

# Monitoring de la ventilation mécanique: notions de base

André Denault MD PhD FRCPC, CSPQ, ABIM-CCM, FASE

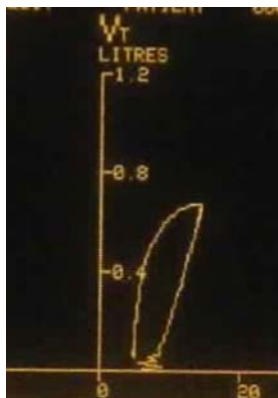
Professeur agrégé de clinique

Département d'anesthésiologie

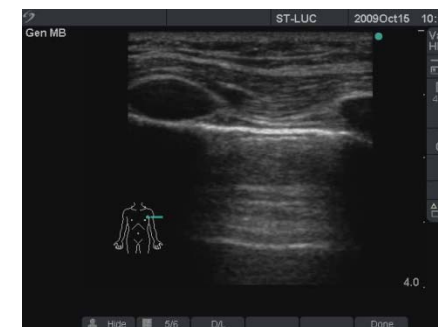
Institut de Cardiologie de Montréal

Service des soins intensifs

Centre Hospitalier Universitaire de Montréal

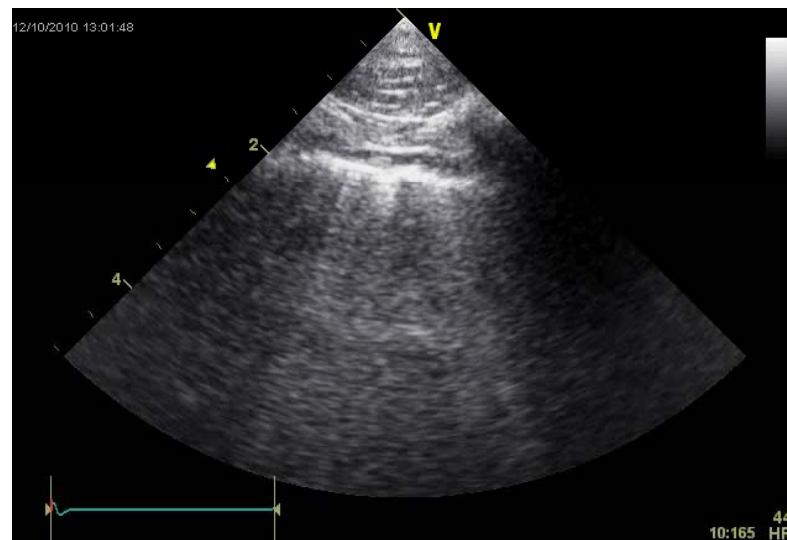


Décembre 2011



# Mon objectif?





# Références:

Article: Évaluation de la détresse respiratoire

Waveform and loop analysis in mechanical ventilation Paul Ouellet, BA, RRt

Society of Critical Care Medicine:FCCS

<http://www.sccm.org>

ARDS network

<http://www.ardsnet.org/>

Capnographie

<http://www.capnography.com>

# SIVA

Société Internationale en Ventilation Artificielle

**DIPLÔME INTERNATIONAL  
EN VENTILATION  
ARTIFICIELLE (DIVA)**

**Jeu 11, Ven 12, et  
Sam 13 Septembre 2008**

<http://siva-qc.org>



**Coordonneurs du programme**

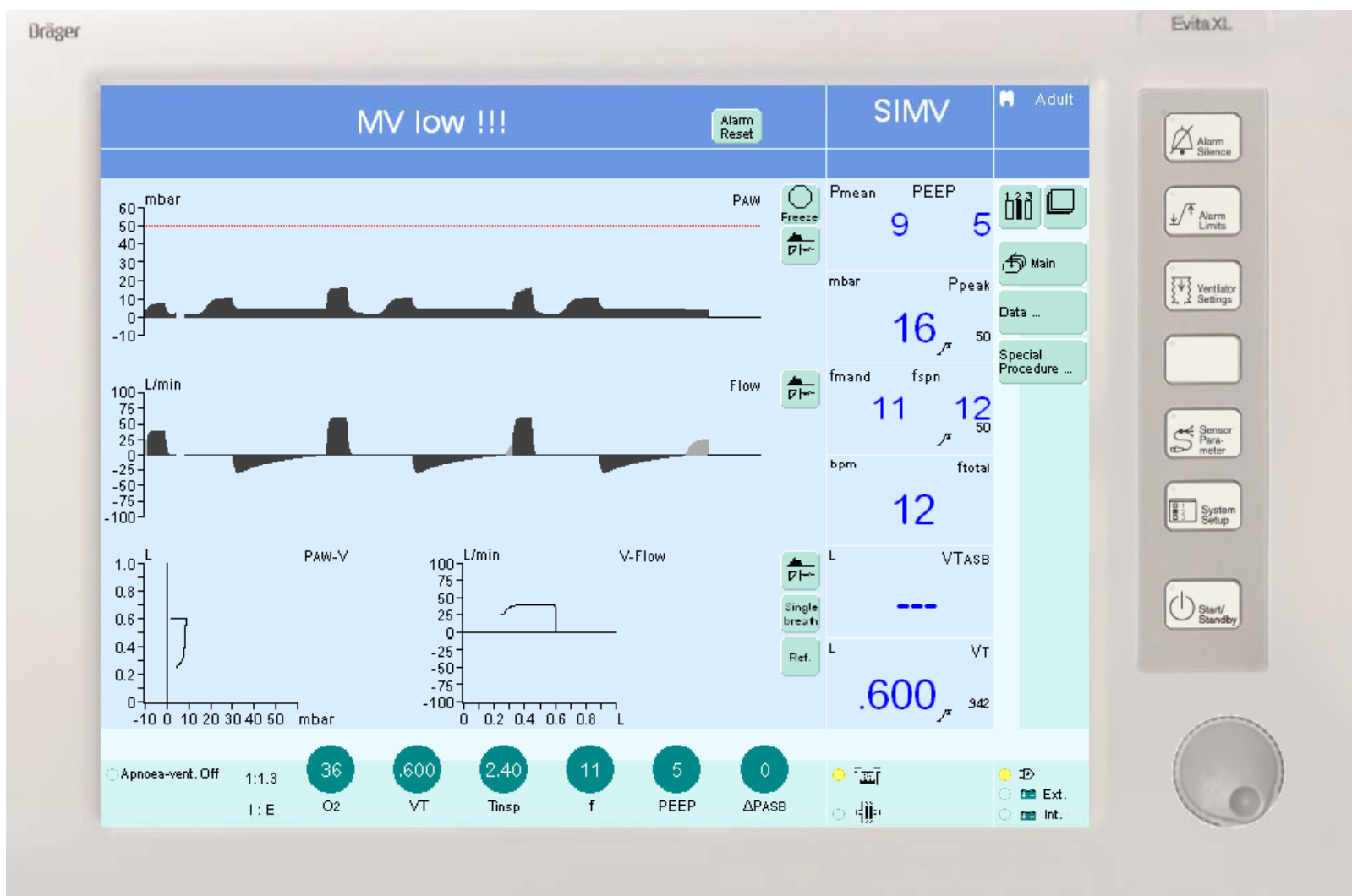
**Stéphane Delisle, RRT, MSc, PhD(c), FCCM,  
Chef des activités respiratoires à HSCM**

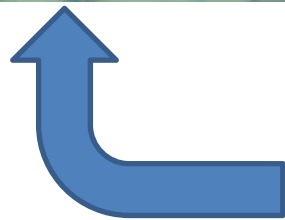
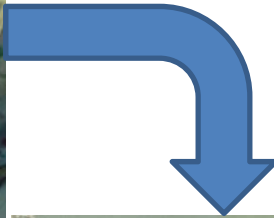
**Paul Ouellet, PhD(c), RRT, FCCM  
Hôpital régional d'Edmundston, N-B**

**Responsables du curriculum**

**Pr Laurent Brochard, Pr Alain Mercat,  
Pr Jean-Christophe M. Richard**

# Simulation: patient normal





# Objectif ultime





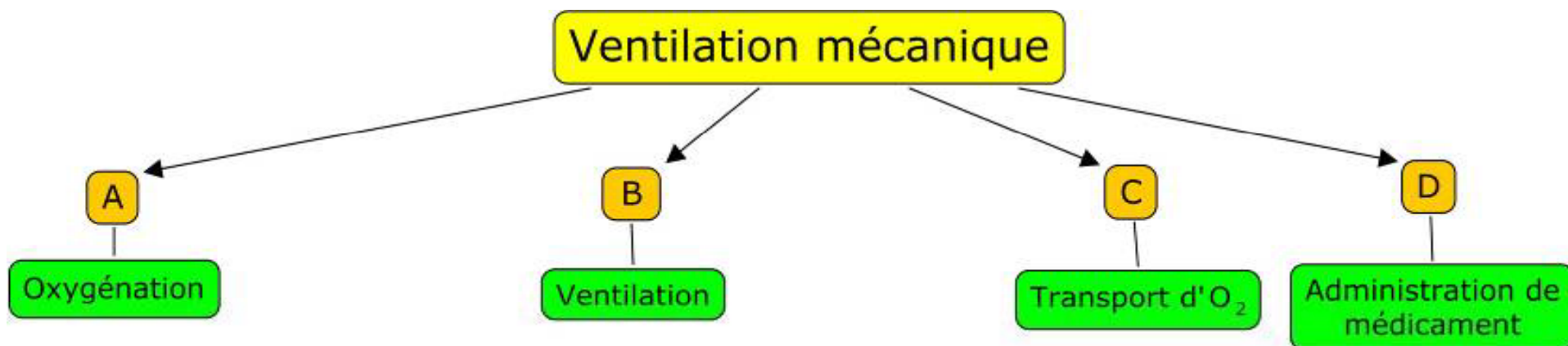
# Monitoring



14 avril 1912

15 avril 1912

# Introduction: les 4 rôles de la ventilation mécanique



# Physiopathologie



Attempt at resuscitation from drowning by insufflation of tobacco smoke per rectum

# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire

Application pratique des concepts théoriques

# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire

# Échange gazeux

Résultat:

- gaz artériels
- saturométrie artérielle, veineuse et cérébrale
- capnographie expirée ou transcutanée

Efficacité:

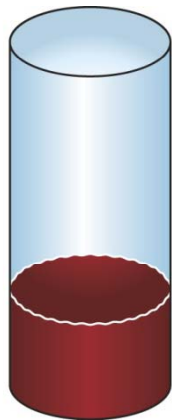
- $P(A-a)O_2$
- $PaO_2/FiO_2$  et  $PaO_2/PAO_2$
- $Q_s/Q_t$
- $V_d/V_t$

Pourquoi peut-on désaturer?

# Échange gazeux: saturation artérielle

- 1- Capacité résiduelle fonctionnelle = 30 ml/kg
- 2- Consommation d'oxygène au repos = 2-3 ml/kg/min
- 3-  $F_{iO_2}$

Air ambient



Pré-O<sub>2</sub>



Femme enceinte



CRF	30 ml/kg	30 ml/kg	15 ml/kg
Réservoir	21%	100%	100%
VO <sub>2</sub>	2-3 ml/min	2-3 ml/min	5 ml/min
Calcul	<u>21% X (30ml/kg)</u>	<u>100% X (30ml/kg)</u>	<u>100% X (15ml/kg)</u>
	2-3 ml/kg/min	2-3 ml/kg/min	5 ml/kg/min
Durée	= 2-3 minutes	= 10-15 minutes	= 3 minutes



Sellick



Positionnement de la tête

Positionnement de la patiente



# Échange gazeux: indices simplifiés

$\text{PaO}_2/\text{FiO}_2$	>300-500	Normal
	200-300	« Acute lung injury »
	< 200	« ARDS »

$\text{PaO}_2/\text{PAO}_2$  0.7-0.8

# Échange gazeux

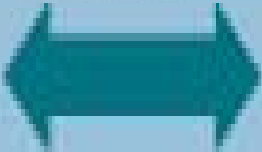
## Étiologie de l'hypoxie:

- Pulmonaire:
- anomalie  $V/\dot{Q}$
  - shunt
  - diffusion anormale
- Extra-pulmonaire:
- $\downarrow$   $FiO_2$
  - hypoventilation
  - $\downarrow$  saturation veineuse  $O_2$

# ÉVALUATION PRÉOPÉRATOIRE DU PATIENT PULMONAIRE

Anna Fabrizi MD  
Octobre 2011

TABLE 3. THE ASSOCIATION BETWEEN PREOPERATIVE LABORATORY TESTS AND THE OCCURRENCE OF POSTOPERATIVE PULMONARY COMPLICATIONS

Variable	Number of Patients with a Particular Finding	Odds Ratio (95% Confidence Interval)	p Value
$PCO_2 \geq 45$ mm Hg <sup>†</sup>	61.0 (3.8–986.4)		0.001
$PO_2 < 75$ mm Hg <sup>†</sup>	13.4 (1.3–14.1)		0.008

\* Among the 145 patients who had spirometry performed.

† Among the 66 patients who had arterial blood gases performed.

‡ Among the 124 patients who had chest radiography performed.

**Hypoxémie**



**↓ Pression inspirée en O<sub>2</sub>**

Pas affich. alarme



67

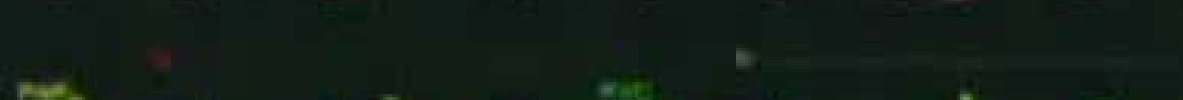
64



11  
07



120/68 (86)



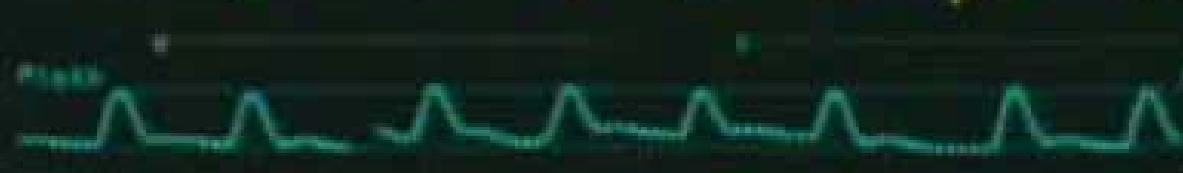
134/67 (84)



41/21 (26)

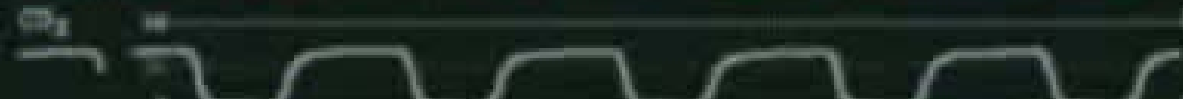
38/13

61



100

69



32

35.5

35.9



10

75

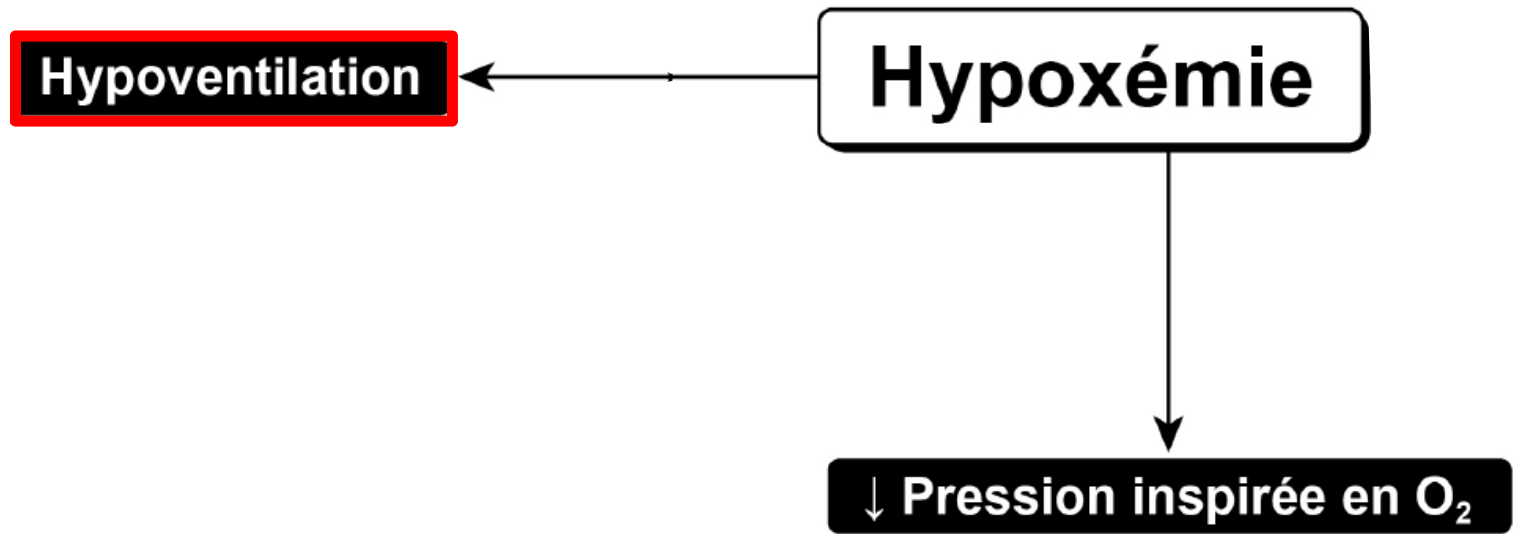
301

1.48

36.2

13

100%  
150%  
150%  
150%





Pas affich. alarme



67

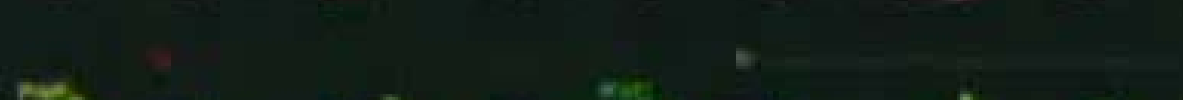
64



67



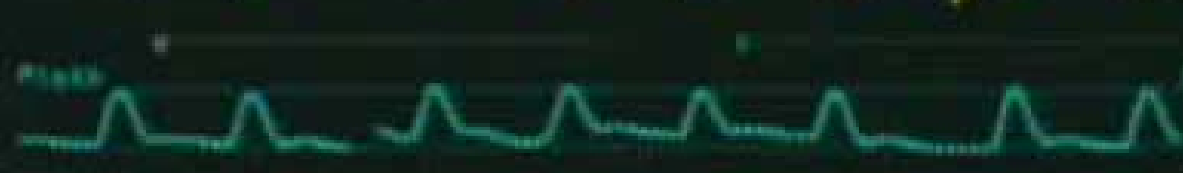
120/68 (86)



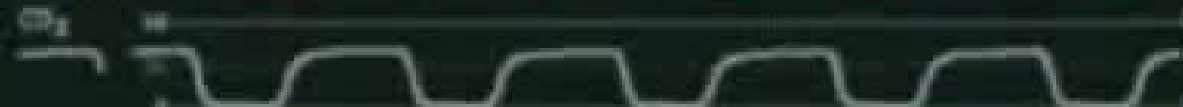
134/67 (84)



41/21 (26)



100



32

61

69

35.5

35.9

36.2

13

FR-arr 10  
Rg-in 75

100%  
100%  
100%  
100%

3.01  
1.48

# Échange gazeux: gradient A-a

$$PaO_2 = 104 - 0.27 (\hat{\text{age}})$$

$$PAO_2 = \frac{FiO_2 (Pb - PH_2O) - PaCO_2/R}{147 - 1.25 PaCO_2}$$

$$\begin{aligned} \text{Gradient A-a} &= PAO_2 - PaO_2 \\ &= 2.5 + 0.21 (\hat{\text{age}}) \end{aligned}$$

# Échange gazeux: aspects pratiques

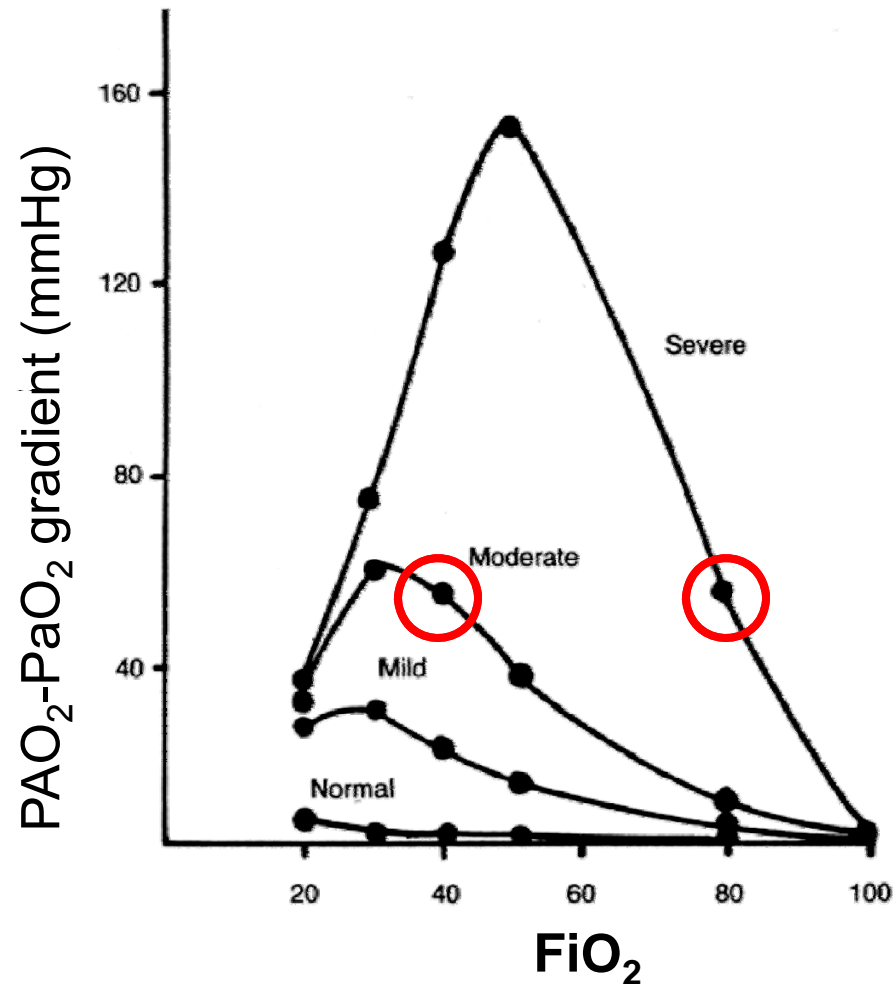
Exemple: 45 ans obèse  
post-op cholecystectomie  
Saturation 91% salle de réveil

1-PaO<sub>2</sub> 60mmHg, PCO<sub>2</sub> 60mmHg?

2-PaO<sub>2</sub> 60mmHg, PCO<sub>2</sub> 40mmHg?

