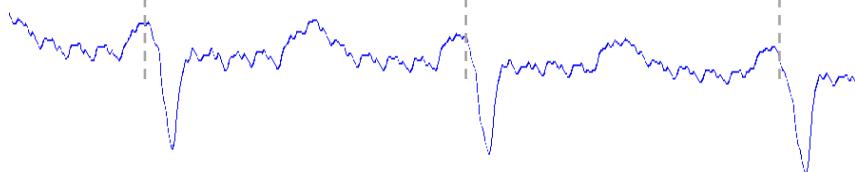
V_T



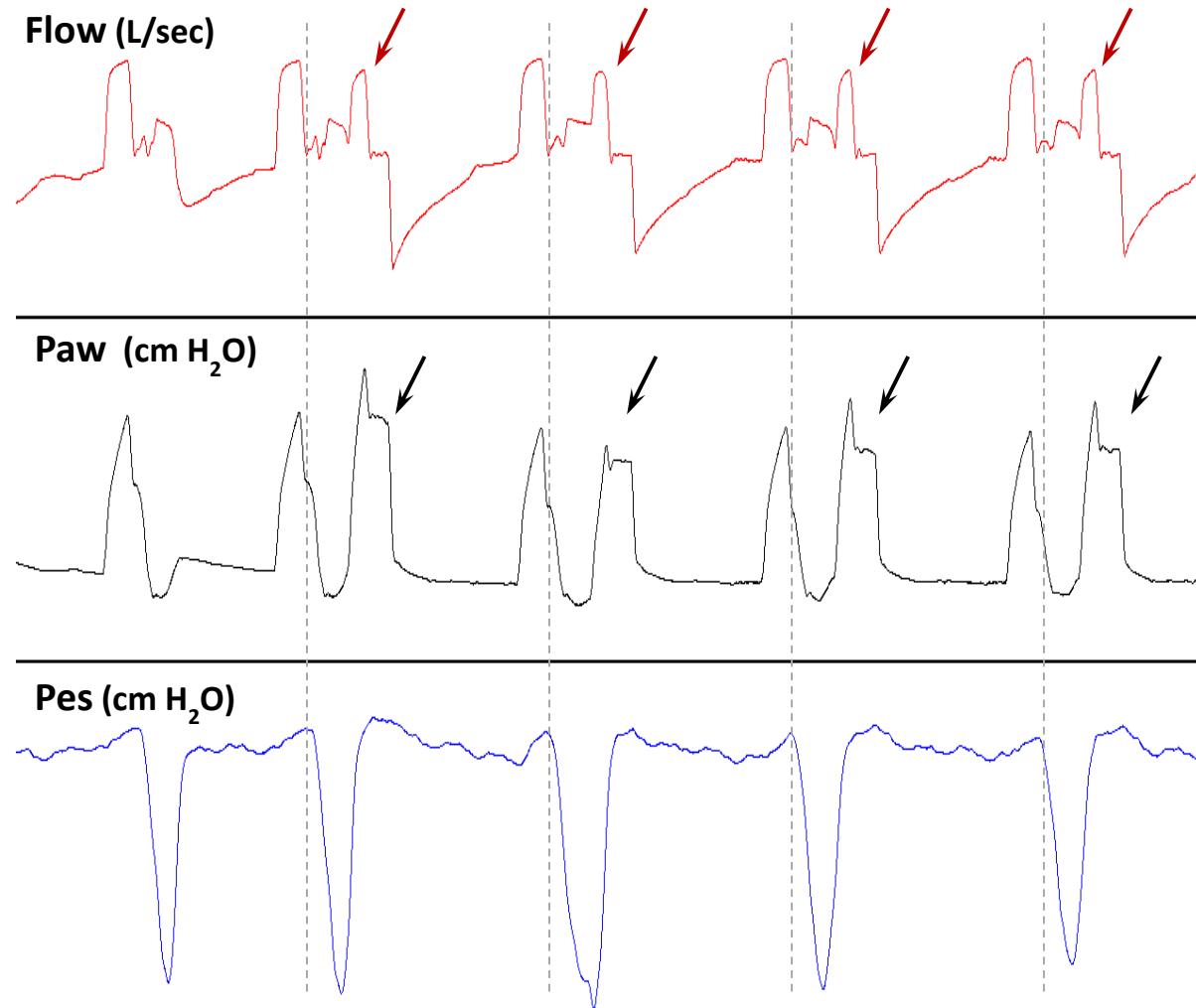
Paw



Pes



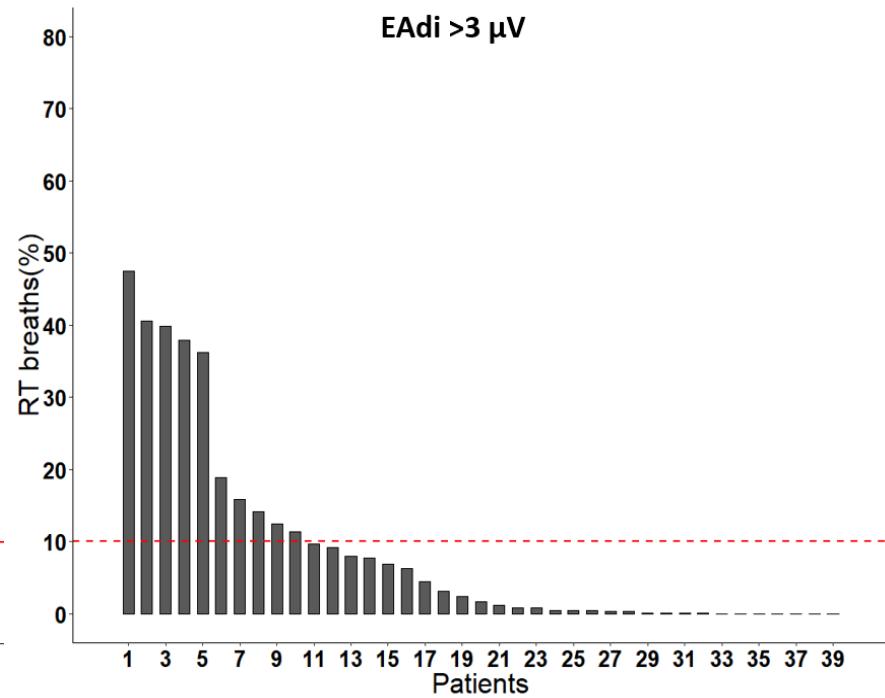