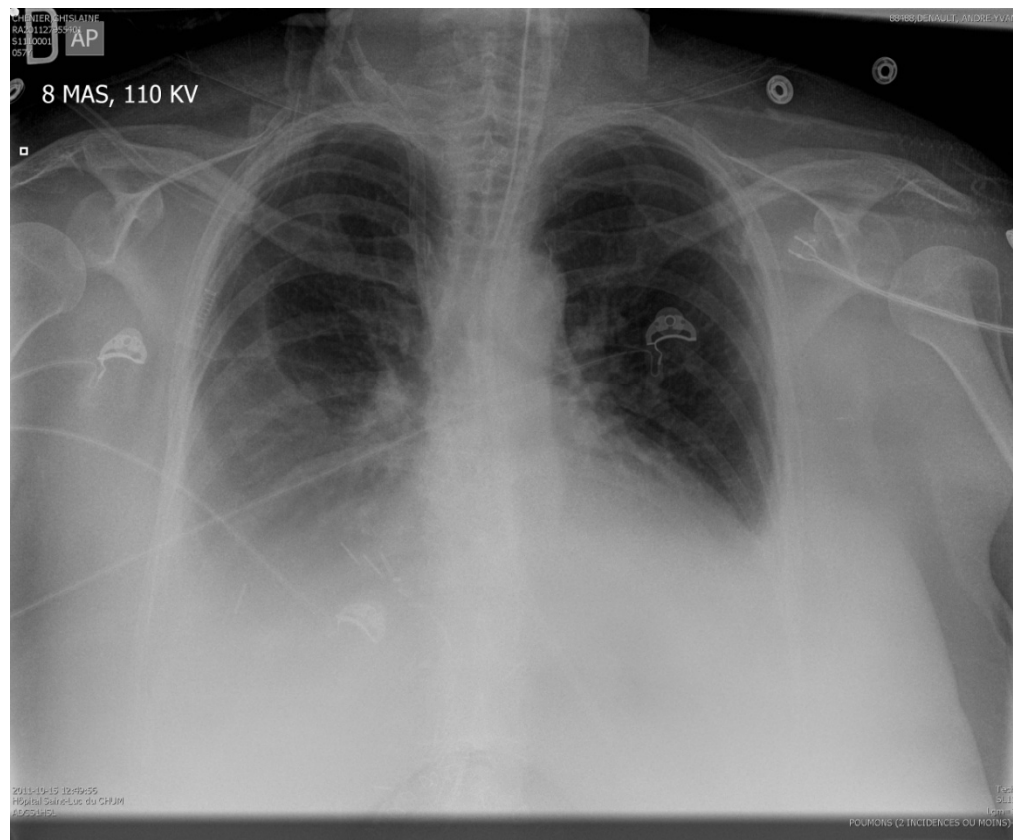
$$1-A-a = 12 \quad 2-A-a = 32$$

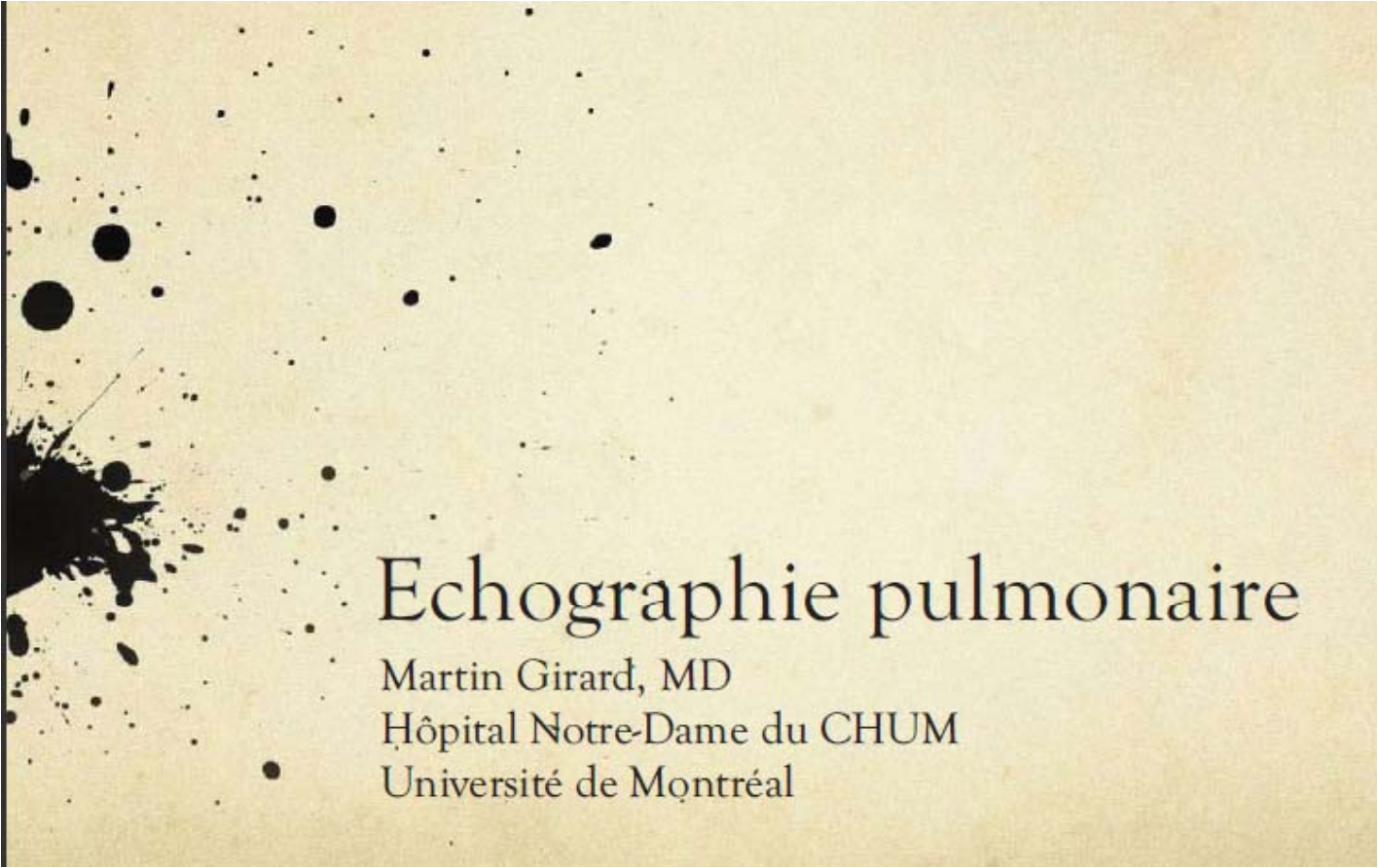
# Limitation: gradient A-a



Comparer à des FiO<sub>2</sub> égales

# ♀ 58 ans post TOF: réintubée et difficile à sevrer



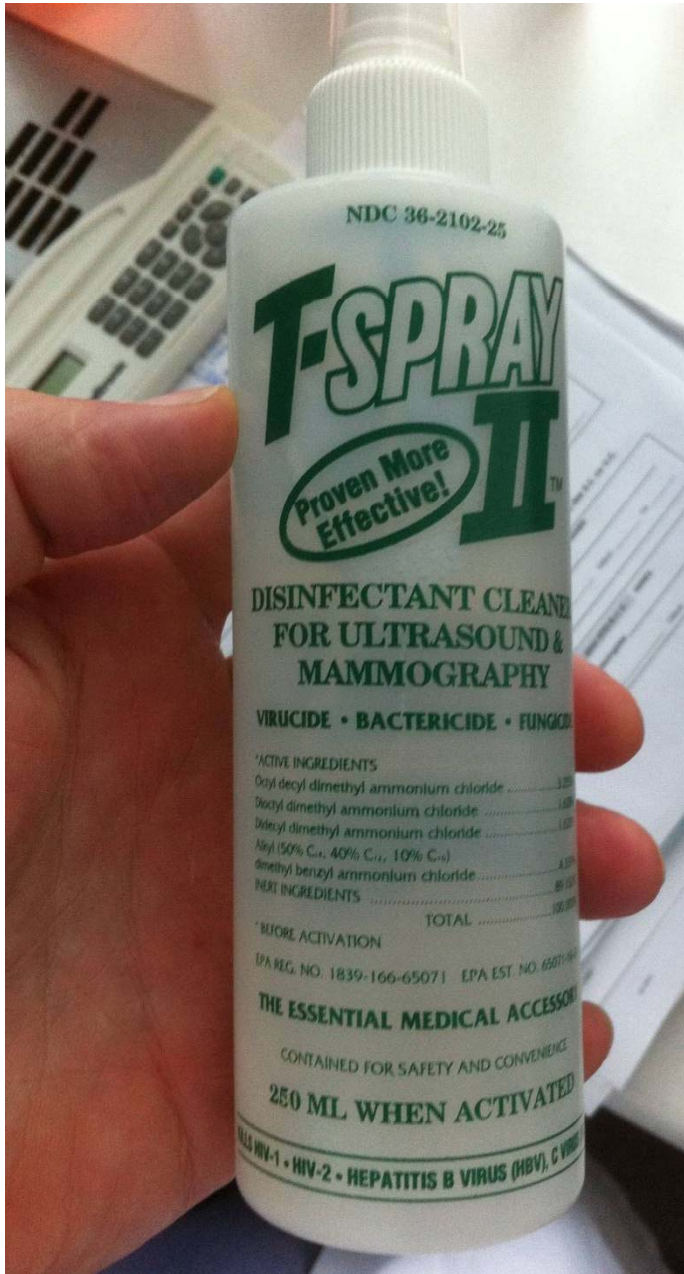


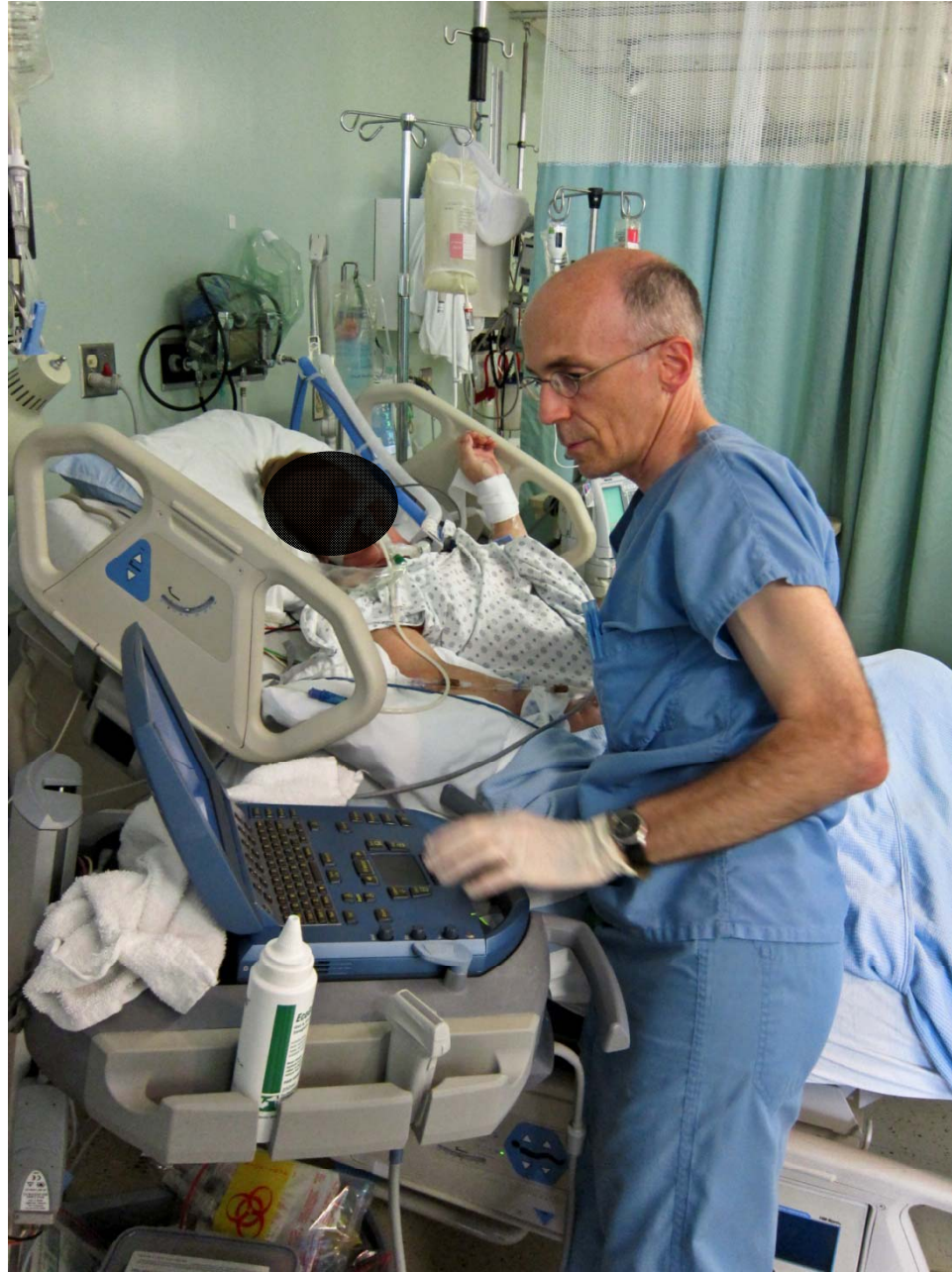
# Echographie pulmonaire

Martin Girard, MD

Hôpital Notre-Dame du CHUM

Université de Montréal









# Diaphragm dysfunction assessed by ultrasonography: Influence on weaning from mechanical ventilation\*

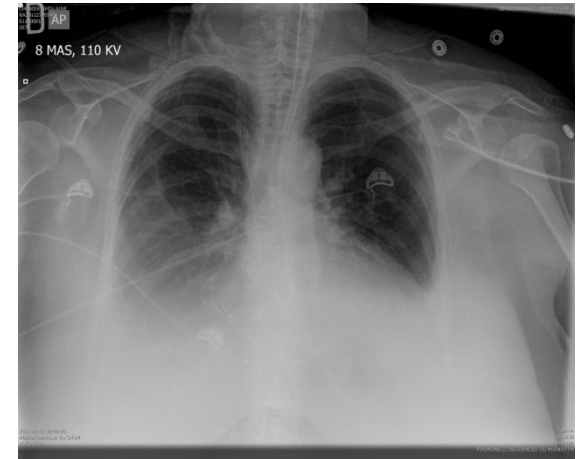
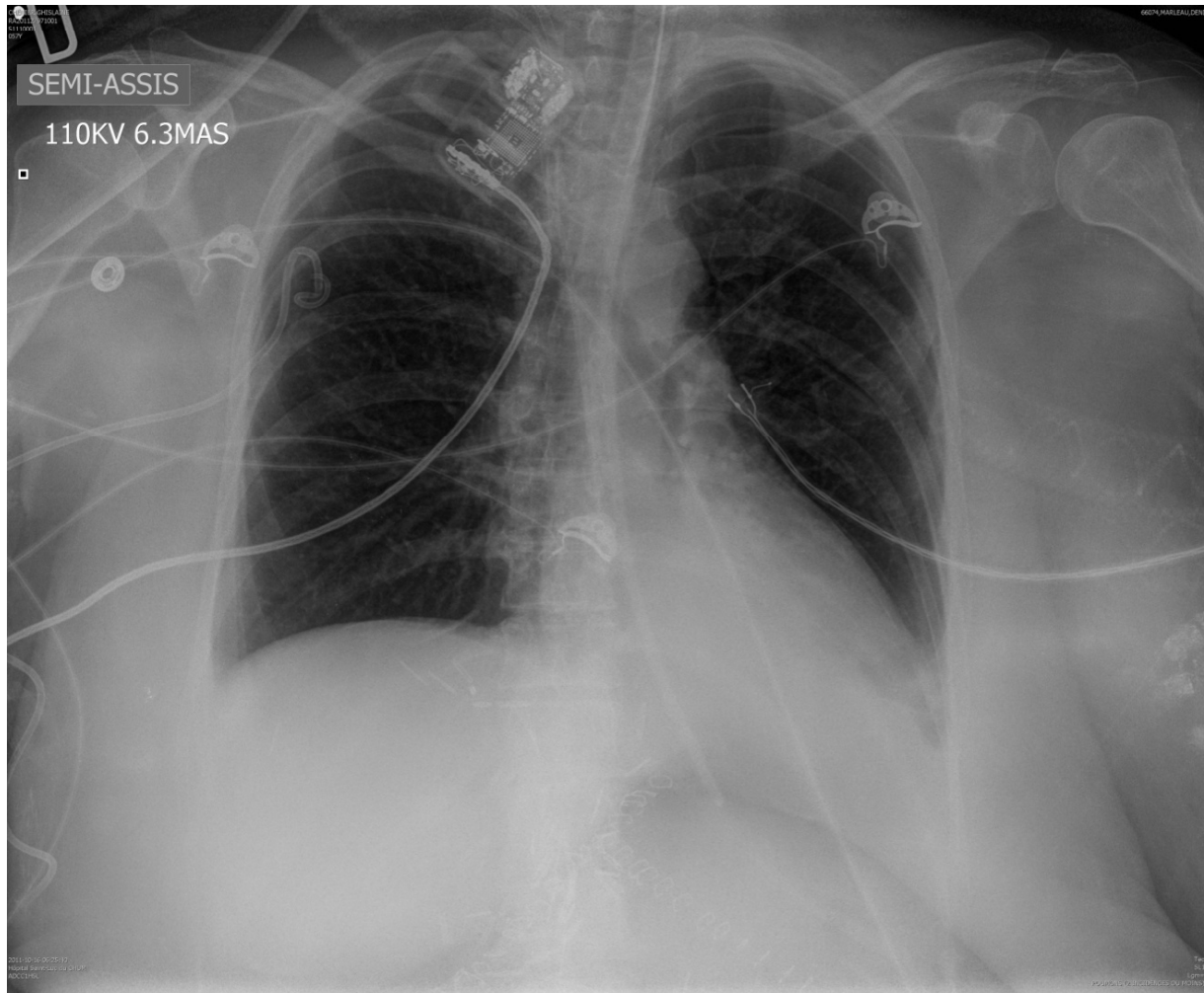
Kim, Won Young MD; Suh, Hee Jung RT; Hong, Sang-Bum MD, PhD; Koh, Younsuck MD, PhD, FCCM; Lim, Chae-Man MD, PhD, FCCM



Rôle de l'échographie du diaphragme: :

- 1-Fonction du diaphragme
- 2- Intubation endobronchique

# Post drainage échoguidé



# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **A Prospective Comparison of Diaphragmatic Ultrasound and Chest Radiography to Determine Endotracheal Tube Position in a Pediatric Emergency Department**

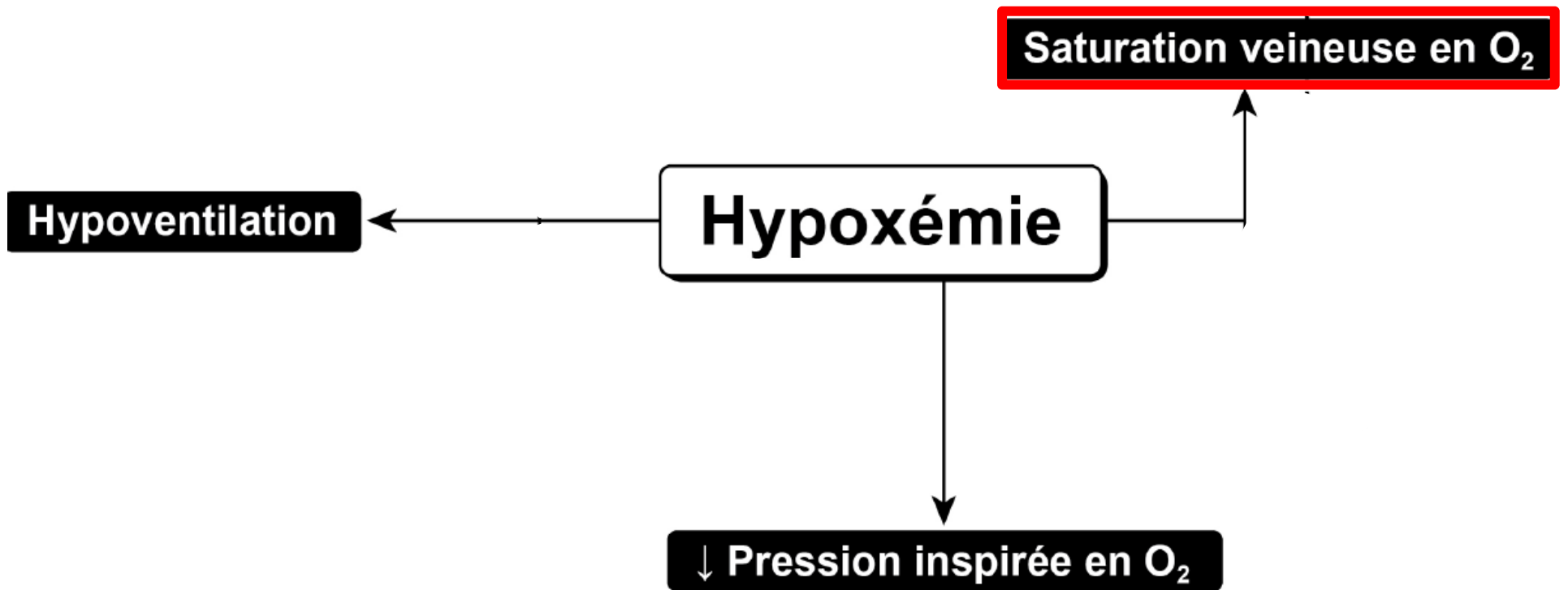
Benjamin Thomas Kerrey, Gary Lee Geis, Andrea Megan Quinn, Richard William Hornung and Richard Michael Ruddy

*Pediatrics* 2009;123:e1039-e1044; originally published online May 4, 2009;

DOI: 10.1542/peds.2008-2828

### **What This Study Adds**

Diaphragmatic ultrasound results disagree significantly with chest radiography results for confirming ETT position within the airway in emergently intubated children. Ultrasound results were faster and highly reproducible.

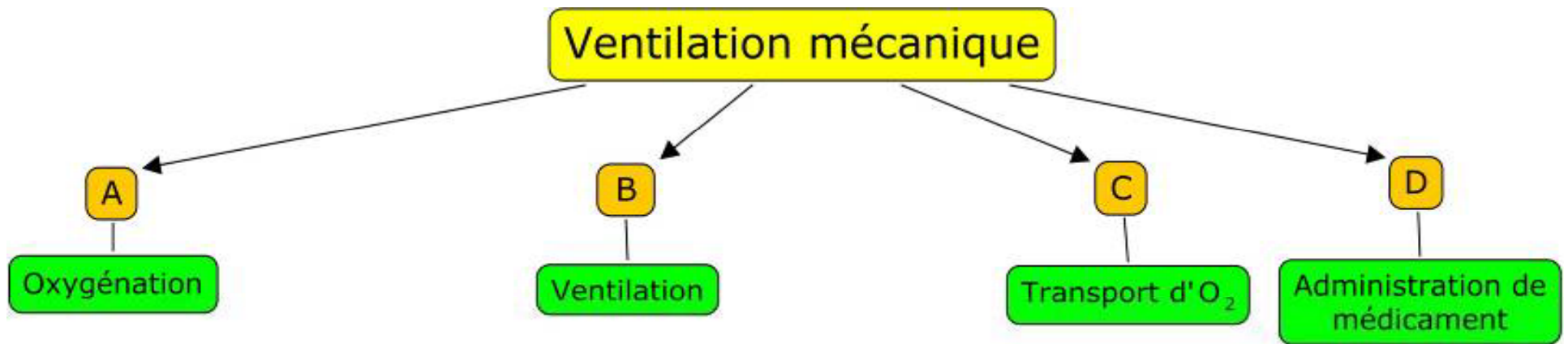


# PHYSIOLOGIE PULMONAIRE. ÉCHANGES GAZEUX. TRANSPORT/CONSOMMATION D'O<sub>2</sub>

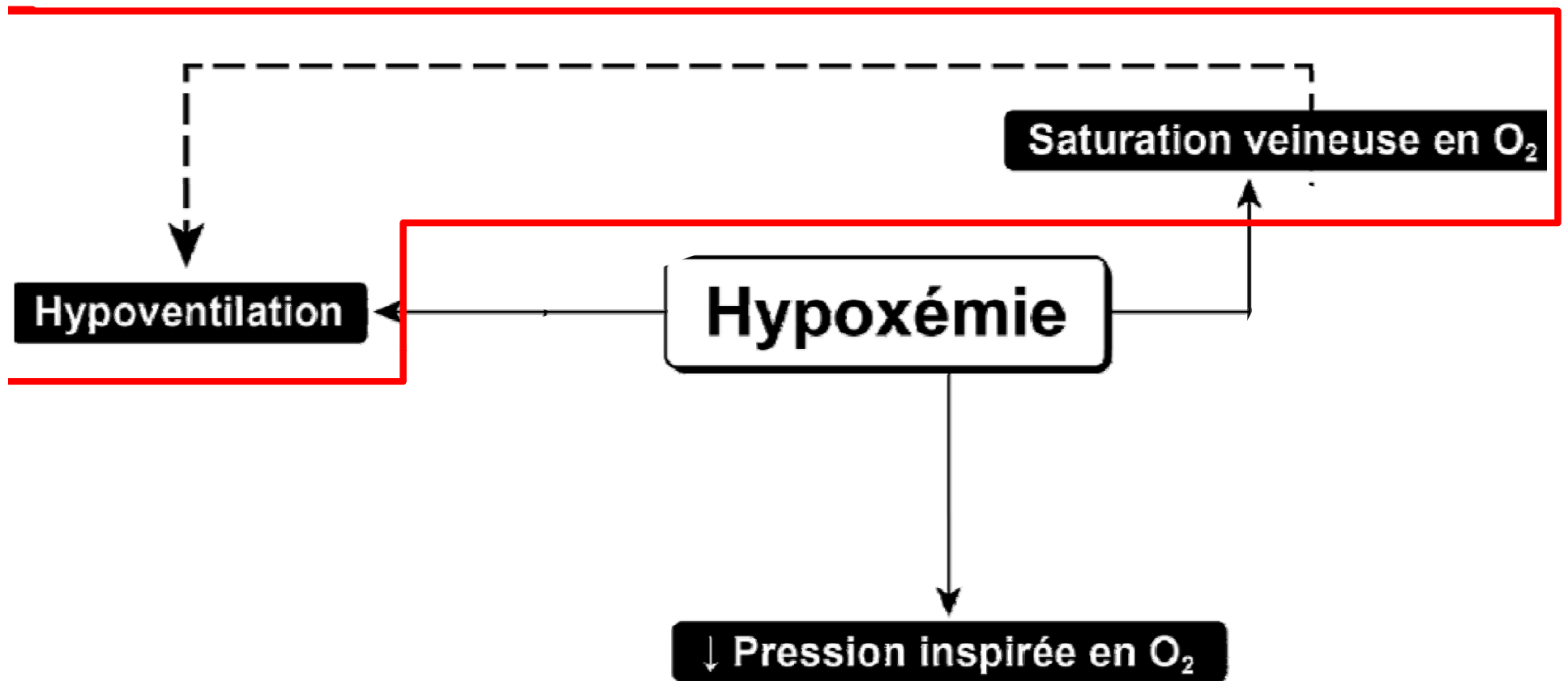


Dr Louise Passerini

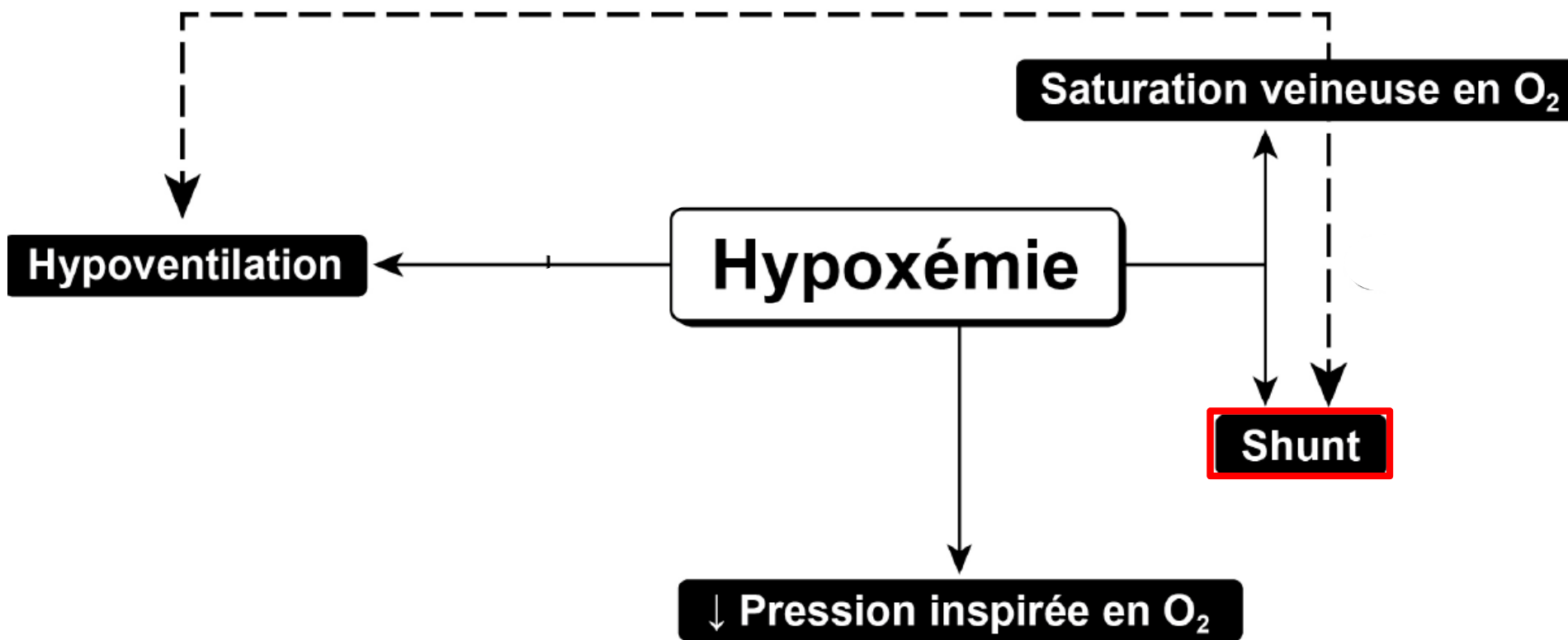
# Ventilation mécanique difficile



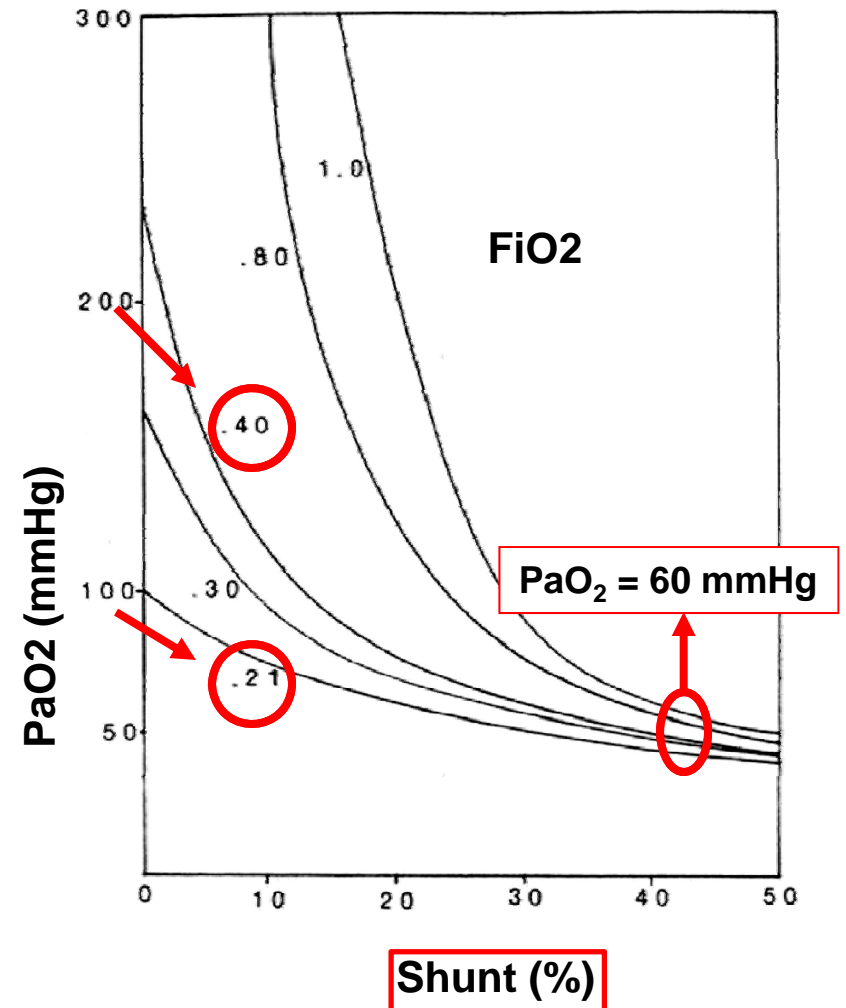
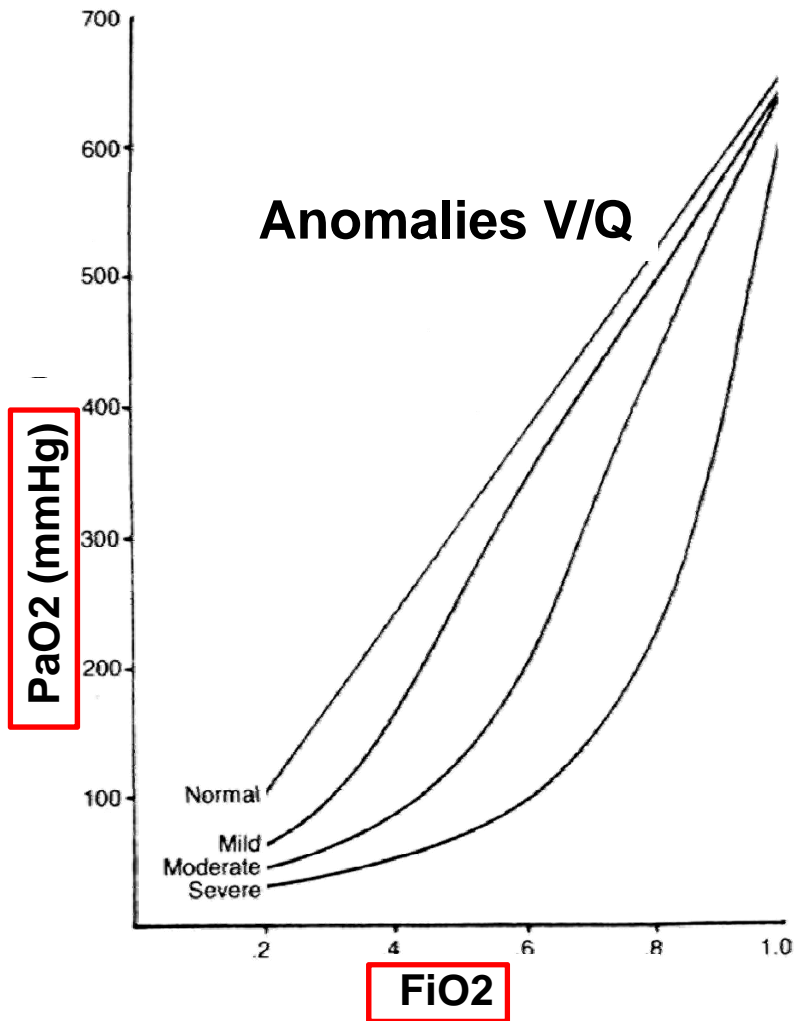
Pourquoi la ventilation peut sauver la vie du patient en choc?





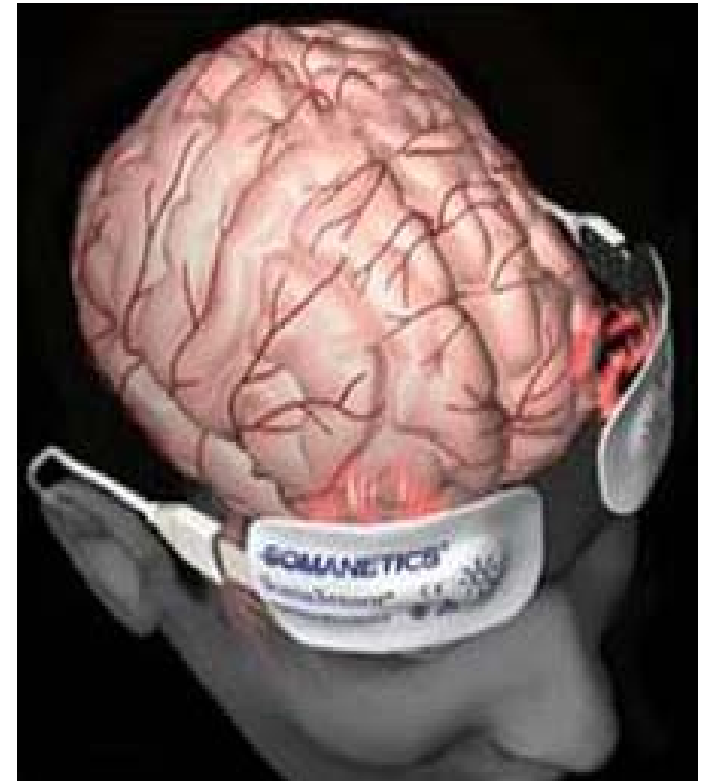


# Échange gazeux: indices simplifiés



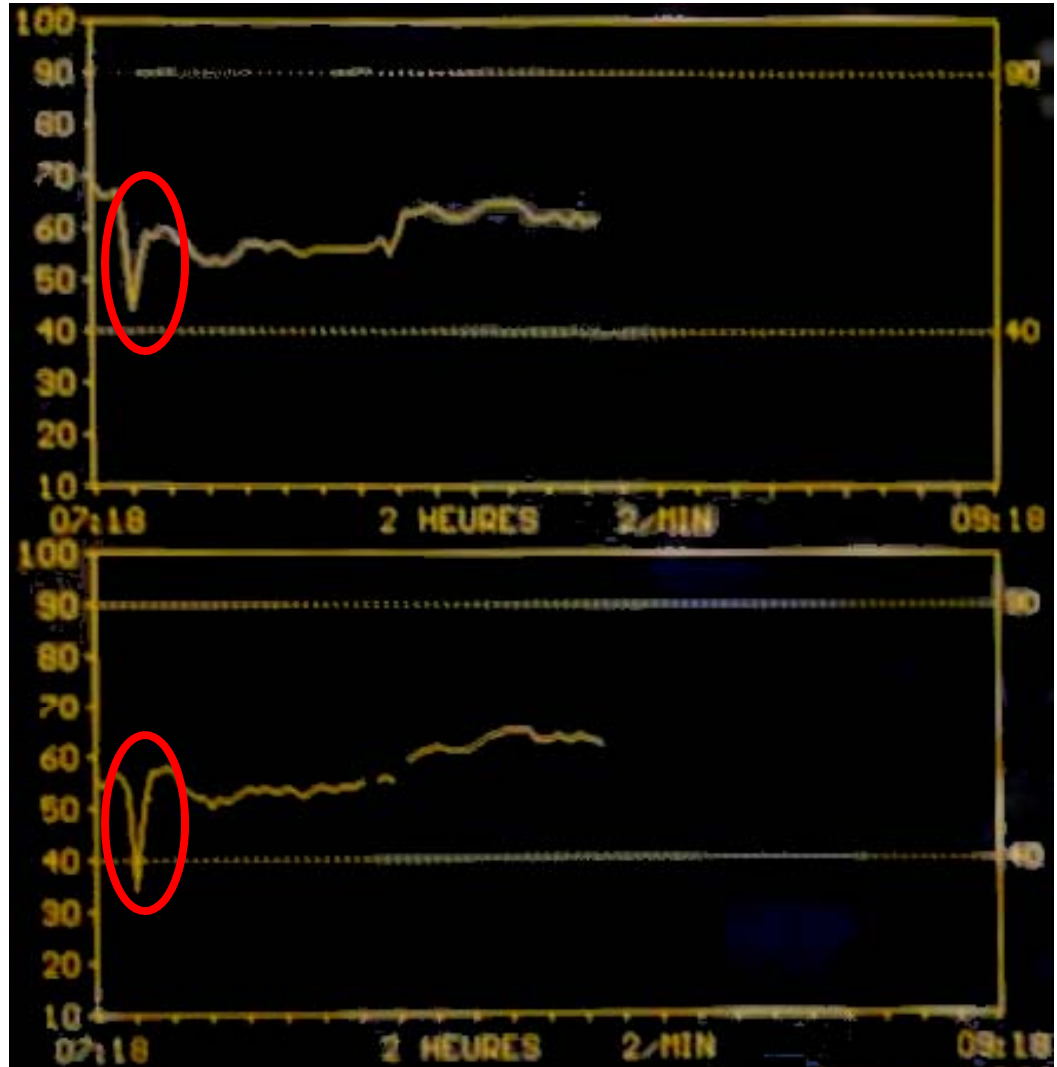
# Mode de fonctionnement

- Système de surveillance de l'oxygénation du cerveau basé sur l'absorption de photons infrarouge dans 2 régions frontales du cerveau
- Valeur normale  $65 \pm 5\%$



# ♂ 84 ans pontage coronarien histoire de dyspnée inexpliquée

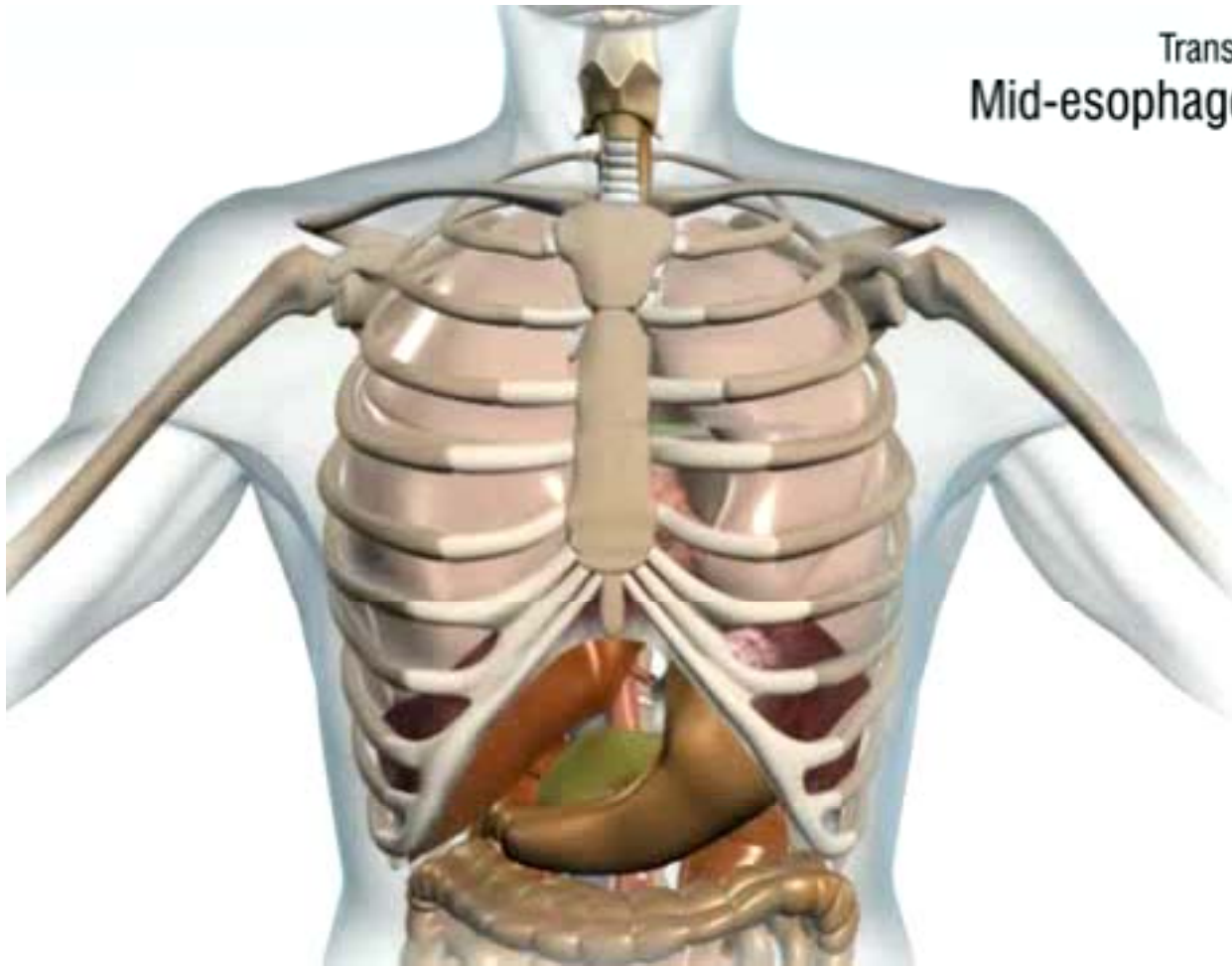
- Désaturation cérébrale et systémique lors de l'induction de l'anesthésie
- Facile à ventiler
- Saturation se normalise avec l'augmentation de la pression artérielle
- Gaz artériel?  
PO<sub>2</sub> = 518 mmHg



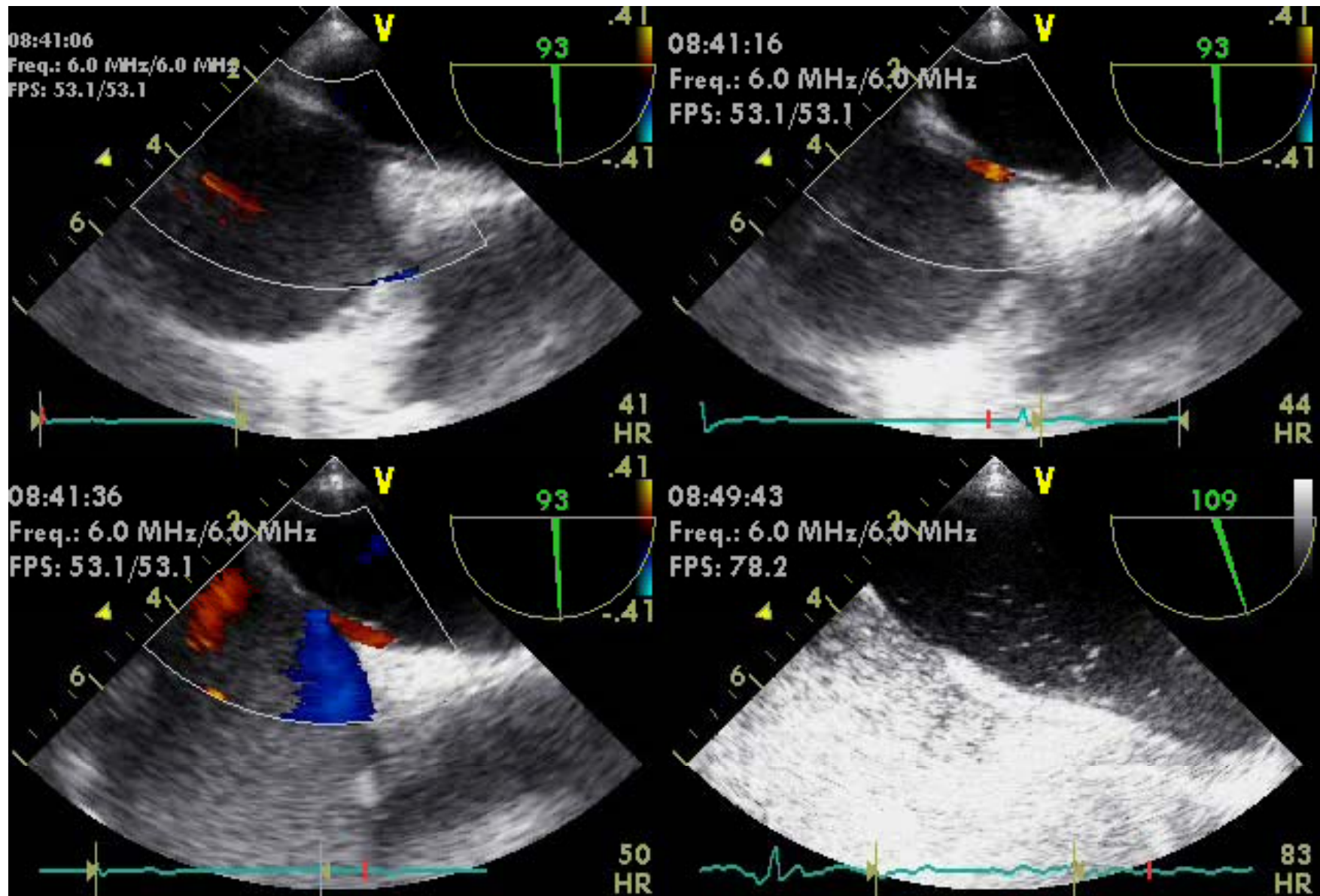
# Signes vitaux

	<b>7:51:48</b>	<b>7:52:00</b>	<b>7:52:12</b>	<b>7:52:24</b>	<b>7:52:36</b>
<b>HR</b>	64	63	60	56	49
<b>ST</b>	-0.1 -0.6	-0.2 -0.6	-0.2 -0.6	-0.2 -0.5	-0.3 -0.4
<b>SAP</b>	136	132	121	114	105
<b>DAP</b>	57	53	51	49	46
<b>MAP</b>	82	77	72	67	62
<b>SaO<sub>2</sub></b>	90	81	71	64	56

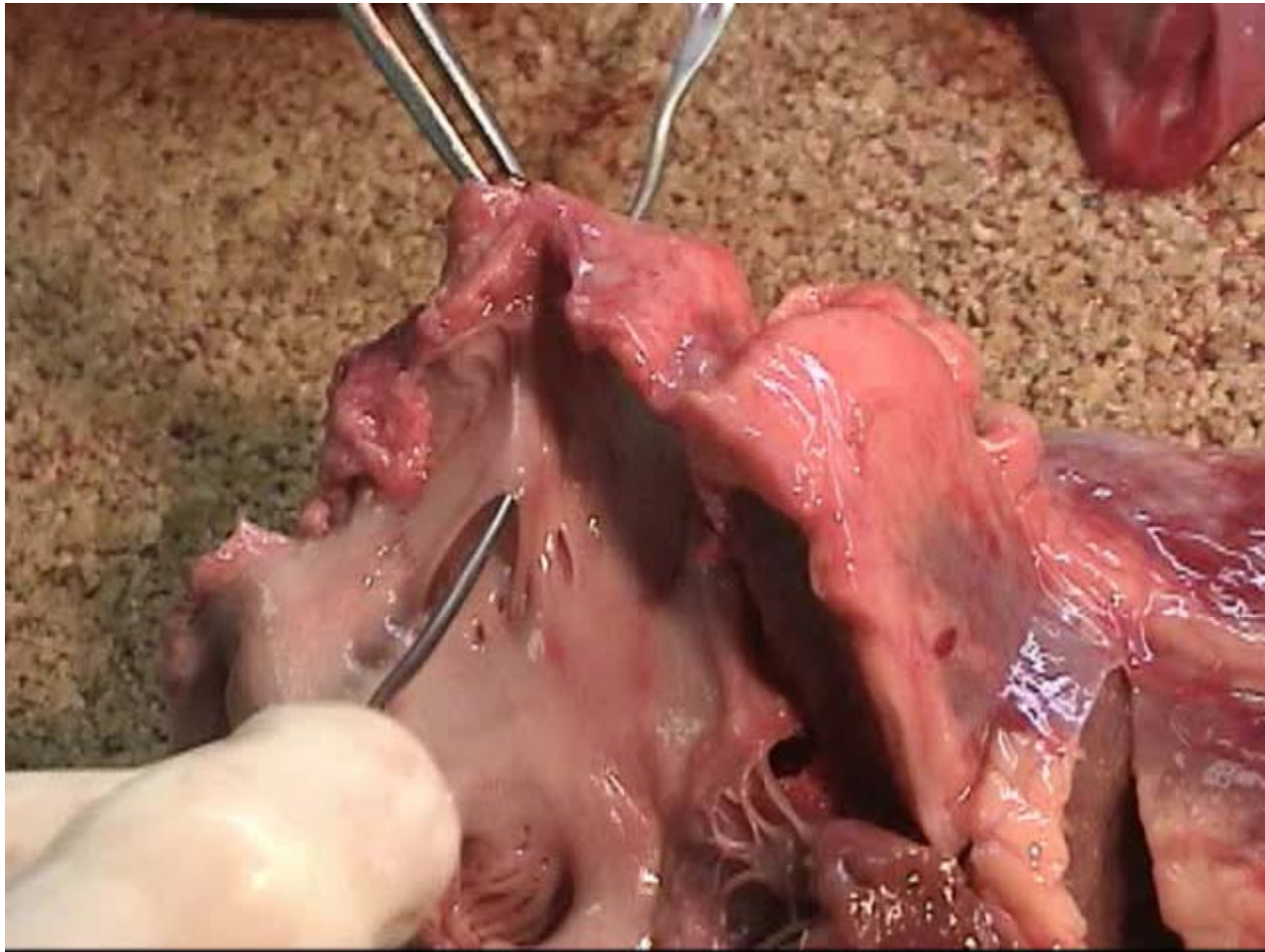
Transesophageal echocardiography  
Mid-esophageal four-chamber view



# Échocardiographie transoesophagienne

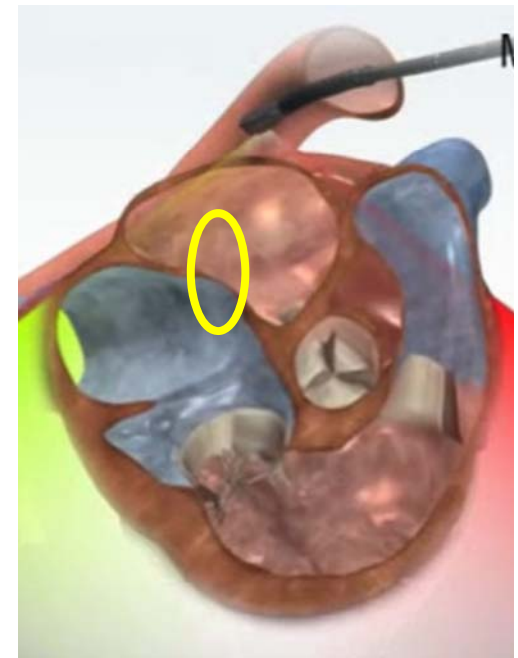
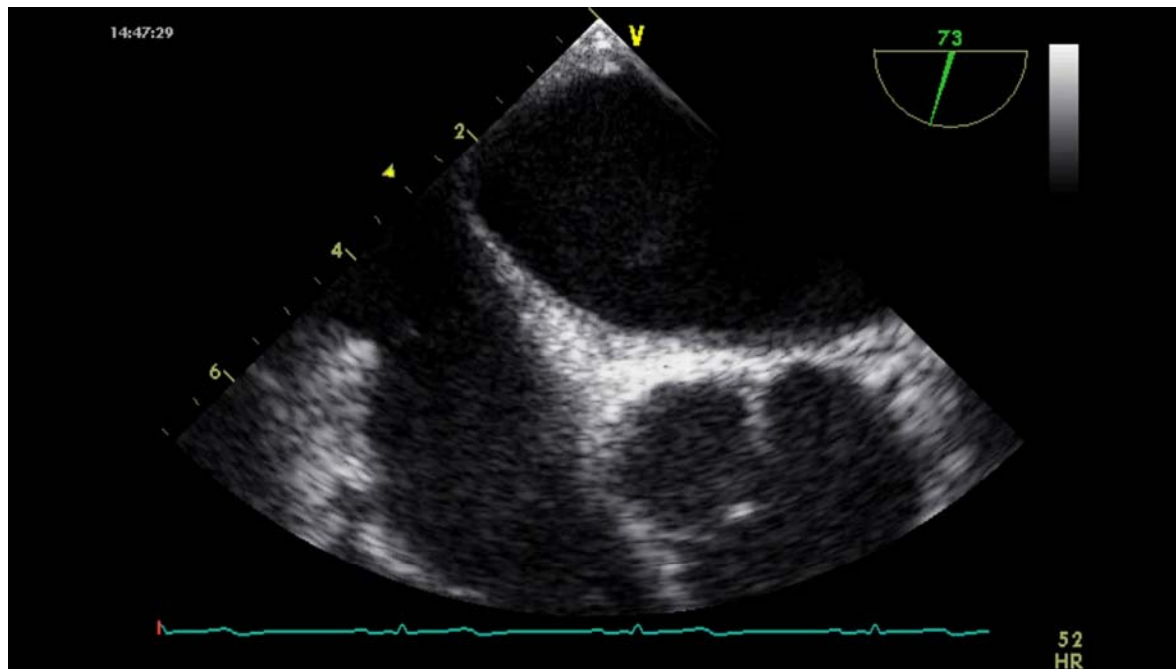


# Greffe pulmonaire et pneumonie: désaturation post-induction aux SI





# Échographie transoesophagienne



Shunt intracardiaque versus intrapulmonaire?