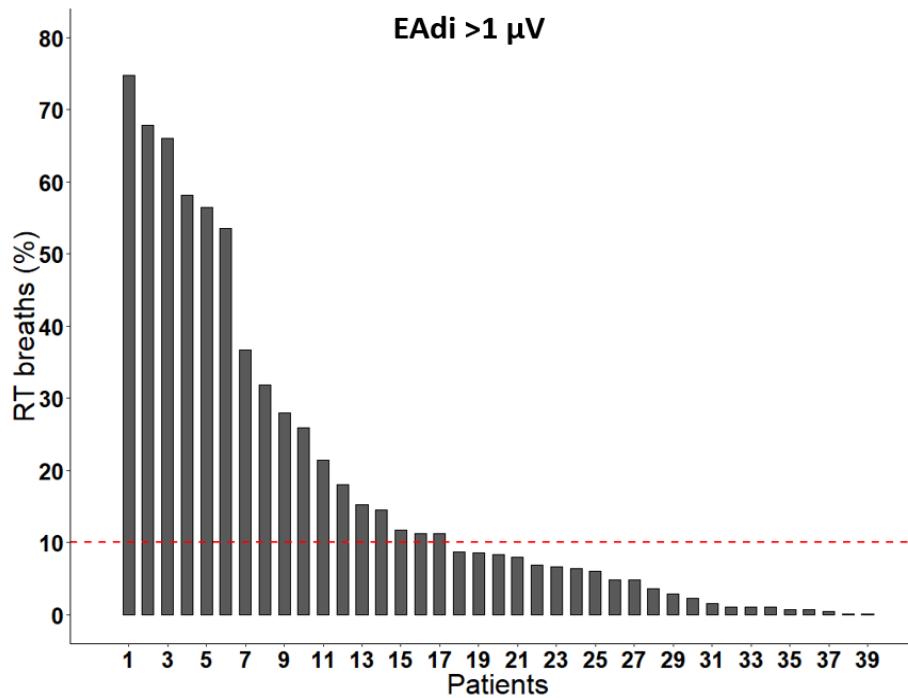
Clinical consequences: double cycle



Reverse triggering dyssynchrony 24 hours after initiation of mechanical ventilation