# Prevalence and prognosis of shunting across patent foramen ovale during acute respiratory distress syndrome \*

Mekontso Dessap, Armand MD, PhD; Boissier, Florence MD; Leon, Rusel MD; Carreira, Serge MD; Roche Campo, Ferran MD; Lemaire, François MD; Brochard, Laurent MD

203 patients avec ARDS

PFO si > 10 bulles

**Résultat: 19.2%**

-plus de coeur pulmonaire (39% vs 18%)

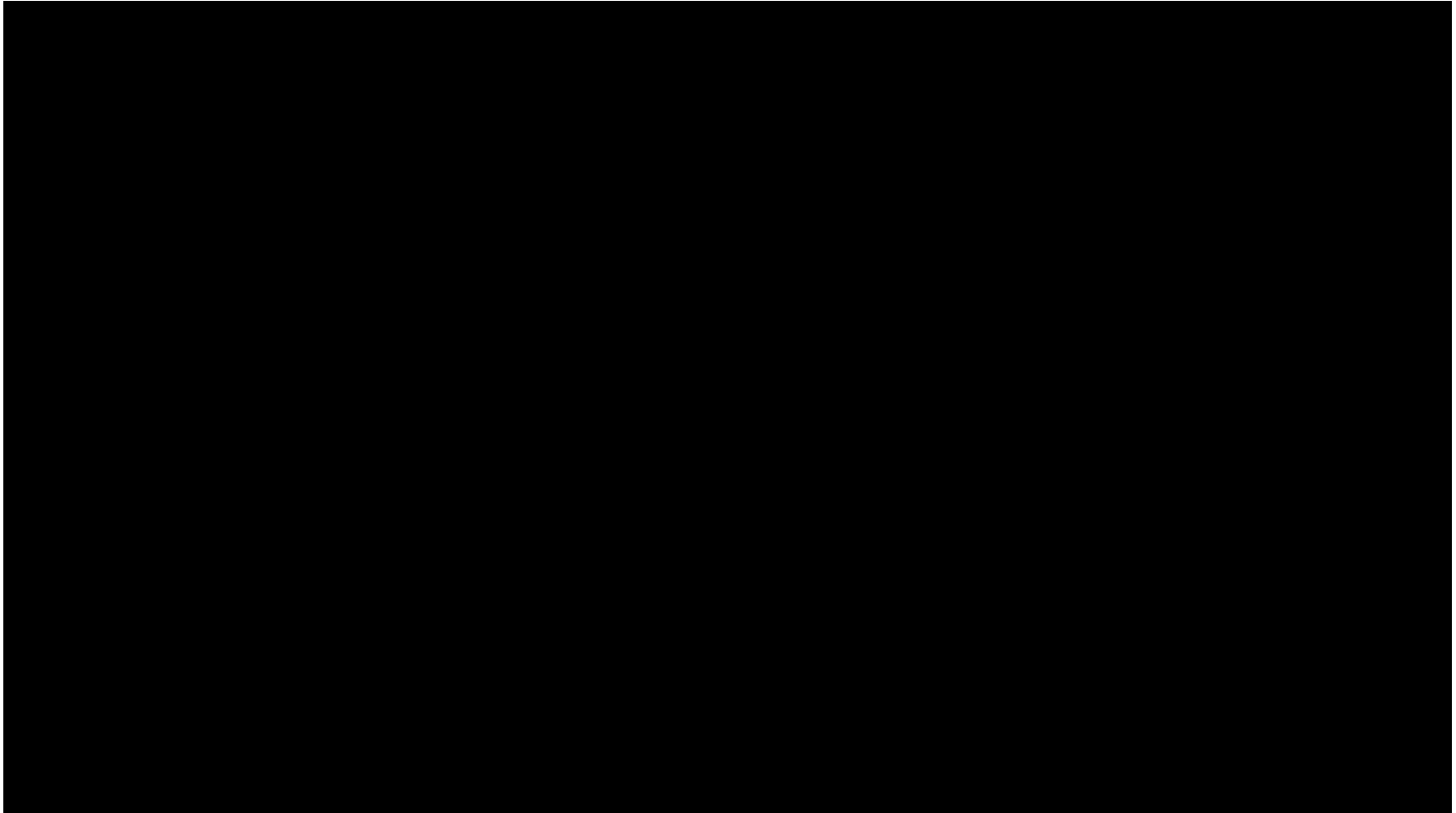
-PaO<sub>2</sub>/FiO<sub>2</sub> plus bas

-Intubé plus longtemps

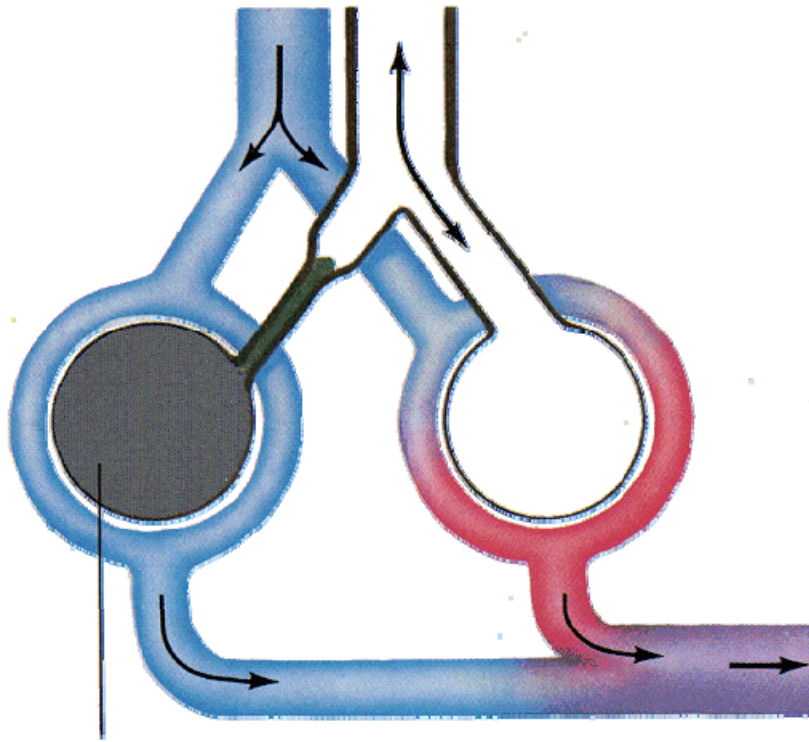
Critical Care Medicine:

September 2010 - Volume 38 - Issue 9 - pp 1786-1792

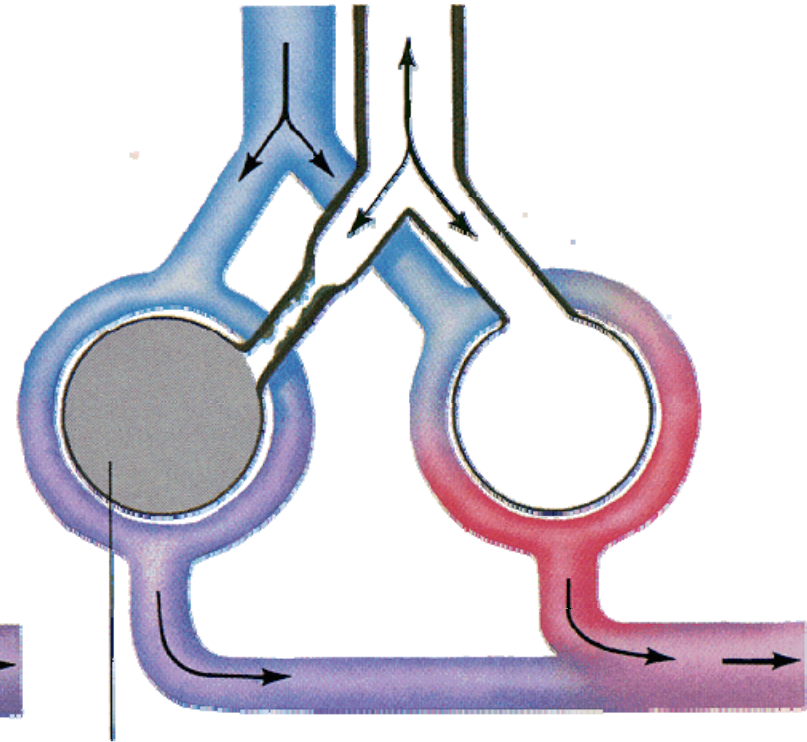
# Traitement du FOP



# Anomalies ventilation-perfusion: shunt



Perfusion sans ventilation



Perfusion et hypoventilation

## LES PNEUMONIES NOSOCOMIALES EN 2011



Dr Louise Passerini

## Pneumonie d'inhalation *Risques de survenue - prévention*

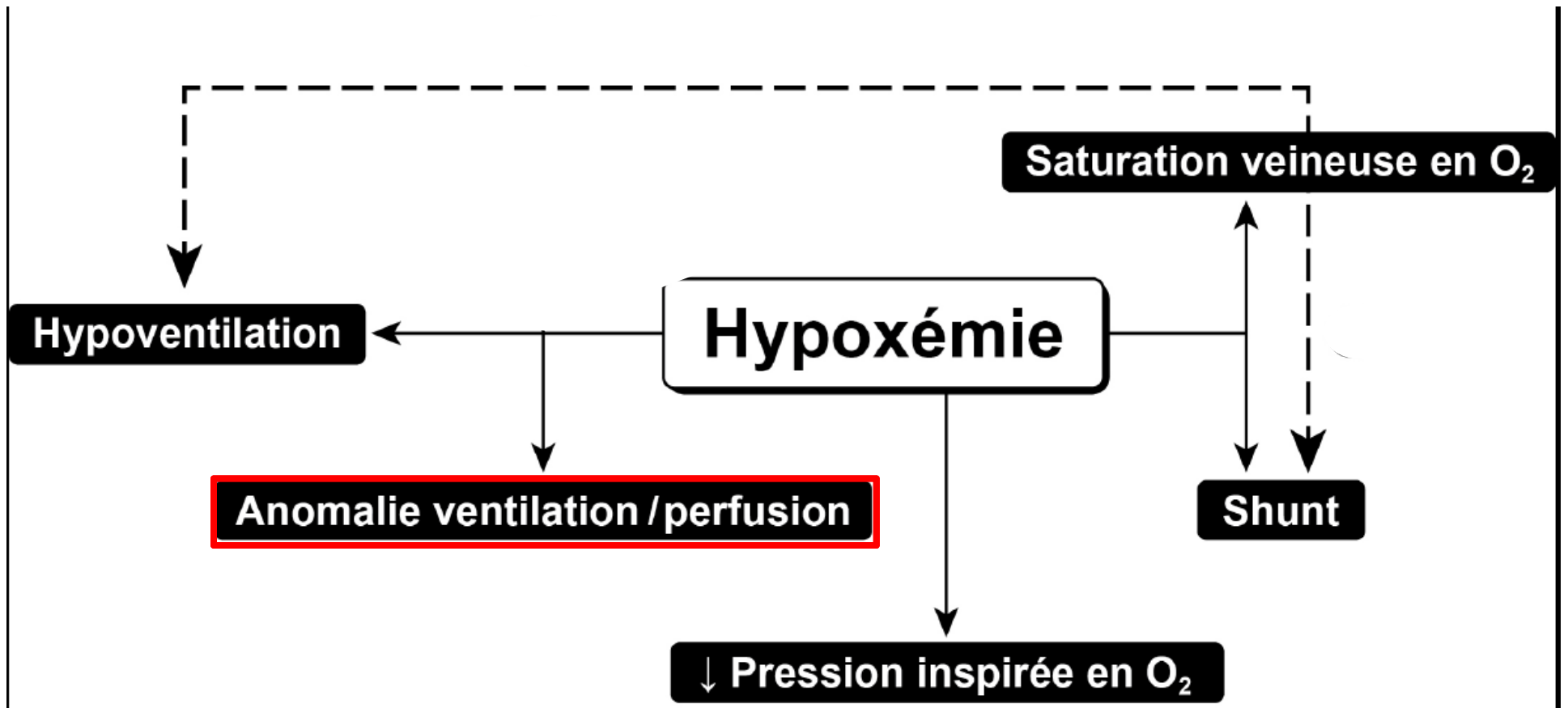
Pour une pratique basée sur  
les données probantes  
*Jean-François Hardy, MD*  
*Centre Hospitalier de l'Université de Montréal*

# Échange gazeux: shunt

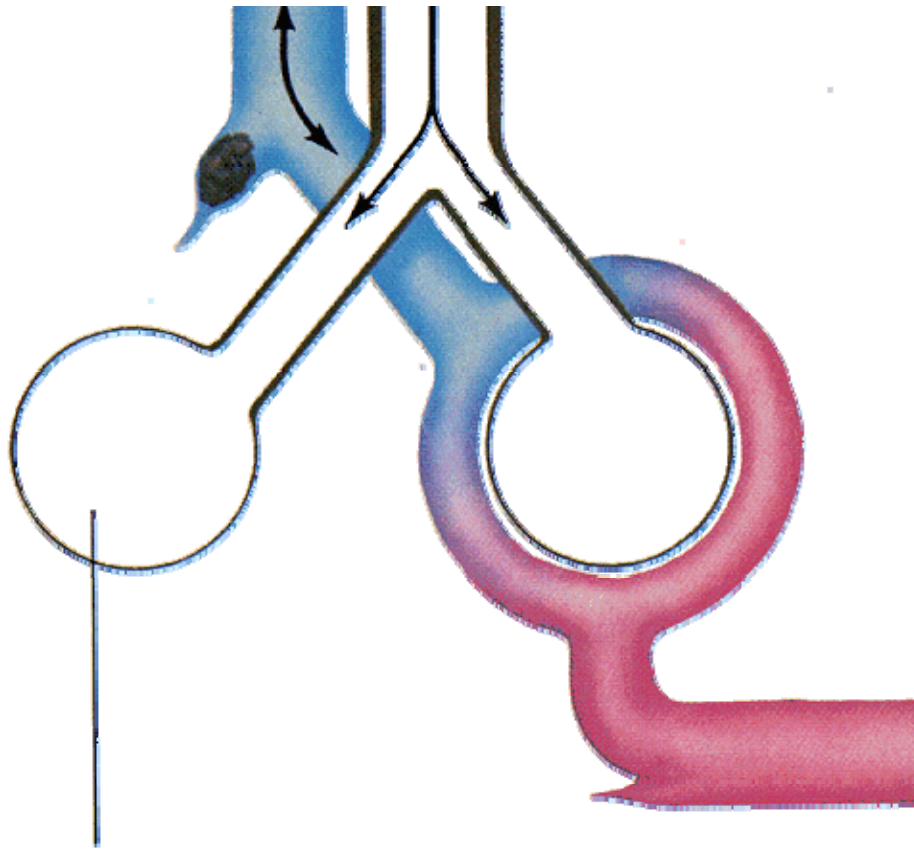
$$\begin{aligned}CaO_2 &= Hb \times SaO_2 \times 1.34 + 0.003 \times PaO_2 \\CvO_2 &= Hb \times SvO_2 \times 1.34 + 0.003 \times PvO_2 \\CcO_2 &= Hb \times ScO_2 \times 1.34 + 0.003 \times PAO_2\end{aligned}$$

$$\begin{aligned}\text{Shunt} = Q_s/Q_t &= \frac{(CcO_2 - CaO_2)}{(CcO_2 - CvO_2)} \\ &= 3-5\% \text{ à } 100\% O_2\end{aligned}$$

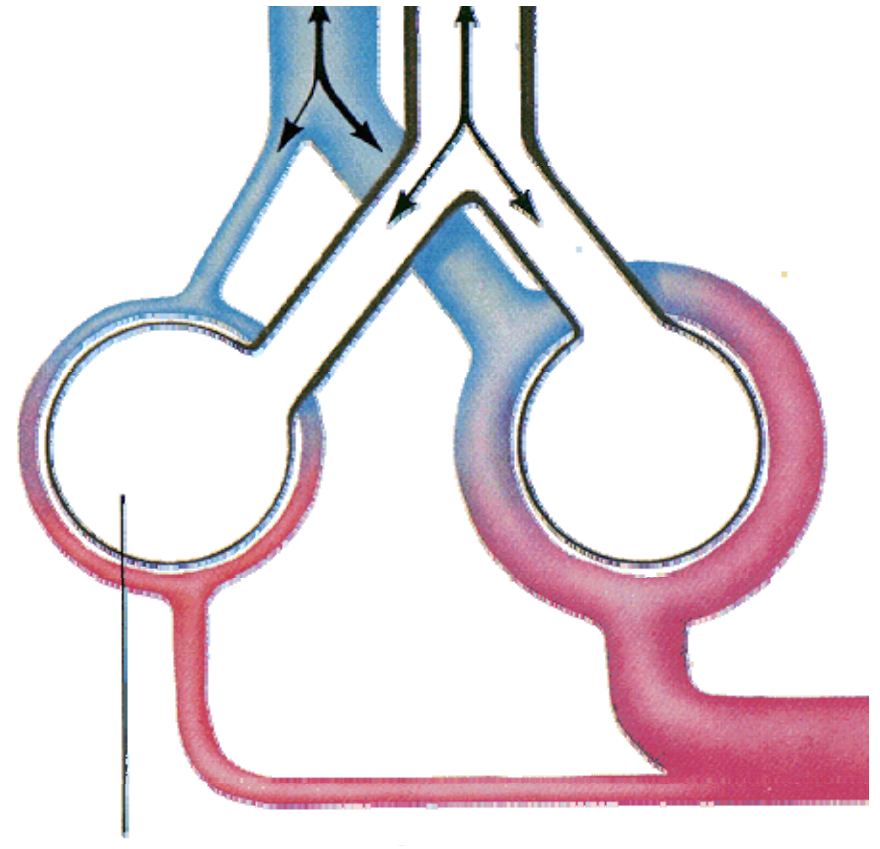
L'optimisation du PEEP se mesure par  
la diminution du shunt



# Anomalies ventilation-perfusion



Ventilation sans perfusion



Ventilation et hypoperfusion



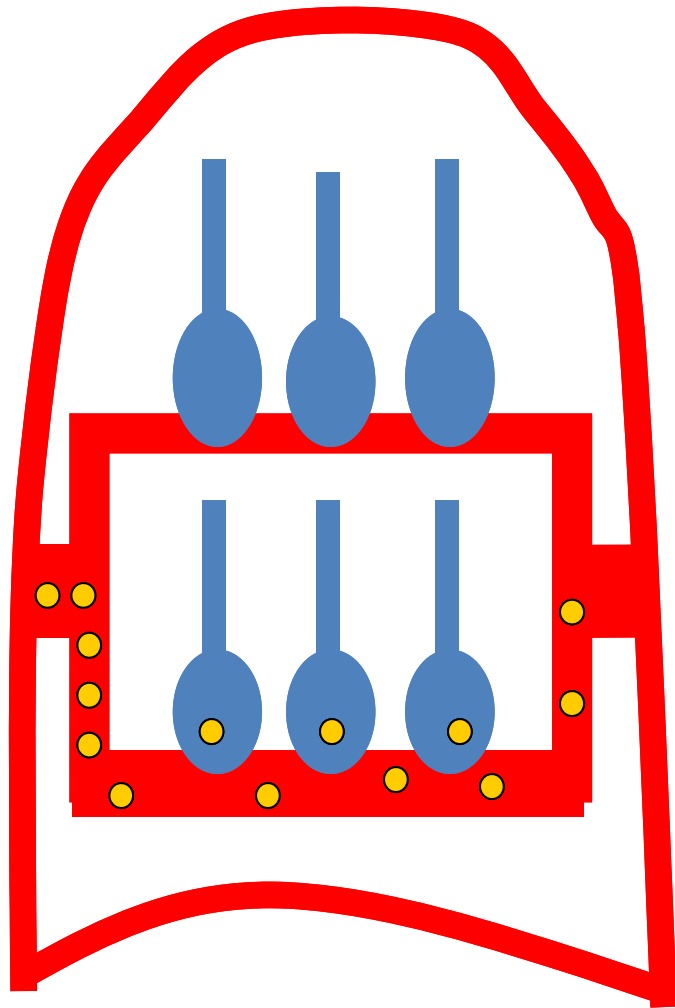
# Échange gazeux: espace mort

$$\begin{aligned} V_d/V_t &= \frac{P_{aCO_2} - P_{ECO_2}}{P_{aCO_2}} \\ &\approx \frac{P_{aCO_2} - ETCO_2}{P_{aCO_2}} \\ &= 25\% + 0.17(\text{âge})\% \end{aligned}$$

1-L'optimisation du PEEP se mesure par l'absence d'augmentation significative de l'espace mort

2-L'espace mort est un facteur pronostique dans l'ARDS

# Zones de West simplifiées



Zone I:  $P_{alv} > P_{vasc}$

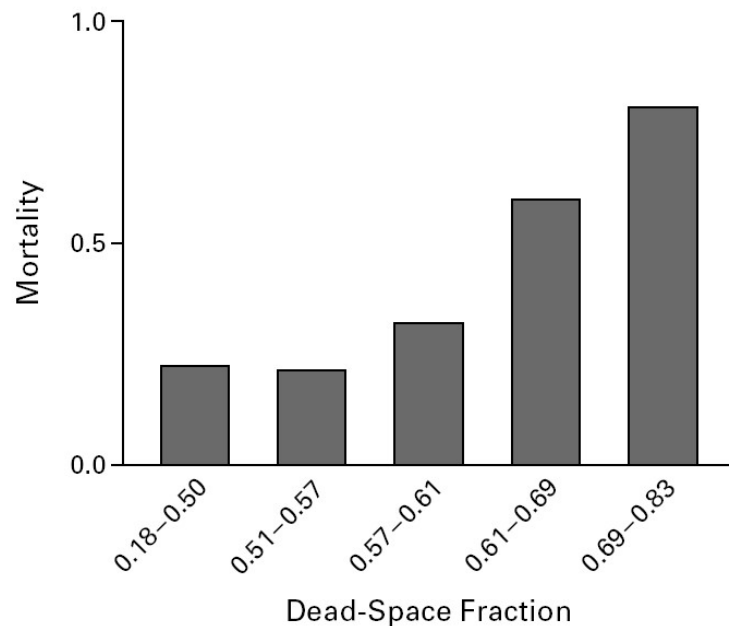
Zone III:  $P_{alv} < P_{vasc}$

# ARDS et espace-mort

## PULMONARY DEAD-SPACE FRACTION IN ARDS

### PULMONARY DEAD-SPACE FRACTION AS A RISK FACTOR FOR DEATH IN THE ACUTE RESPIRATORY DISTRESS SYNDROME

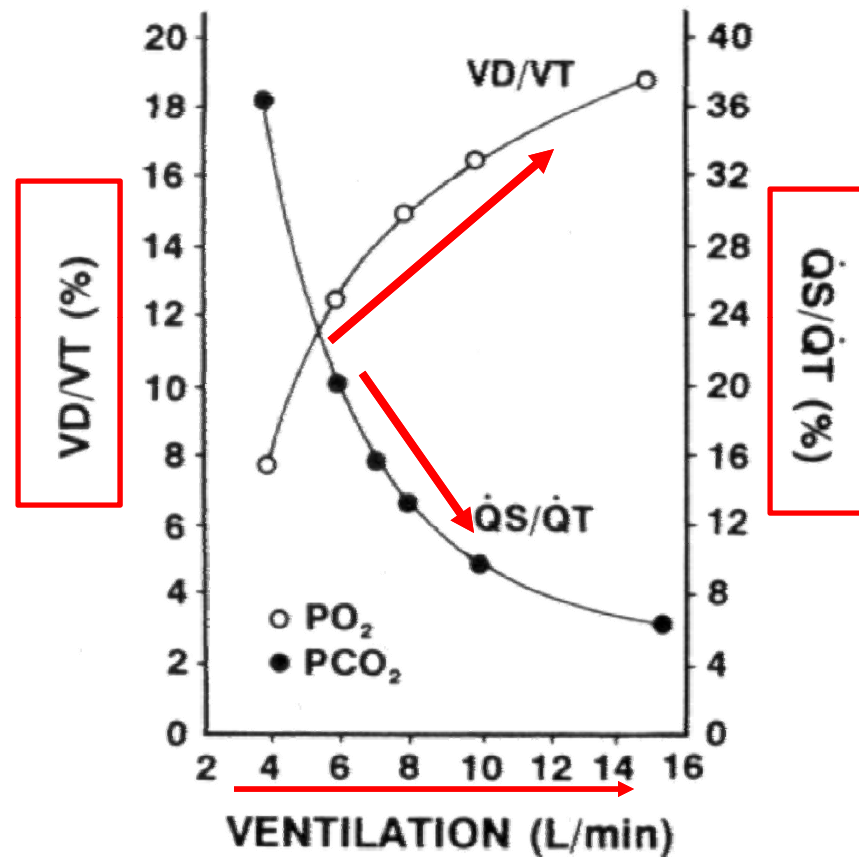
THOMAS J. NUCKTON, M.D., JAMES A. ALONSO, R.R.T., RICHARD H. KALLET, R.R.T., M.S., BRIAN M. DANIEL, R.R.T.,  
JEAN-FRANÇOIS PITTET, M.D., MARK D. EISNER, M.D., M.P.H., AND MICHAEL A. MATTHAY, M.D.

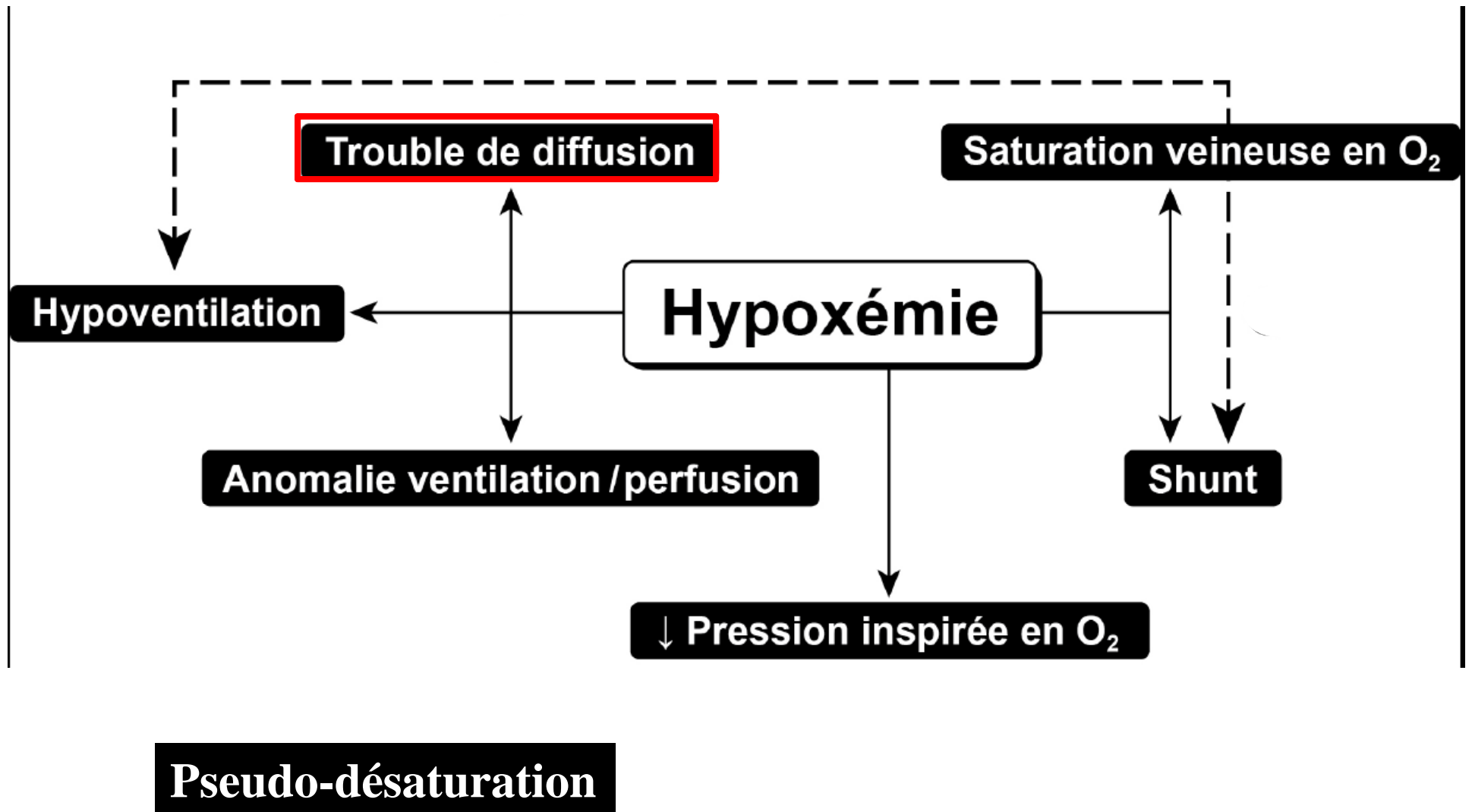


« Elevated value are associated with an increase risk of death »

**Figure 1.** The Observed Mortality According to the Quintile of Dead-Space Fraction in 179 Patients with the Acute Respiratory Distress Syndrome.

# Limitation: shunt et espace mort

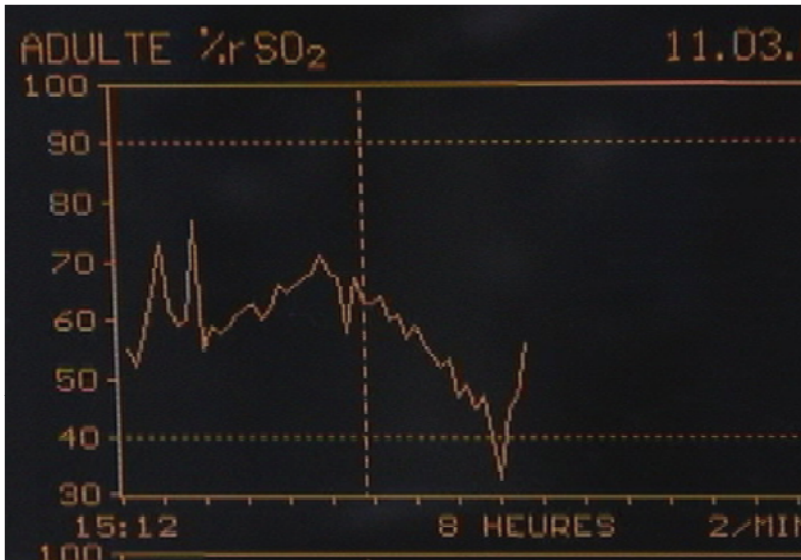




# Effets hémodynamiques de l'hypoxie ?

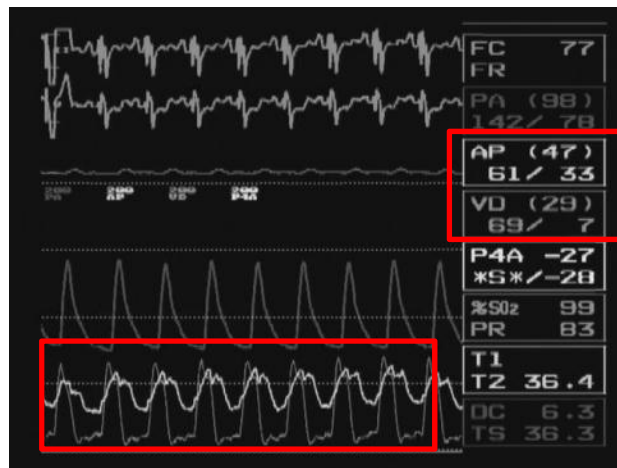
- Hypertension pulmonaire
- Dilatation cavités droites

# Hypoxie et effet hémodynamique



Saturométrie cérébrale

- Homme de 48 ans  
cardiomyopathie ischémique
- Désaturation systémique post-  
CEC et hypertension pulmonaire
- Rx: PEEP et nitroglycérine

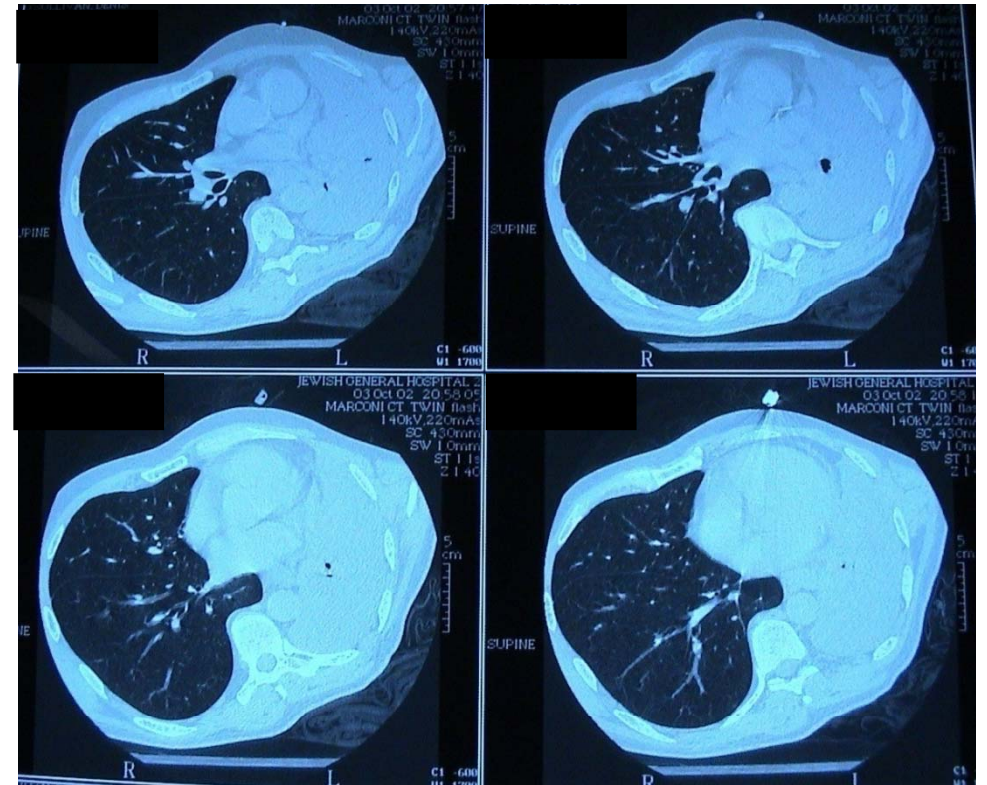
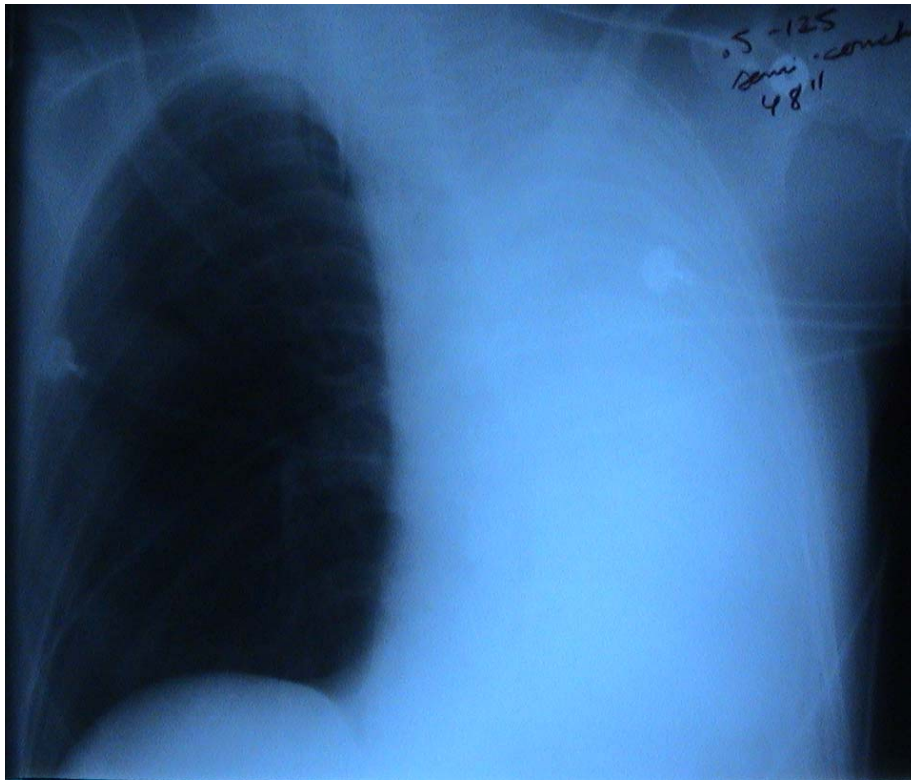


Pendant l'hypoxie



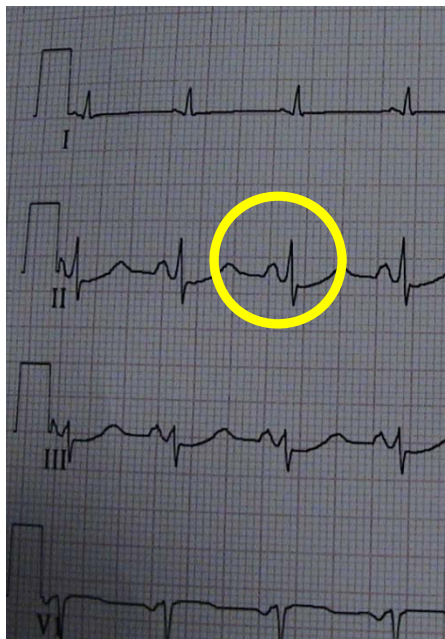
Après hypoxie

# Homme de 57 ans tumeur bronchique: hypoxie per-procédure

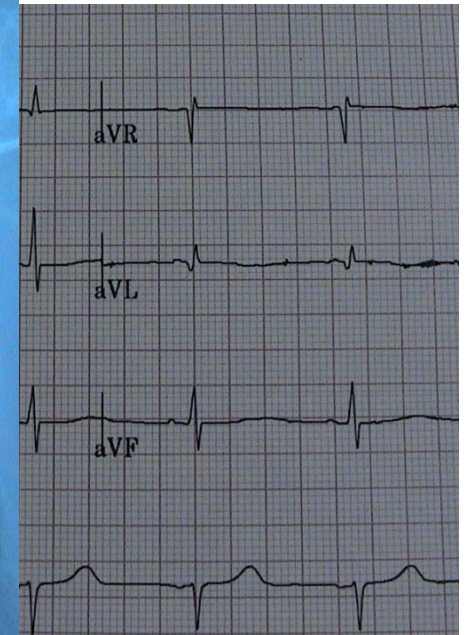
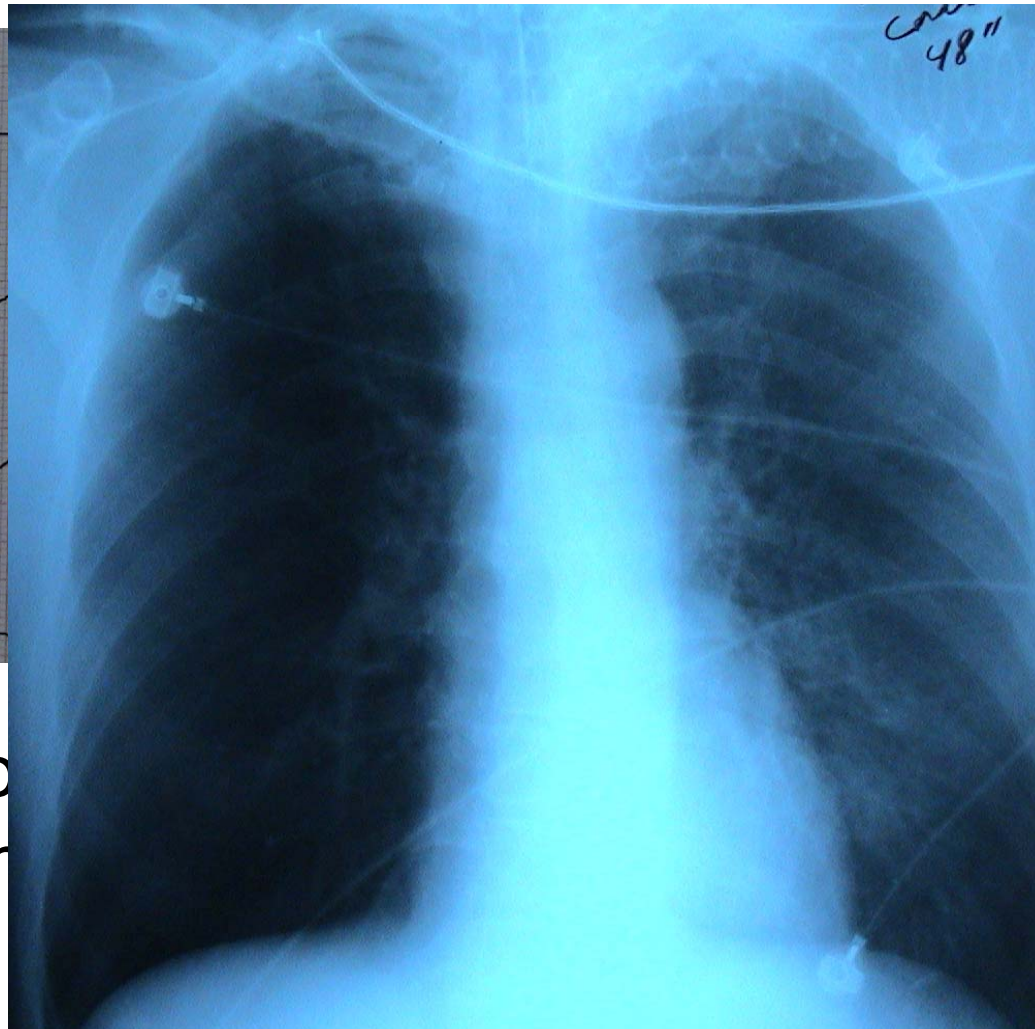




# Homme de 57 ans tumeur bronchique: hypoxie per-procédure



ECG post  
imm



endemain

# Coté obscur de l'oxygénation

- Danger de trop oxygéner
- Hypoperfusion tissulaire malgré saturation normale
- Complications pulmonaires: hypercapnie et atélectasie de résorption



# Association Between Arterial Hyperoxia Following Resuscitation From Cardiac Arrest and In-Hospital Mortality

J. Hope Kilgannon, MD

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Alan E. Jones, MD

---

Nathan I. Shapiro, MD, MPH

---

Mark G. Angelos, MD

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Barry Milcarek, PhD

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Krystal Hunter, MBA

---

Joseph E. Parrillo, MD

---

Stephen Trzeciak, MD, MPH

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for the Emergency Medicine Shock  
Research Network (EMShockNet)

Investigators

# Outcome

**Table 4. Outcomes of Study Patients**

	All Patients (N = 6326)	Hypoxia (n = 3999)	Normoxia (n = 1171)	Hyperoxia (n = 1150)
In-hospital mortality, No. (%) [95% CI] <sup>a</sup>	3561 (56) [55-58]	2297 (57) [56-59]	582 (45) [43-48]	782 (68) [60-66]
Survivors, No. (%)	2765 (44)	1702 (43)	689 (55)	424 (37)
Independent functional status at hospital discharge, No. (%) [95% CI] <sup>b</sup>				
Discharge destination, No. (%)				
Home	1203 (44)	746 (44)	294 (46)	163 (38)
Rehabilitation facility	405 (15)	248 (15)	87 (14)	70 (17)
Nursing home	759 (27)	462 (27)	162 (25)	135 (32)
Transfer to another acute care hospital	91 (3)	64 (4)	13 (2)	14 (3)
Other or unknown	307 (11)	182 (11)	83 (13)	42 (10)

<sup>a</sup> $P < .001$  for both comparison of hyperoxia with normoxia and for hyperoxia with hypoxia.

<sup>b</sup>Defined as able to live at home and requiring no assistance to complete activities of daily living.  $P = .002$  for comparison of hyperoxia with normoxia and  $P = .10$  for comparison of hyperoxia with hypoxia.

# Mortality and O<sub>2</sub>

Mortality also was significantly higher in the hyperoxia group compared with

**Table 5.** Multiple Logistic Regression Model With In-Hospital Mortality as the Dependent Variable<sup>a</sup>

Variable		
Hypoxia exposure	1.3 (1.1-1.5)	.009
Hyperoxia exposure	1.8 (1.5-2.2)	<.001
Active chemotherapy	2.0 (1.0-4.0)	<.001
High heart rate in ICU <sup>b</sup>	1.9 (1.7-2.1)	<.001
Hypotension at ICU arrival <sup>c</sup>	2.1 (1.9-2.3)	<.001
Hypoxia exposure	1.3 (1.1-1.5)	.009
Hyperoxia exposure	1.8 (1.5-2.2)	<.001

Abbreviations: CI, confidence interval; ICU, intensive care unit; OR, odds ratio.

<sup>a</sup>Event rates (mortality) for each variable and for the relevant reference group appear in eTable 2 at <http://www.jama.com>. The following variables were removed from the model because of nonsignificance: female sex, OR, 1.1 (95% CI, 1.0-1.2; *P* = .29); chronic respiratory disease, OR, 1.3 (95% CI, 1.0-1.6; *P* = .05); human immunodeficiency virus, OR, 1.9 (95% CI, 1.0-3.7; *P* = .06); and requiring inotropic therapy, OR, 1.1 (95% CI, 0.9-1.3; *P* = .19).

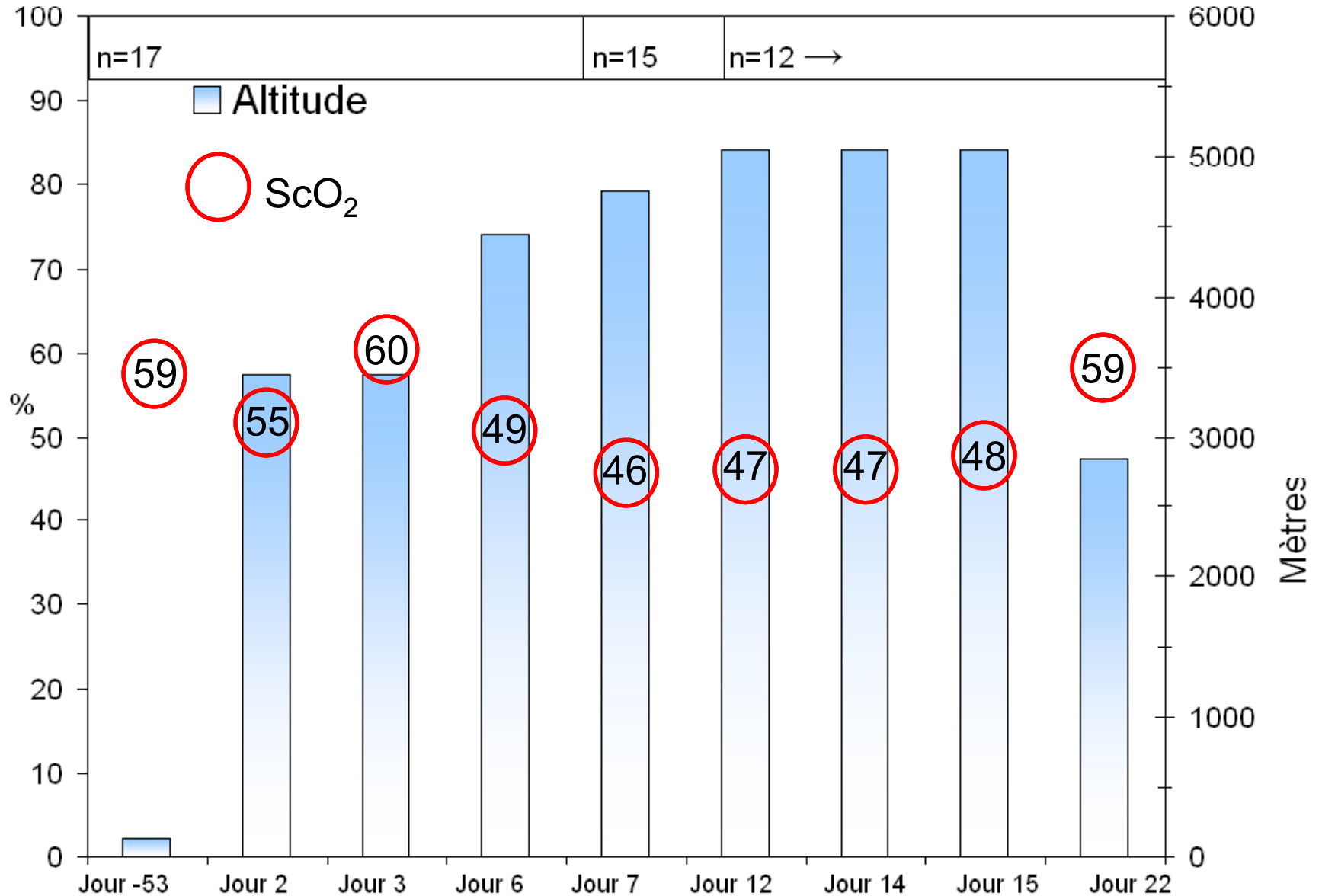
<sup>b</sup>Indicates the highest value for first 24 hours in the ICU (1 = exceeds median; 0 = median or lower).

<sup>c</sup>Defined as any systolic blood pressure of less than 90 mm Hg within 1 hour of ICU arrival.<sup>14</sup>

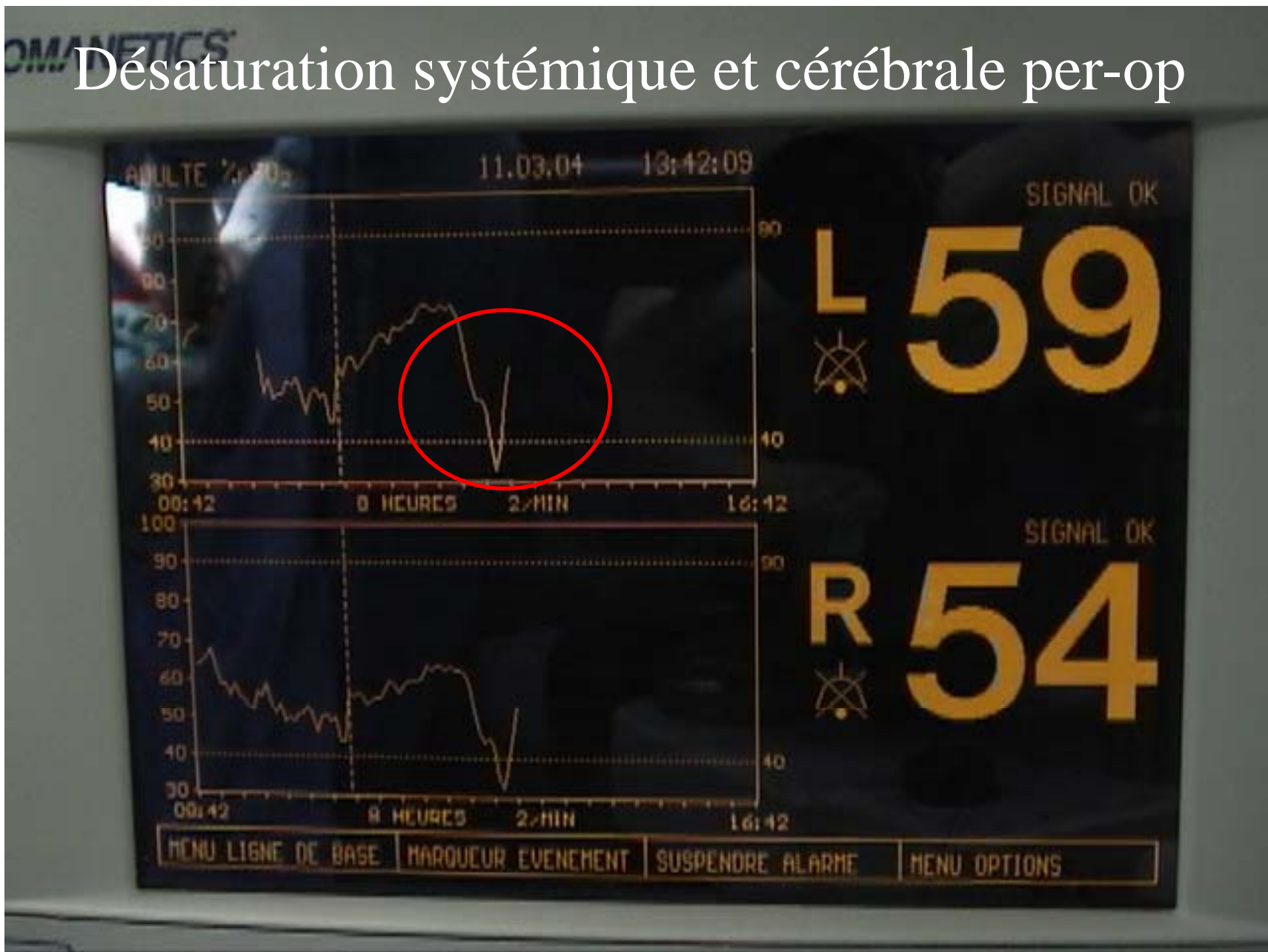
# **Noninvasive assessment of cerebral oxygenation during high altitude trekking in the Nepal Himalayas (2850–5600 m)**



# High Altitude and rSO<sub>2</sub>

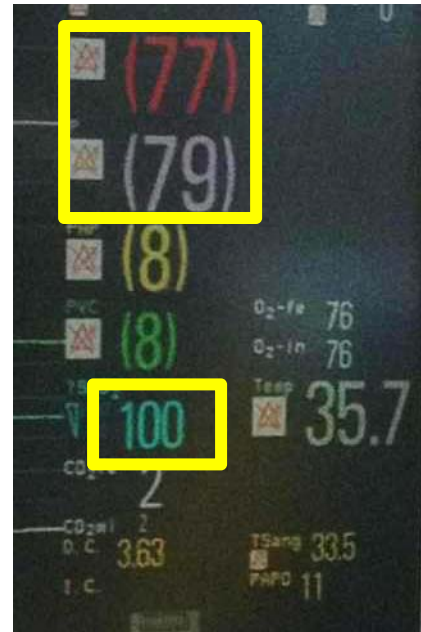


# Désaturation systémique et cérébrale per-op





♂ de 80 ans  
(16 Septembre 2011)



# **The Effect of Supplemental Oxygen on Hypercapnia in Subjects With Obesity-Associated Hypoventilation**

## **A Randomized, Crossover, Clinical Study**

Meme Wijesinghe, MBBS, Mathew Williams, DipExSci, Kyle Perrin, PhD,  
Mark Weatherall, MBChB and Richard Beasley, DSc

24 patients apnée du sommeil

Effet de 100% de  $\text{FiO}_2$  X 20 minutes (2 visites)

### **Résultats:**

↑  $\text{ETCO}_2$  de 5 mmHg

Baisse de 1.4 litres de VM

Augmentation espace mort

En anesthésie...