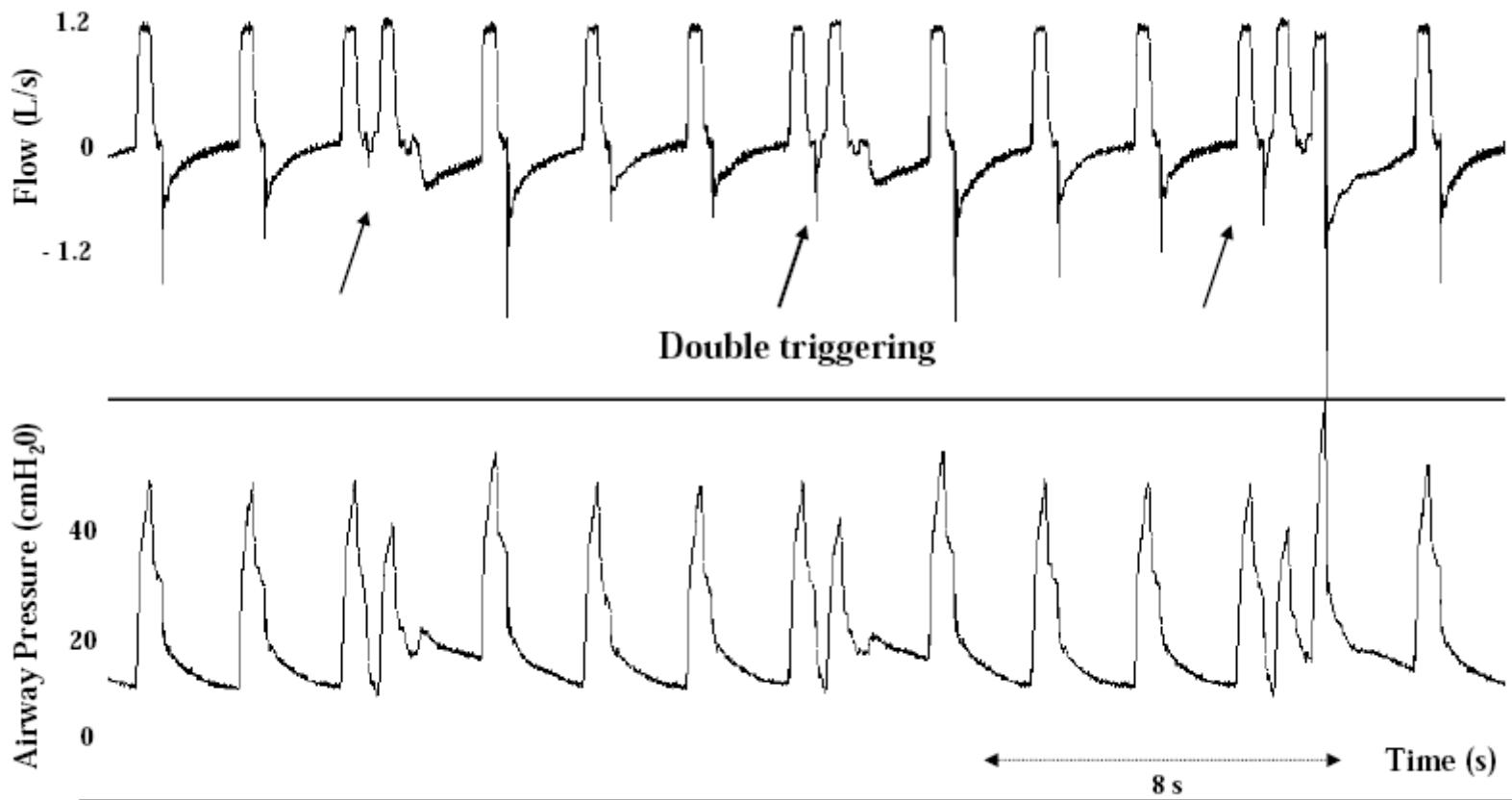
Ricard Mellado Artigas, L. Felipe Damiani, Thomas Piraino, ...Laurent Brochard
In revision

40% (1 μ V) or 26% (3 μ V) patients have > 10% RT



| Variable | RT>8% | RT≤8% |
|--|-----------------|------------------|
| Median Peak Eadi, μV | 1.7 (0.8-4.3) | 0.7 (0.7-0.8)*** |
| Patient-triggered breaths over the 1 hour recording, % | 12 (8-26) | 1 (0-3)*** |
| Assisted mode/extubation within 24h | 13 (68) | 7 (35)* |

ACV

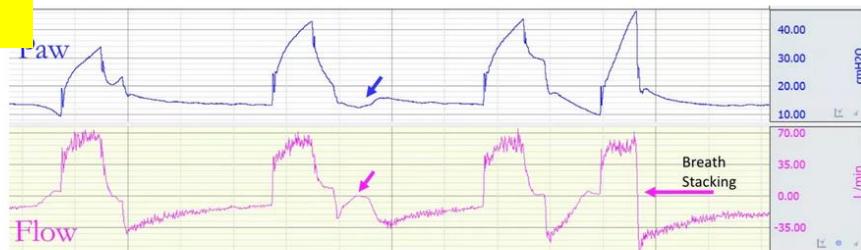




Reverse Triggering

CoEMV.ca

May 15, 2019 | 3

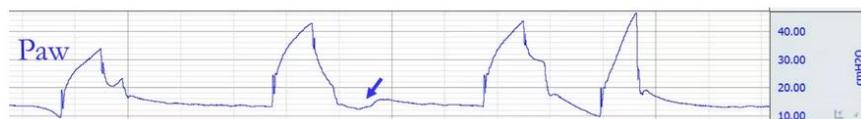


Reverse triggering is a type of dyssynchrony that occurs when a patient effort occurs after ('is triggered by') the initiation of a ventilator (non-patient triggered) breath. Usually, it is a phenomenon occurring over many consecutive breaths and also referred to as 'entrainment'. Diagnosis The visual detecting of reverse triggering is slightly different between modes of...

[Read More](#)

Name this Asynchrony 4

May 7, 2019 | 5



About the CoEMV

The Toronto Centre of Excellence in Mechanical Ventilation (CoEMV) at St. Michael's Hospital leads in personalized and evidence-based mechanical ventilation through collaborative practice, education, research, and innovation.

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