# Inspiratory Oxygen Fraction and Postoperative Complications in Obese Patients

## *A Subgroup Analysis of the PROXI Trial*

Anne K. Staehr, M.D.,\* Christian S. Meyhoff, M.D., Ph.D.,†  
Lars S. Rasmussen, M.D., Ph.D., D.M.Sc.,‡ PROXI Trial Group

### What We Already Know about This Topic

- In the Danish multicenter PROXI Trial involving 1,400 patients, no significant reduction in surgical site infection was observed when 80% oxygen was given during and 2 h after abdominal surgery compared with use of 30% oxygen in all patients, although obese patients may be at high risk

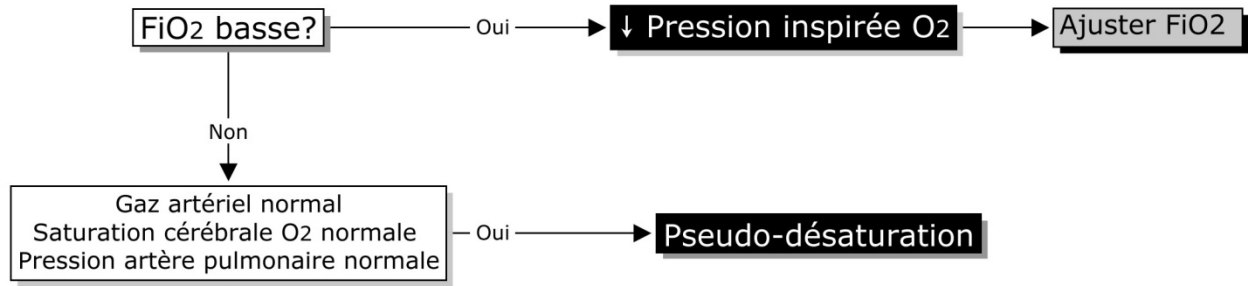
### What This Article Tells Us That Is New

- In this planned analysis of the obese subgroup (body mass index  $\geq 30$  kg/m<sup>2</sup>, n = 231) of the PROXI Trial, there was no significant difference in the frequency of surgical site infection or postoperative pulmonary complications

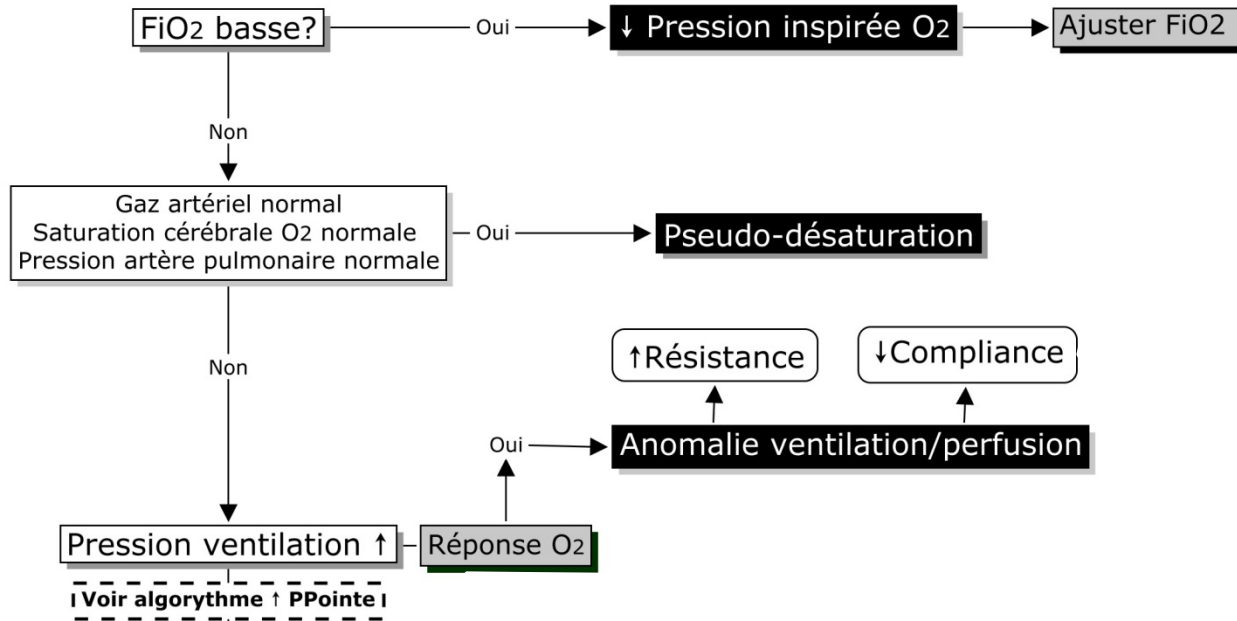
# Désaturation aiguë



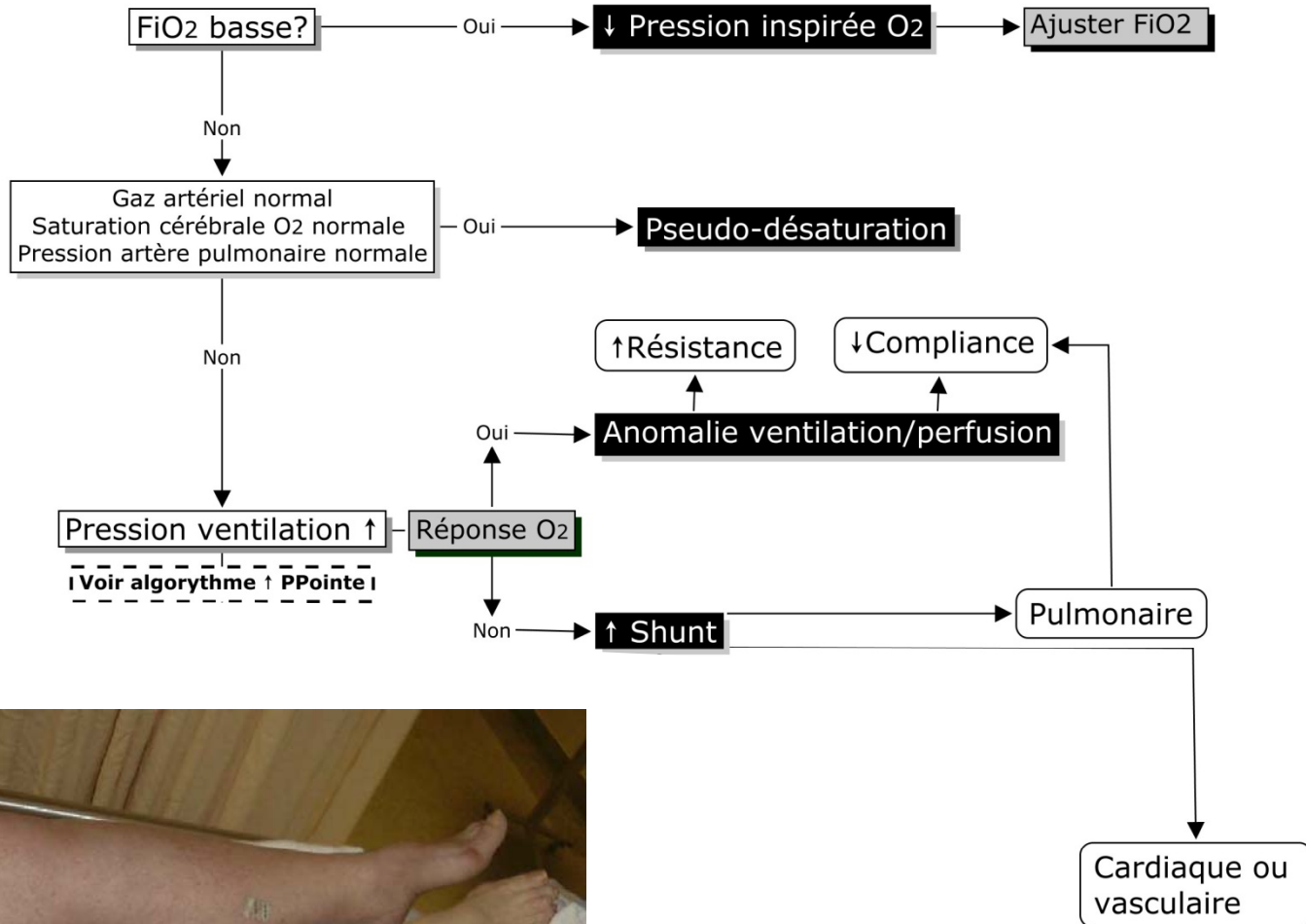
# Désaturation aiguë



# Désaturation aiguë

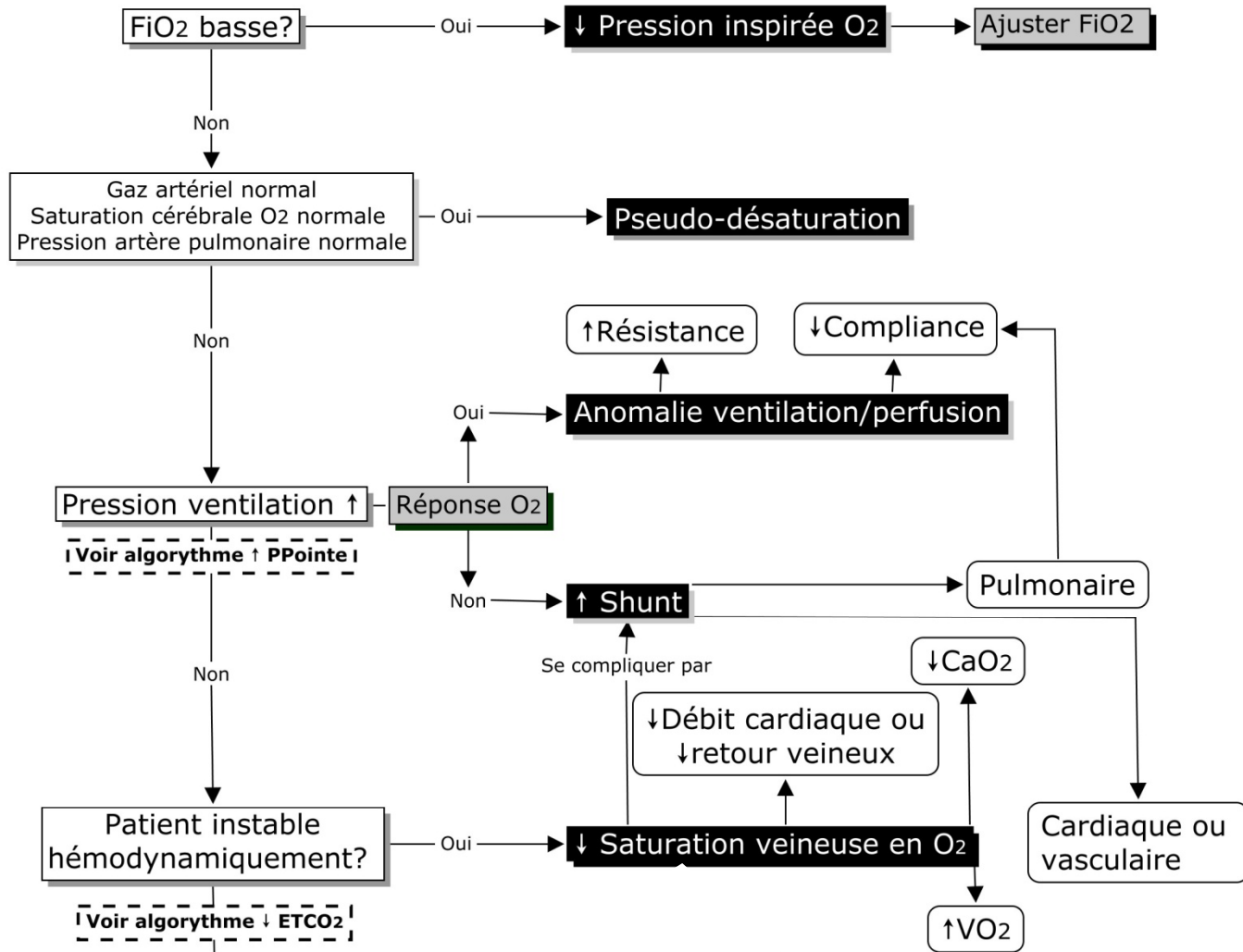


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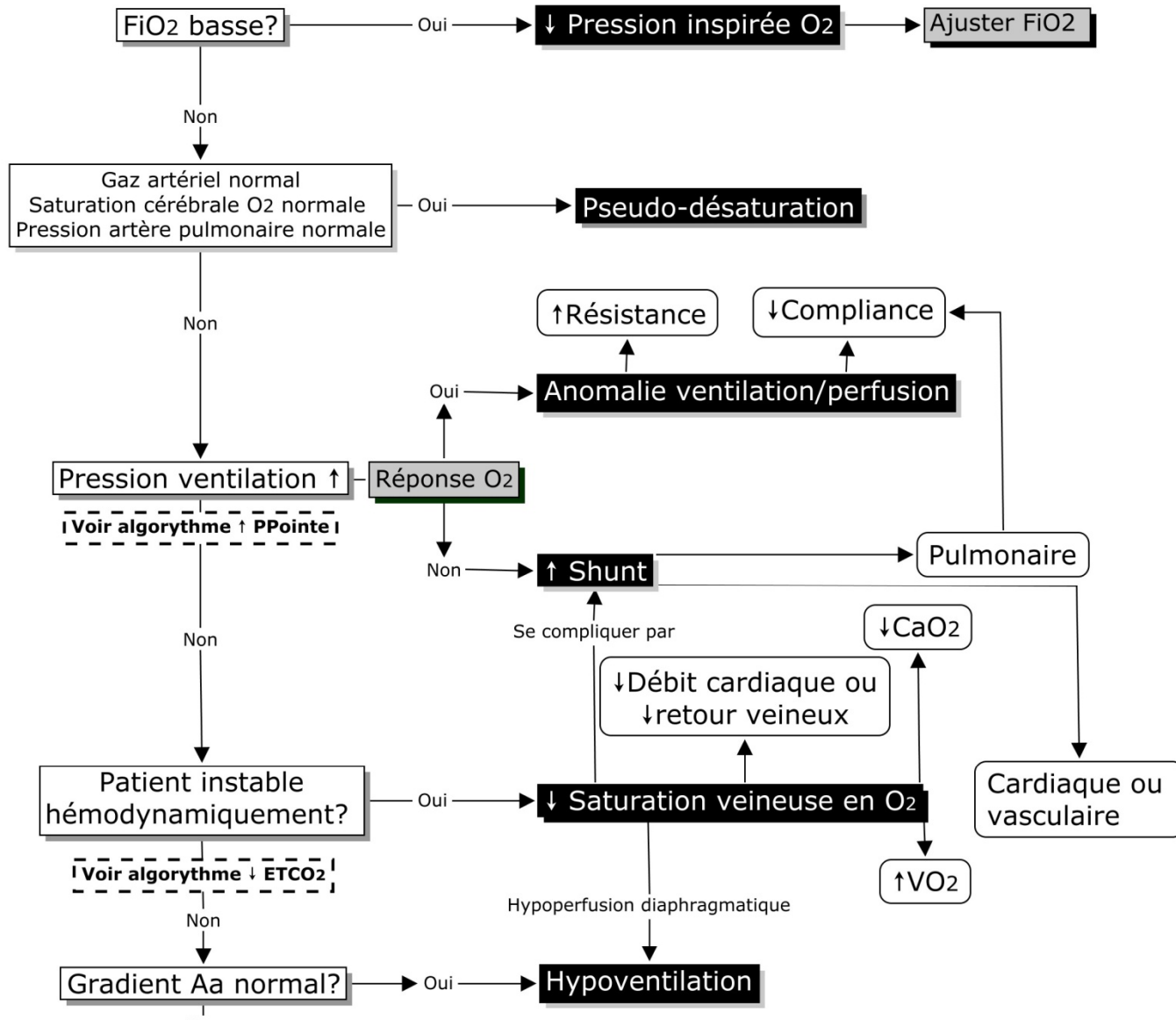




# Désaturation aiguë

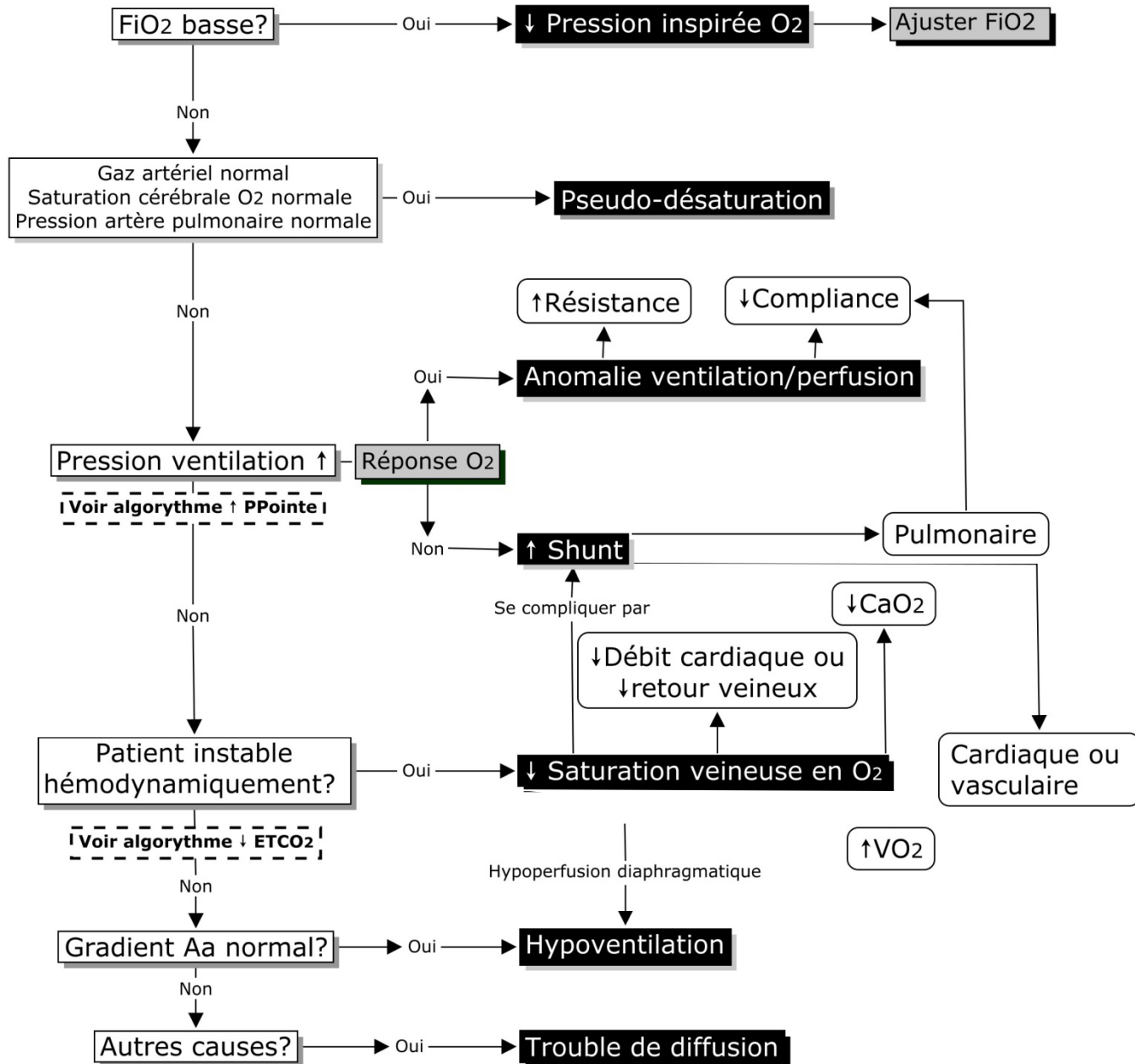


# Désaturation aiguë



# Désaturation aiguë

Une fois corrigé: SaO2 entre 92-94%



Pause

# Monitoring respiratoire

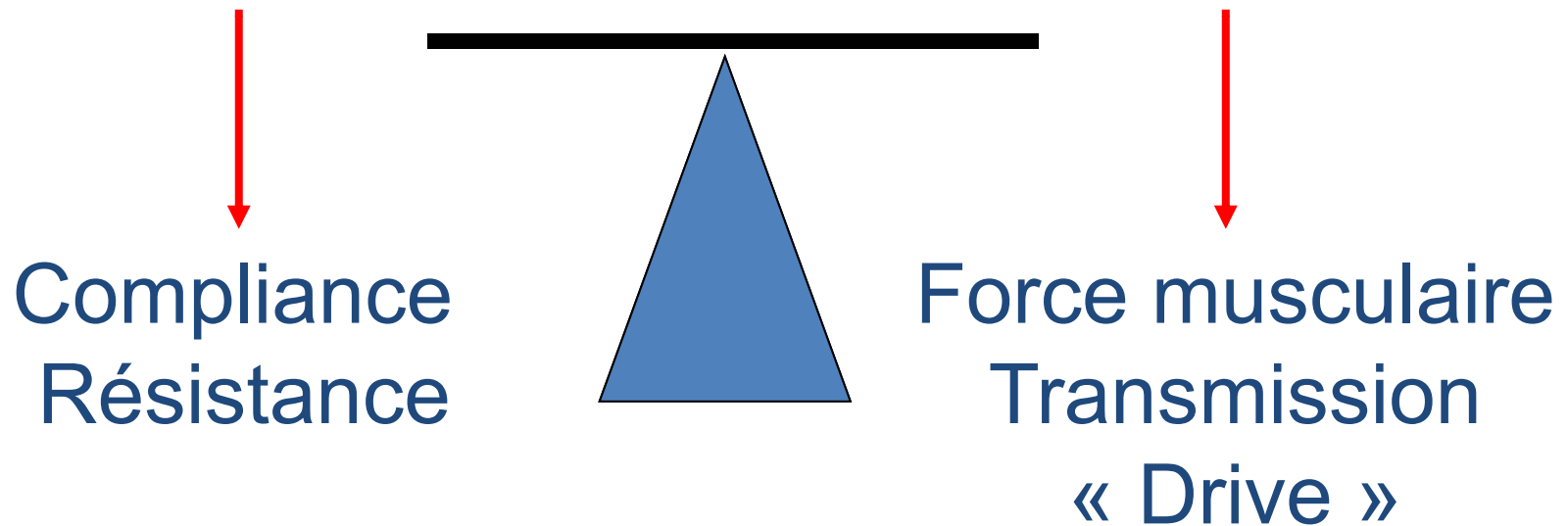
## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire

# Charge et capacité du système respiratoire

Charge du système respiratoire

Compétence neuro-musculaire



Comment évaluer la force musculaire respiratoire?

# Force musculaire

Force inspiratoire maximale	= $115 \pm 27$ cm H <sub>2</sub> O
Force expiratoire maximale	= $180 \pm 40$ cm H <sub>2</sub> O
Capacité vitale	= 65 - 75 ml/kg

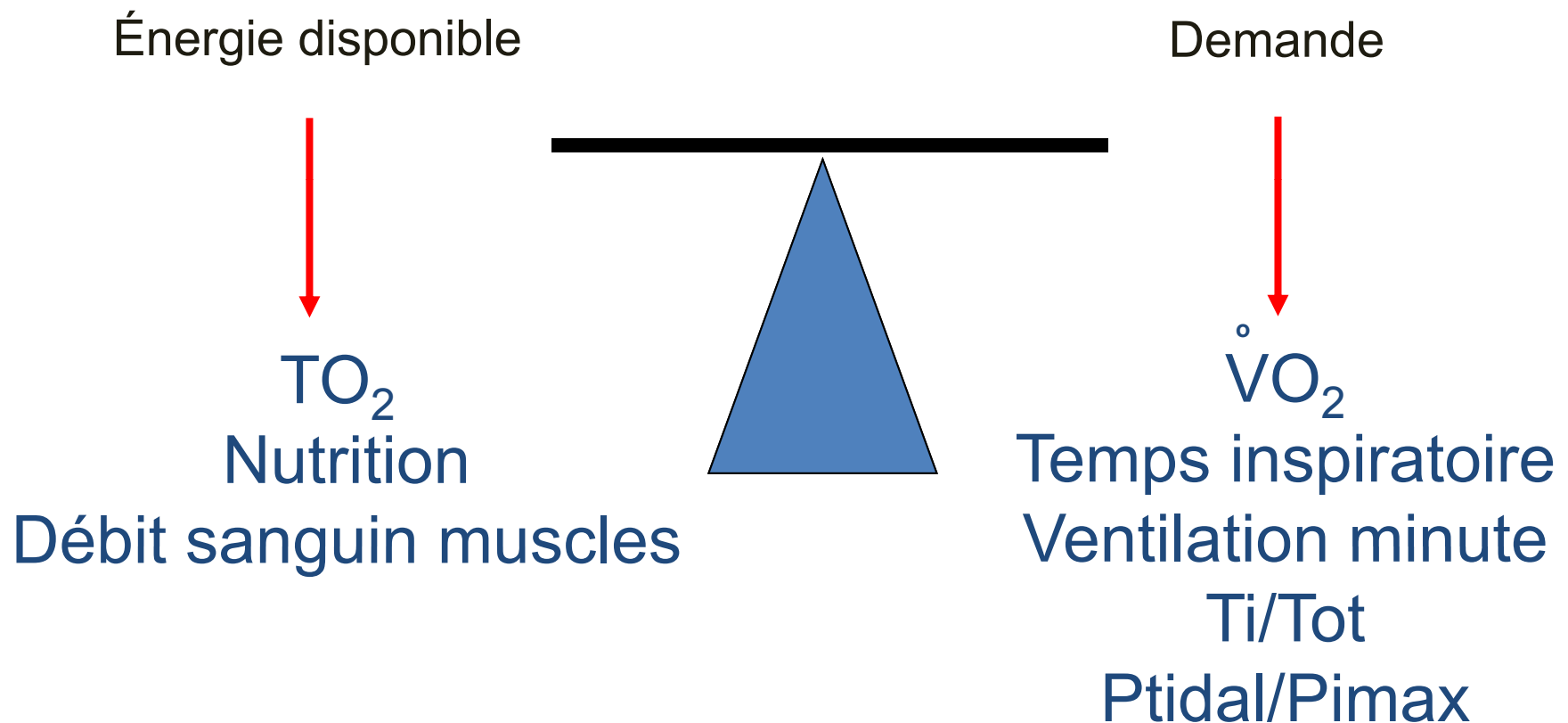
Hypercapnie lorsque la  $Fi_{Max}$  est diminuée à 30%  
Critères d'intubation pour myasthénie ou GBS

## Règle 20-30-40

- capacité vitale < 20 ml/kg
- force inspiratoire maximale < 30 cm H<sub>2</sub>O
- force expiratoire maximale < 40 cm H<sub>2</sub>O



# Charge et capacité du système respiratoire

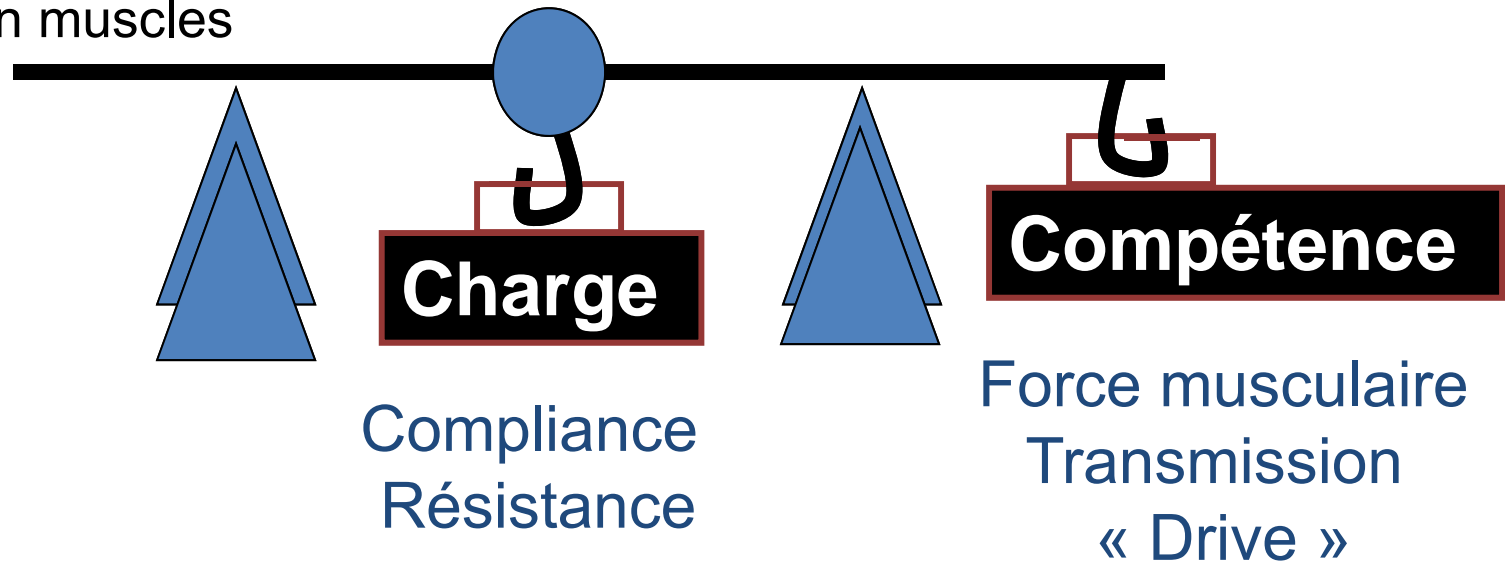


# Demande

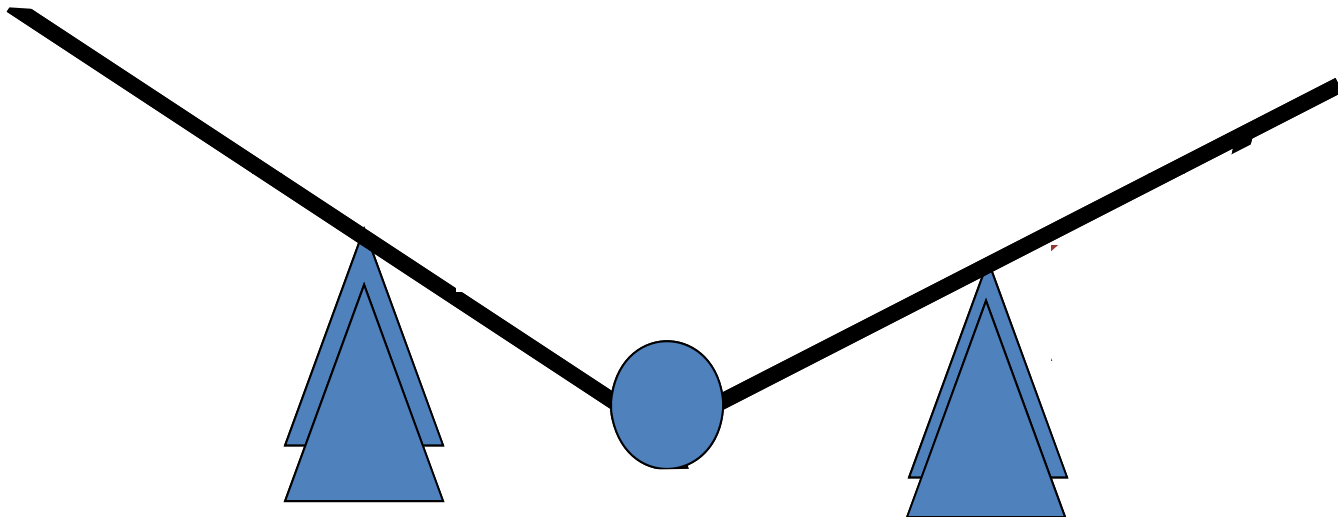
Énergie  
disponible

$TO_2$   
Nutrition  
Débit sanguin muscles

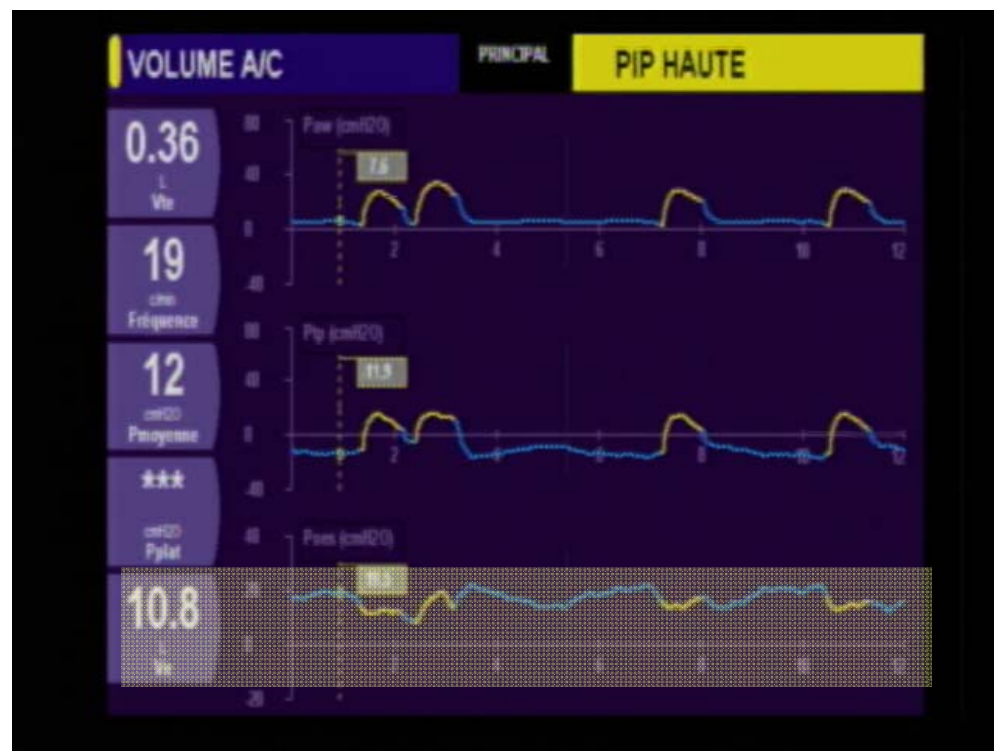
$VO_2$   
Temps inspiratoire  
Ventilation minute  
 $Ti/Tot$   
 $P_{tidal}/P_{imax}$



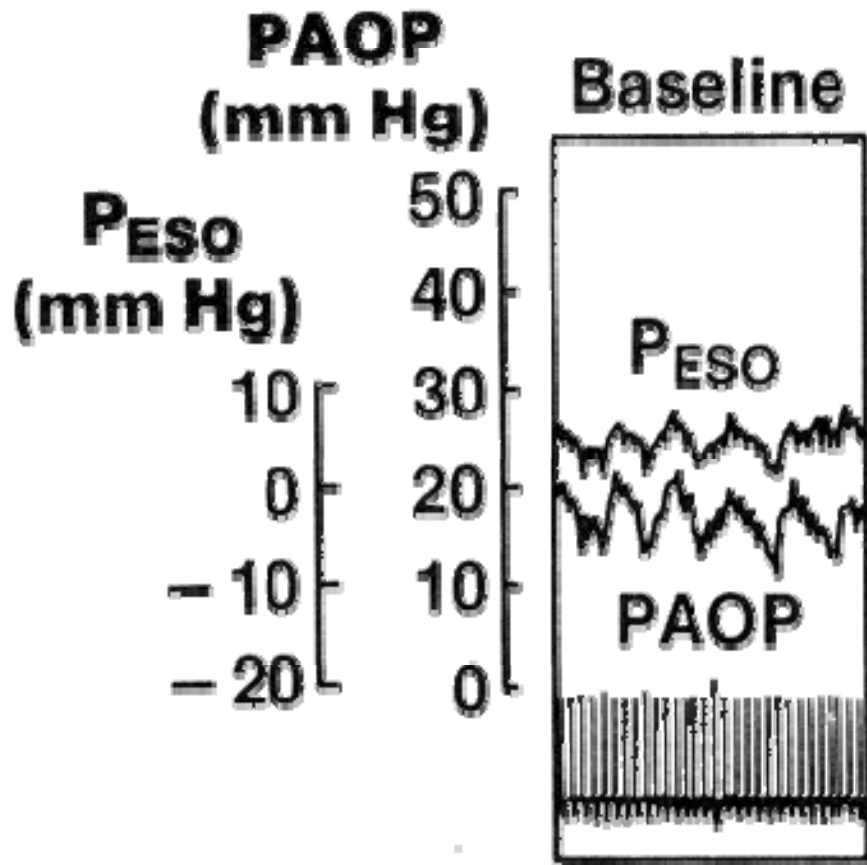
# Insuffisance respiratoire



# Mesure de la pression esophagienne



# OAP post-extubation?



*SV = spontaneous ventilation*

# The Oxygen Cost of Breathing in Patients with Cardiorespiratory Disease<sup>1-3</sup>

S. FIELD, S.M. KELLY, and P.T. MACKLEM

## Introduction

In normal subjects breathing quietly, the oxygen cost of breathing ( $\dot{V}O_{2,resp}$ ) is a small proportion of the total oxygen requirement ( $\dot{V}O_{2,tot}$ ). Although estimates of the magnitude of  $\dot{V}O_{2,resp}$  vary considerably (1-6), it is usually less than 5% of  $\dot{V}O_{2,tot}$ .

The  $\dot{V}O_{2,resp}$  increases with increasing levels of ventilation (1, 4, 5, 7) because of the increase in power output of the respiratory muscles. Obstructive and restrictive lung disease will elevate  $\dot{V}O_{2,resp}$  for the same reason (3, 4, 8). In addition, decreased respiratory muscle efficiency, caused by alterations in resting muscle length and isometric contraction of some muscles, will

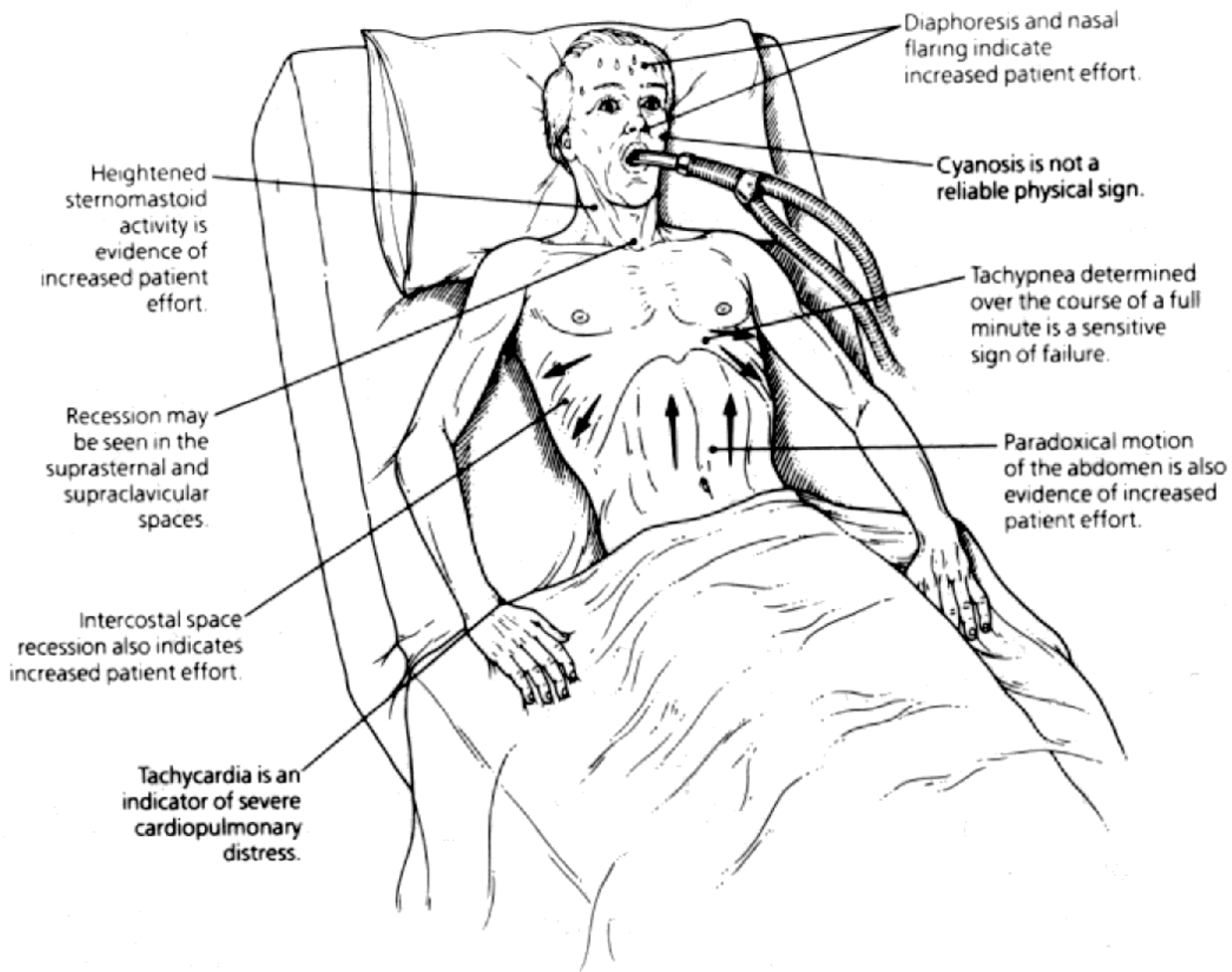
**SUMMARY** We measured the oxygen cost of breathing ( $\dot{V}O_{2,resp}$ ) in 13 patients with cardiorespiratory disease requiring artificial ventilation as the difference between the oxygen consumption during spontaneous respiration ( $\dot{V}O_{2,tot}$ ) and that during artificial ventilation ( $\dot{V}O_{2,nonresp}$ ). Average  $\dot{V}O_{2,tot}$  was  $312 \pm 90$  ml/min (mean  $\pm$  1 SD), whereas  $\dot{V}O_{2,nonresp}$  was  $246 \pm 38$  ml/min ( $p < 0.01$ ). Average  $\dot{V}O_{2,resp}$  was  $75 \pm 82$  ml/min (range, 8 to 286), representing 24% of  $\dot{V}O_{2,tot}$  or  $8.7 \pm 8.9$  ml  $O_2$ /L ventilation. In normal resting adults,  $\dot{V}O_{2,resp}$  is 5 to 10 ml/min, about 1 to 3%  $\dot{V}O_{2,tot}$ , or 0.25 to 2.5 ml  $O_2$ /L ventilation. The  $\dot{V}O_{2,resp}$  had an exponential relationship with FEV<sub>1</sub> ( $r=0.97$ ) in 6 patients who had had prior spirometry. Because minute ventilation was normal in our patients ( $8.8 \pm 2.2$  L/min), the elevated  $\dot{V}O_{2,resp}$  represented an increase in the work of breathing as well as a decrease in the efficiency of the respiratory muscles. These results suggest that, where  $O_2$  transport is compromised, artificial ventilation may release substantial quantities of oxygen for use by other body systems.

AM REV RESPIR DIS 1982; 126:9-13

tion and that with the patient relaxed during artificial ventilation, therefore, is a reasonable estimate of the  $\dot{V}O_{2,resp}$ . Several investigators (8, 11-14)

whether such an increase was due to a greater minute ventilation, an increased work of breathing, or both.

Défaillance et arrêt cardiaque précédé par l'arrêt respiratoire





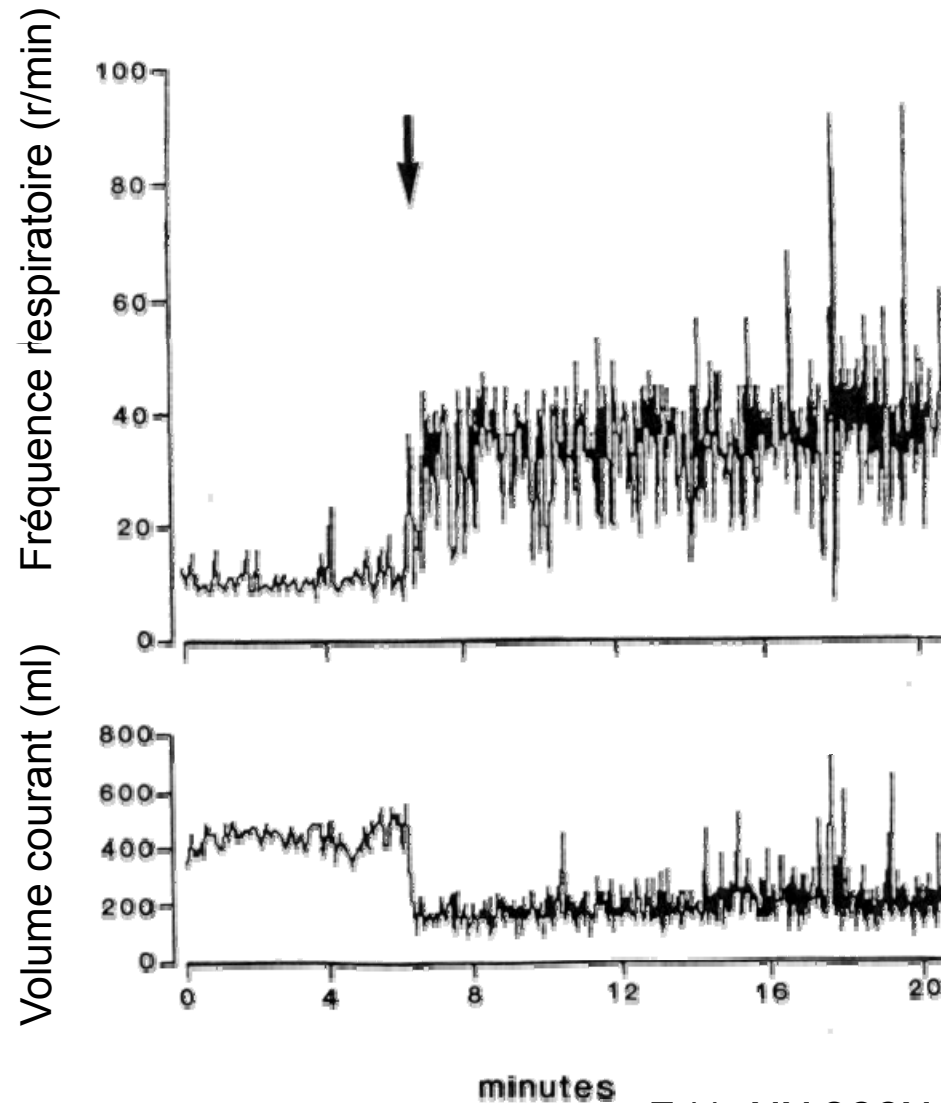


# LE SUPPORT VENTILATOIRE NON-INVASIF

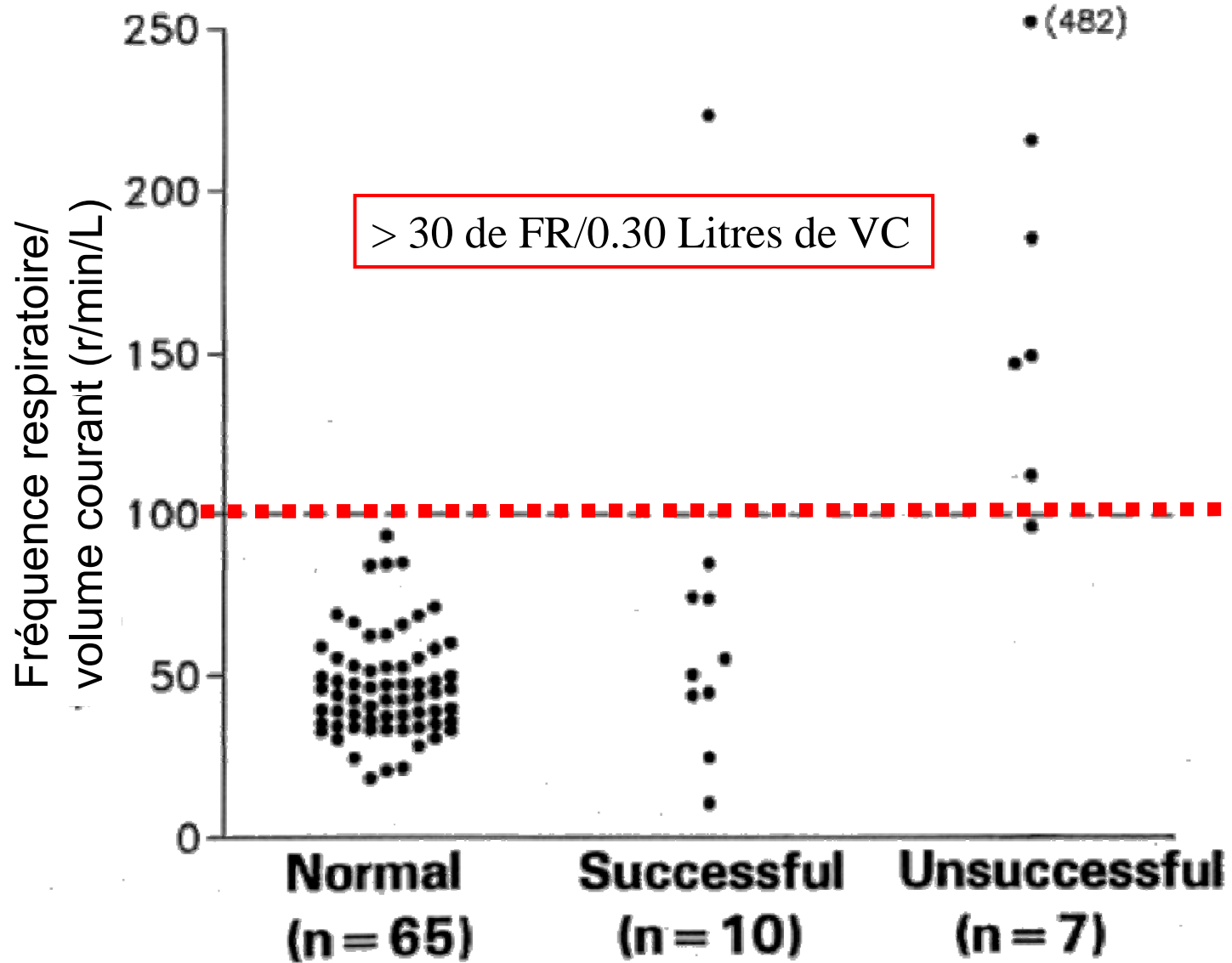
Pierre Aslanian, MD FRCPC  
Intensiviste, Hôpital Saint-Luc



# Pourquoi ce patient n'a pas toléré le sevrage du ventilateur?



# Index de Tobin

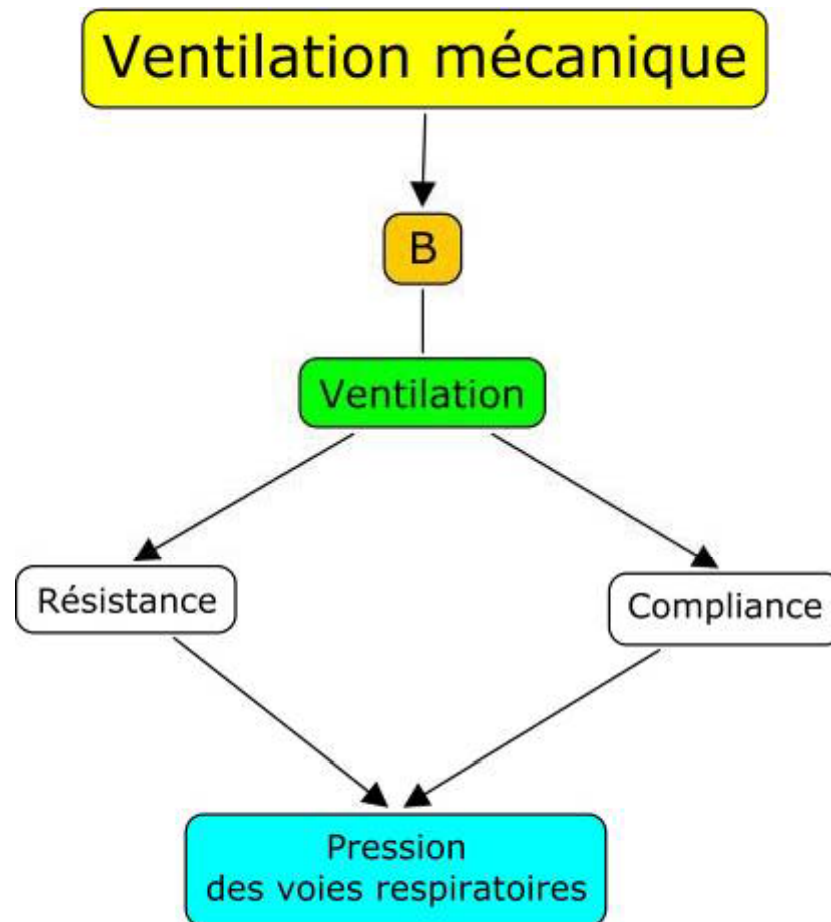


# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire
  - Compliance
  - Résistance
  - Auto-PEEP
  - Ratio I:E

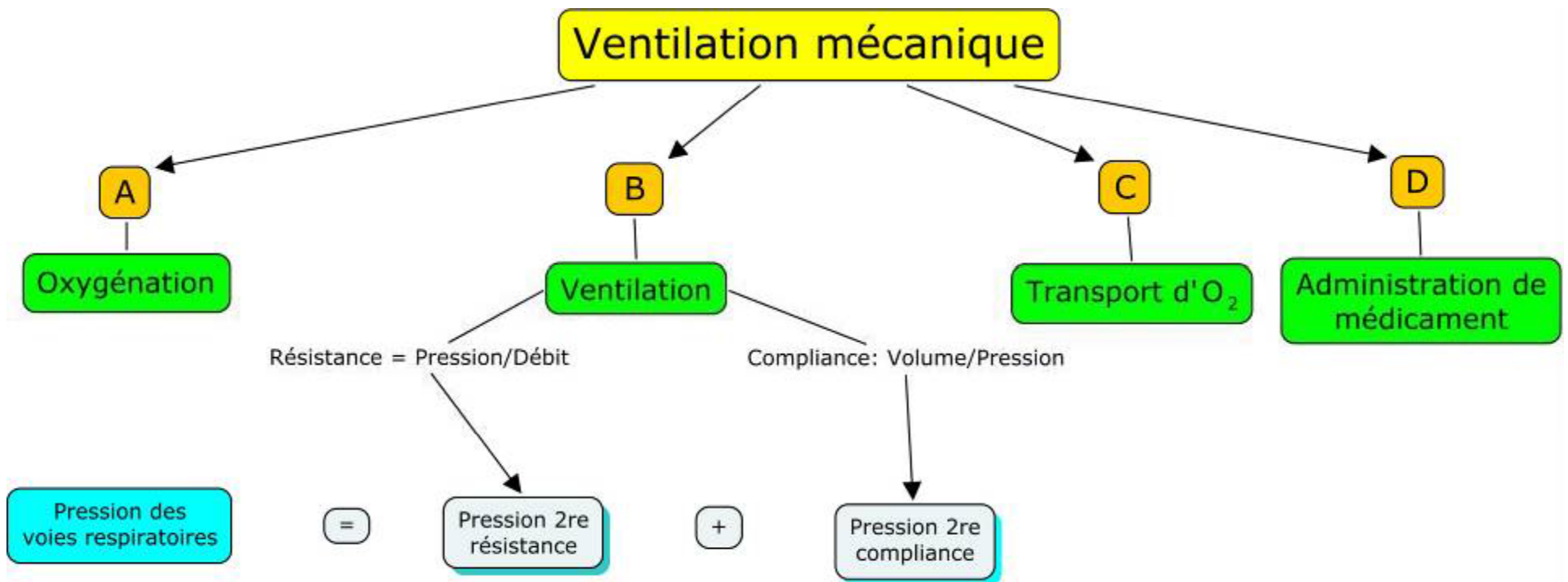
# Les 2 variables importantes en ventilation mécanique



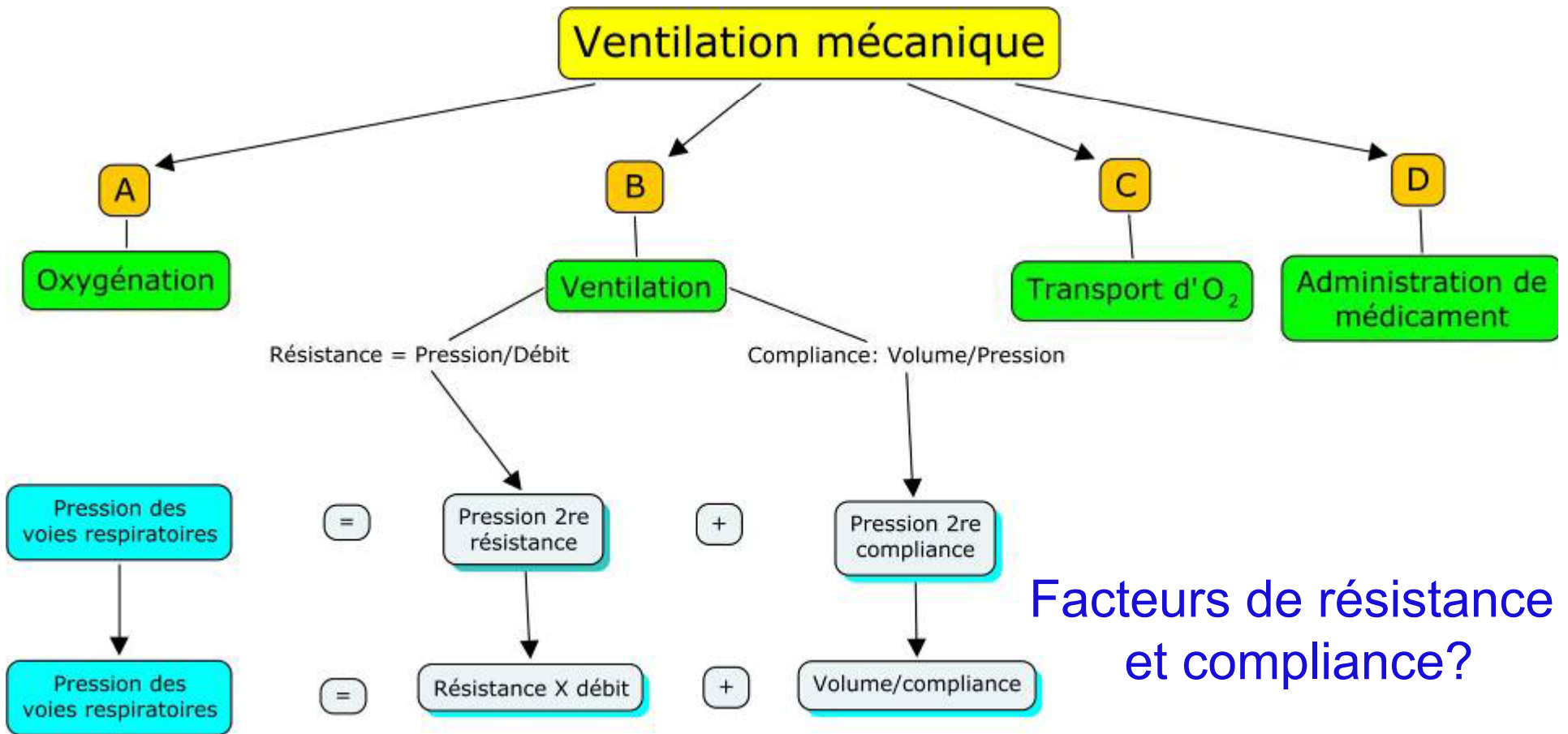
# Équation du système respiratoire

- Pression voies aériennes = somme
  - 1-Pression élastique: élastance ou compliance  
(= Volume/Pression)
  - 2-Pression résistive: résistance  
( = Pression/Débit)
  - 3-PEEP et auto-PEEP
  - 4-Pression 2<sup>aire</sup> à l'inertie
- $P_{va} = \text{Volume/Compliance} + \text{Résistance} \times \text{Débit}$
- $P_{va} = \text{Élastance} \times \text{Volume} + \text{Résistance} \times \text{Débit}$

# Déterminants de la pression des voies respiratoires

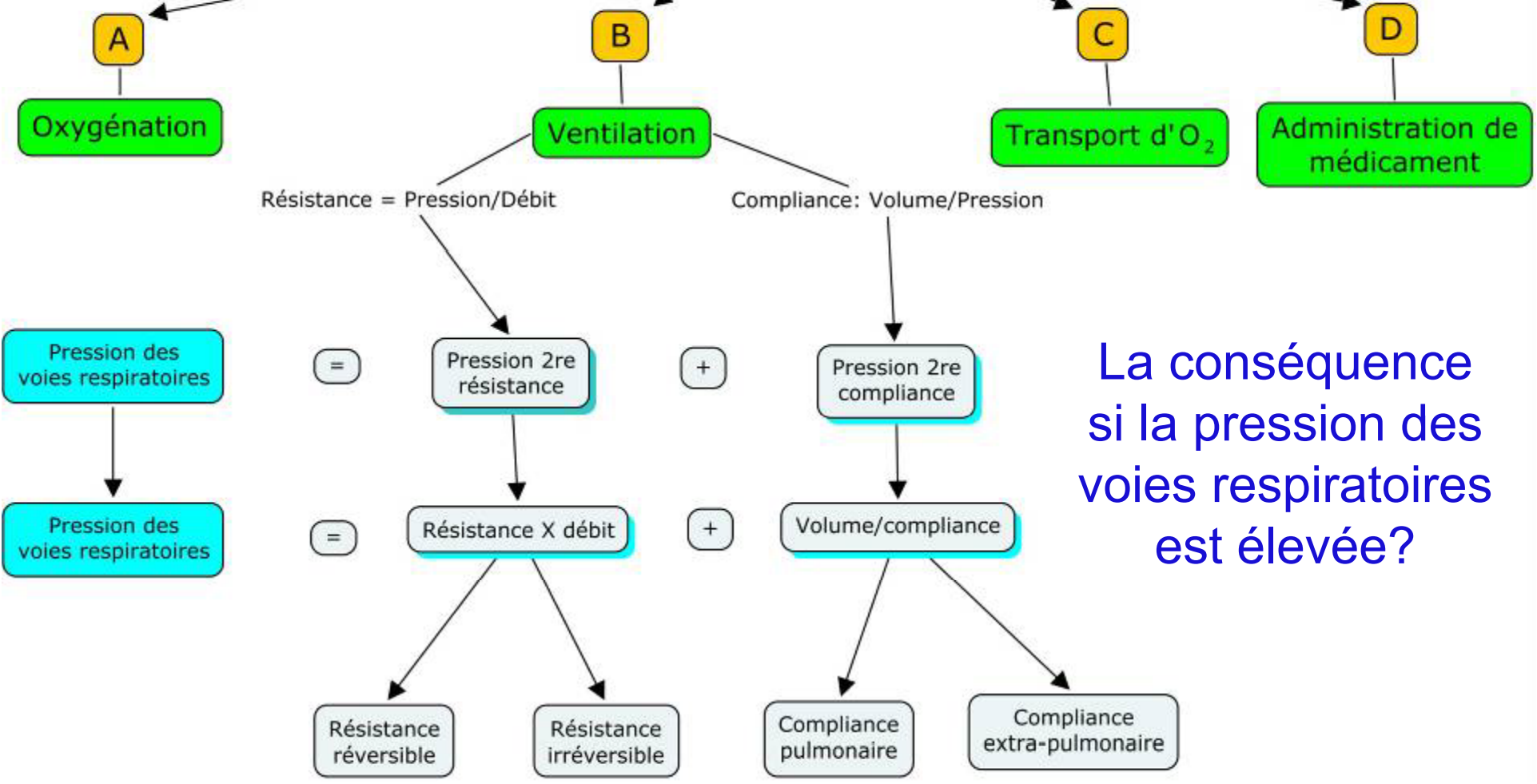


# Autrement dit...



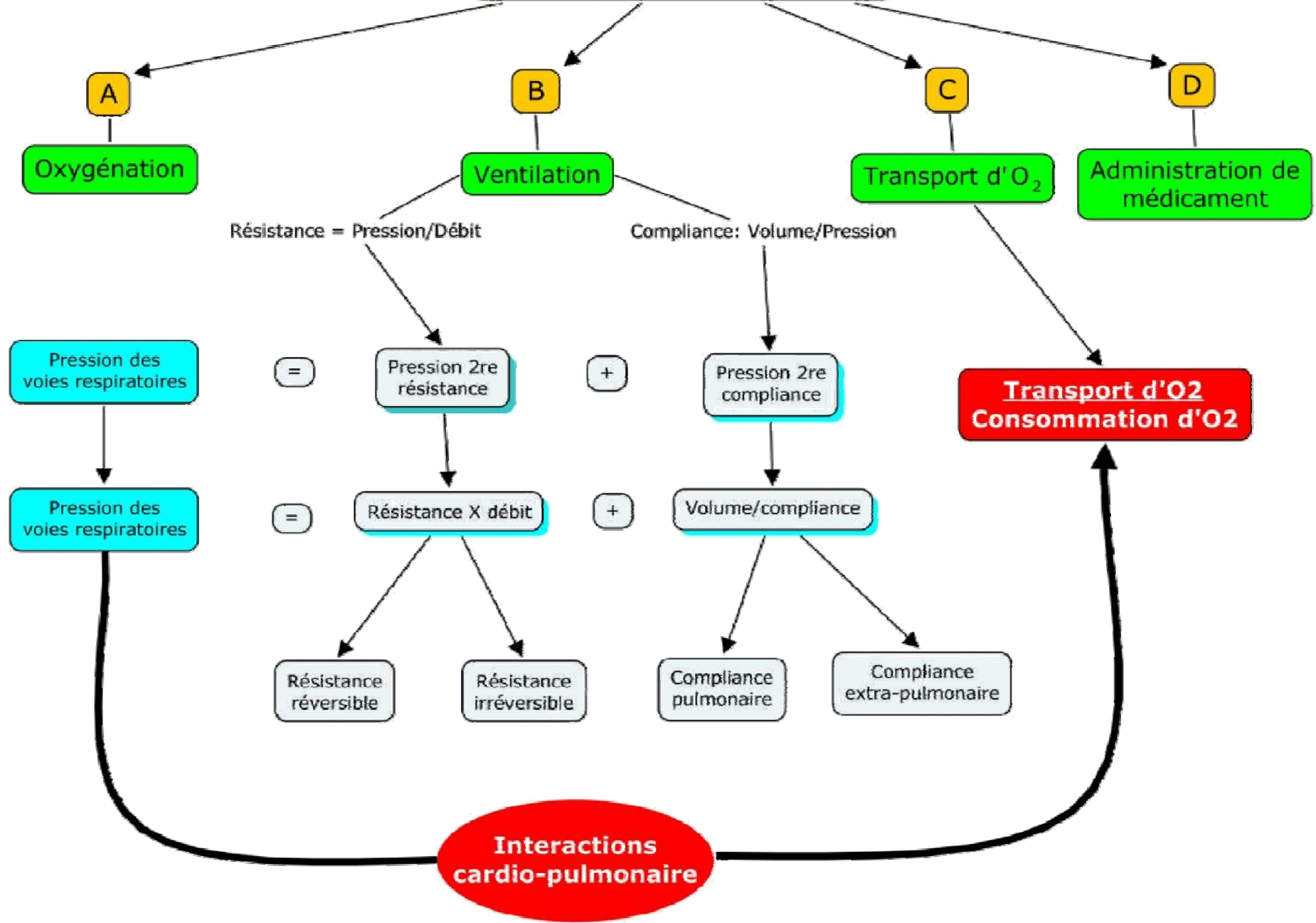


# Ventilation mécanique



La conséquence si la pression des voies respiratoires est élevée?

# Ventilation mécanique



# Paramètres ventilateurs

## Paramètres réglés

- 1-Mode
- 2-Volume courant
- 3-Fréquence
- 4-Débit inspiratoire et ratio I:E
- 5-PEEP et  $FiO_2$

## Paramètres mesurés

- 1-Compliance
- 2-Résistance
- 3-Saturation artérielle et cérébrale
- 4- $CO_2$  expiré

# Constante de temps

« La constante de temps est la relation existant entre le contenant et le débit qui lui est associé »

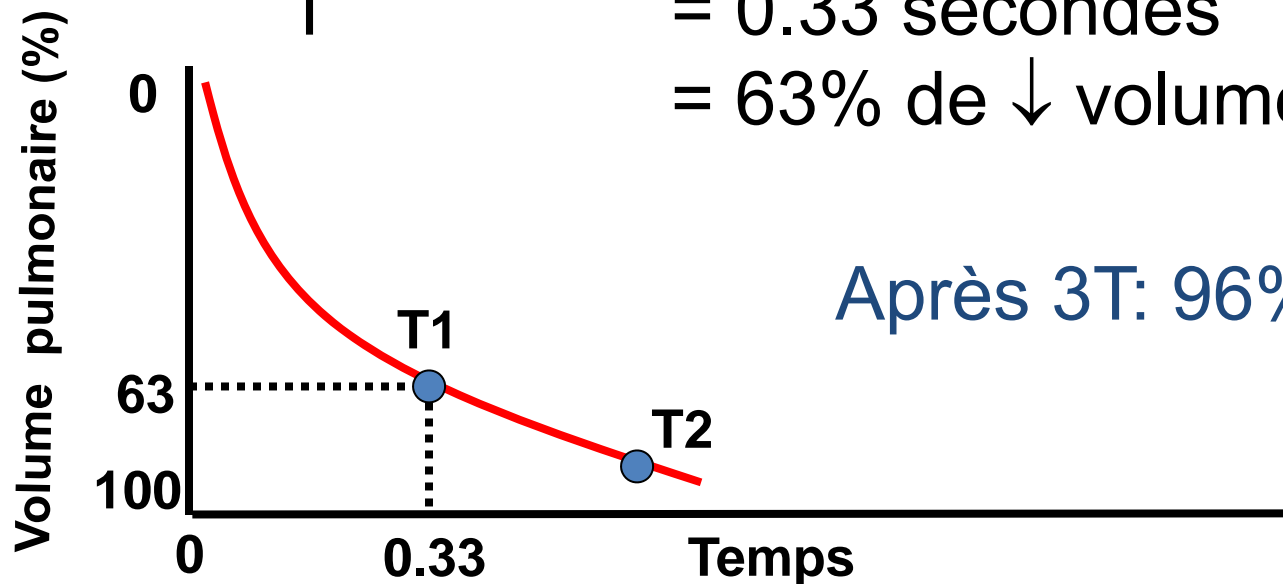
$$T = R \times C$$

si R vrs = 10 cm H<sub>2</sub>O/L/sec

si Cst = 33 ml/cm H<sub>2</sub>O

T = 0.33 secondes

= 63% de ↓ volume pulmonaire



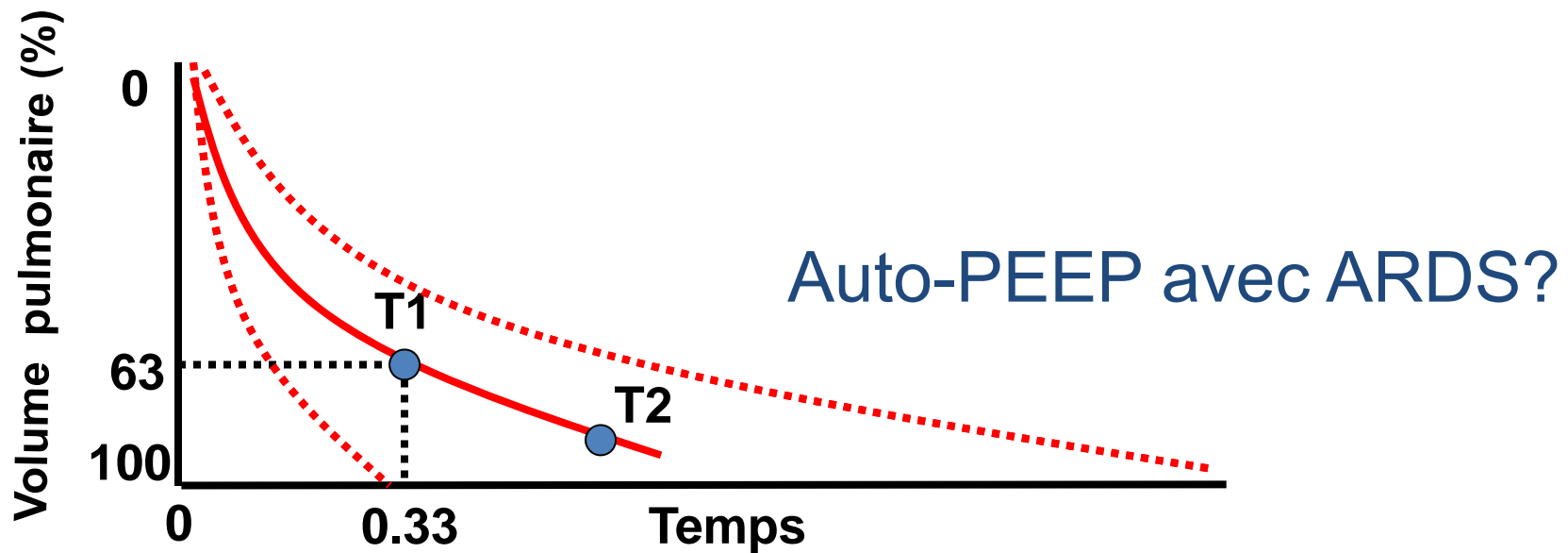
# Constante de temps

« La constante de temps est la relation existant entre le contenant et le débit qui lui est associé »

$\tau = R \times C$

Si  $\downarrow R$  ou  $\downarrow C$

Si  $\uparrow R$  ou  $\uparrow C$

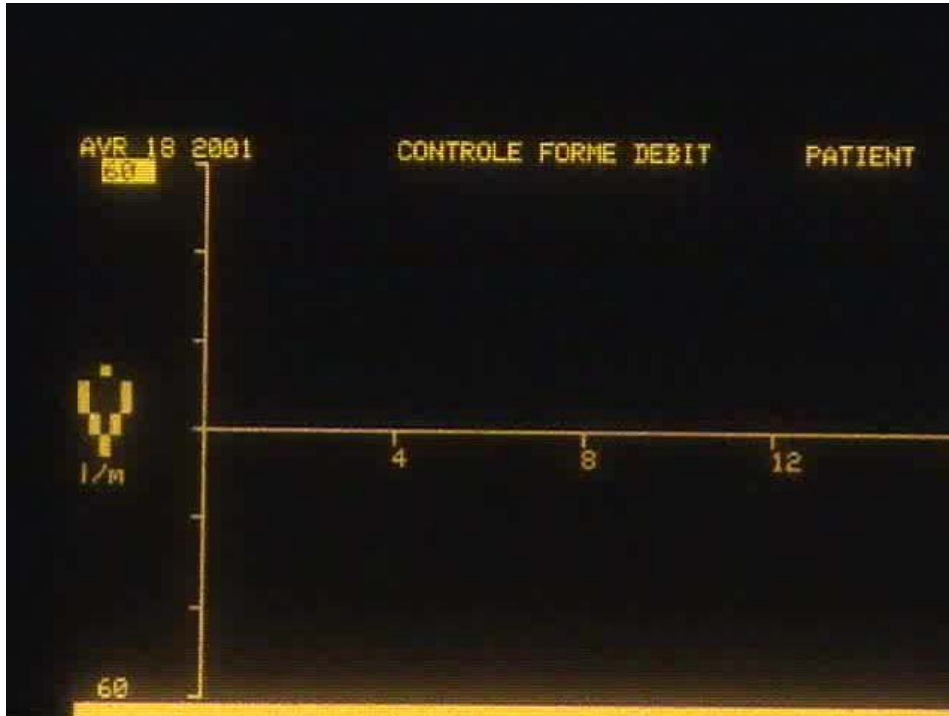


# Mécanique du système respiratoire

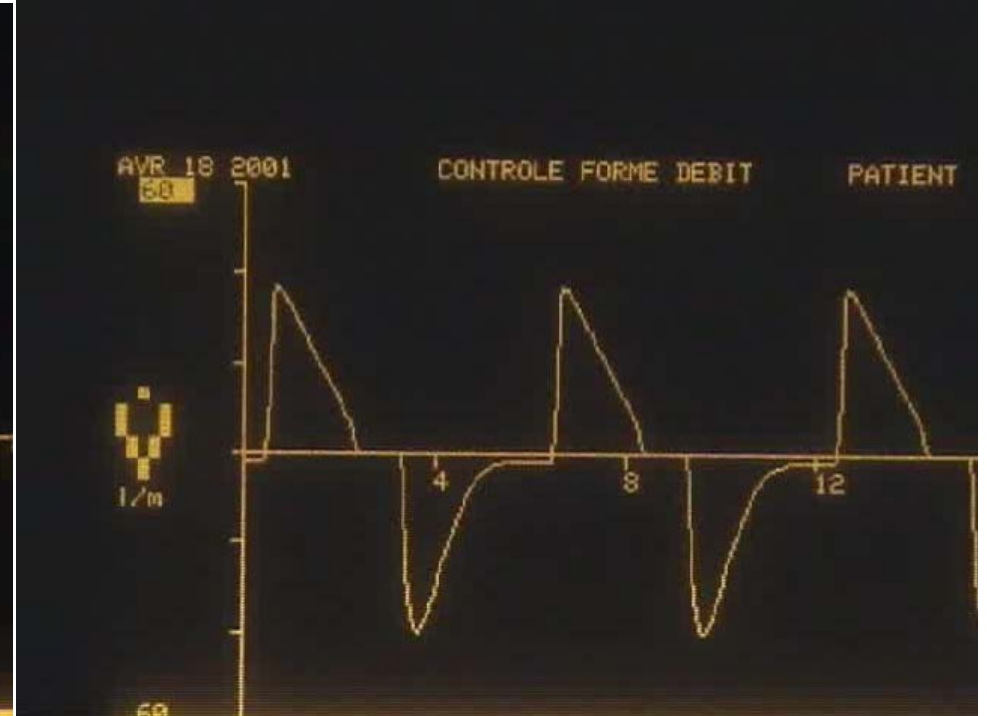
Simulateur: ventilation débit constant

Courbe de débit-temps:

Modification de la constante de temps



Augmentation de la résistance



Courbe normale

# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire
  - Compliance
  - Résistance
  - Auto-PEEP
  - Ratio I:E

# Compliance

$$\text{Compliance} = \frac{\Delta \text{ Volume}}{\Delta \text{ Pression}}$$

$$\begin{aligned} \text{Compliance pulmonaire (Cp)} &= \frac{\text{Volume courant}}{P_{\text{alv}} - P_{\text{pl}}} \\ &= 200 \text{ ml/cm H}_2\text{O} \end{aligned}$$

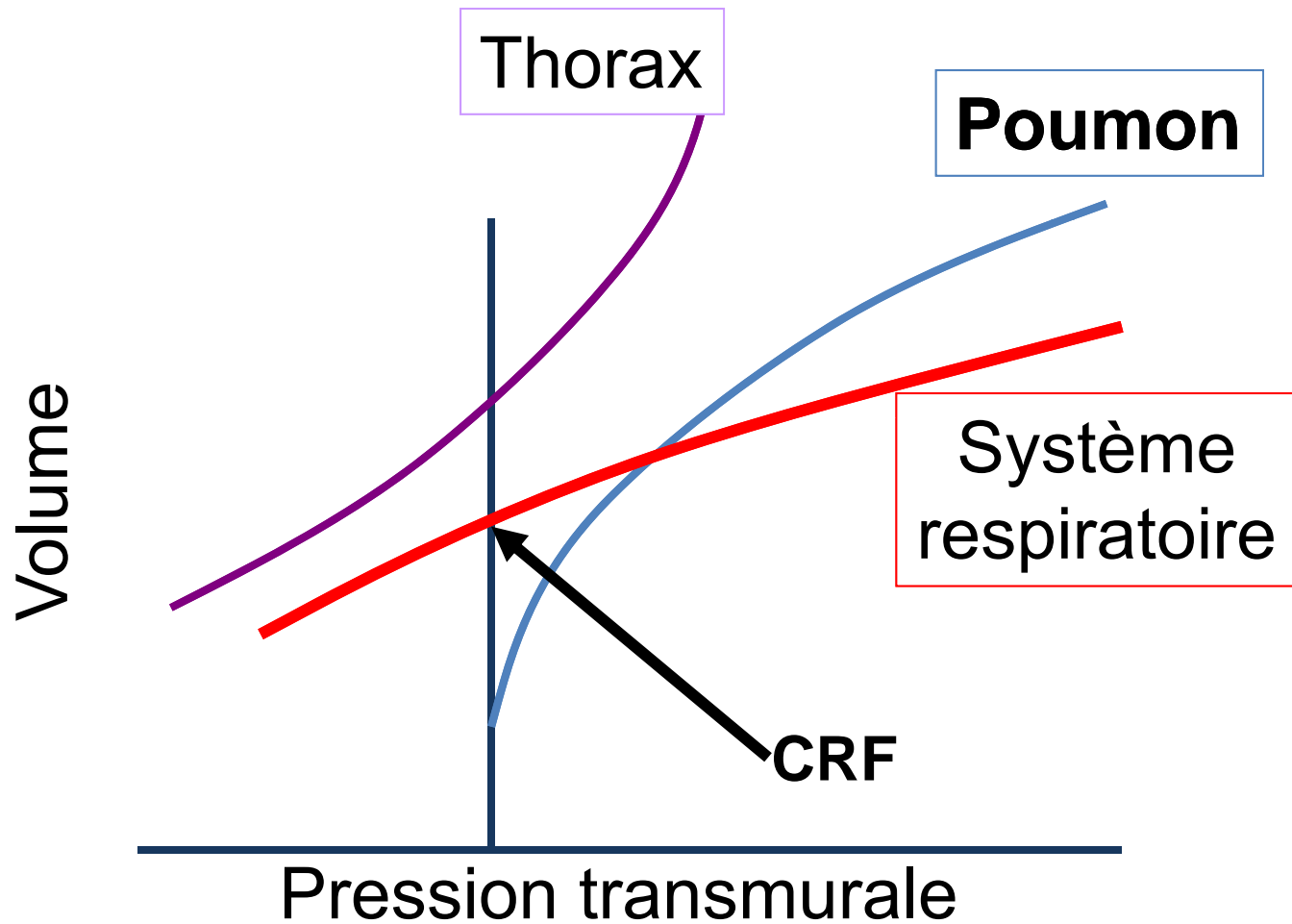
$$\begin{aligned} \text{Compliance thoracique (Ct)} &= \frac{\text{Volume courant}}{P_{\text{pl}} - P_{\text{atm}}} \\ &= 200 \text{ ml/cm H}_2\text{O} \end{aligned}$$

$$\begin{aligned} \text{Compliance système respiratoire} &= \frac{\text{Volume courant}}{P_{\text{alv}}} \\ &= 100 \text{ ml/cm H}_2\text{O} \end{aligned}$$

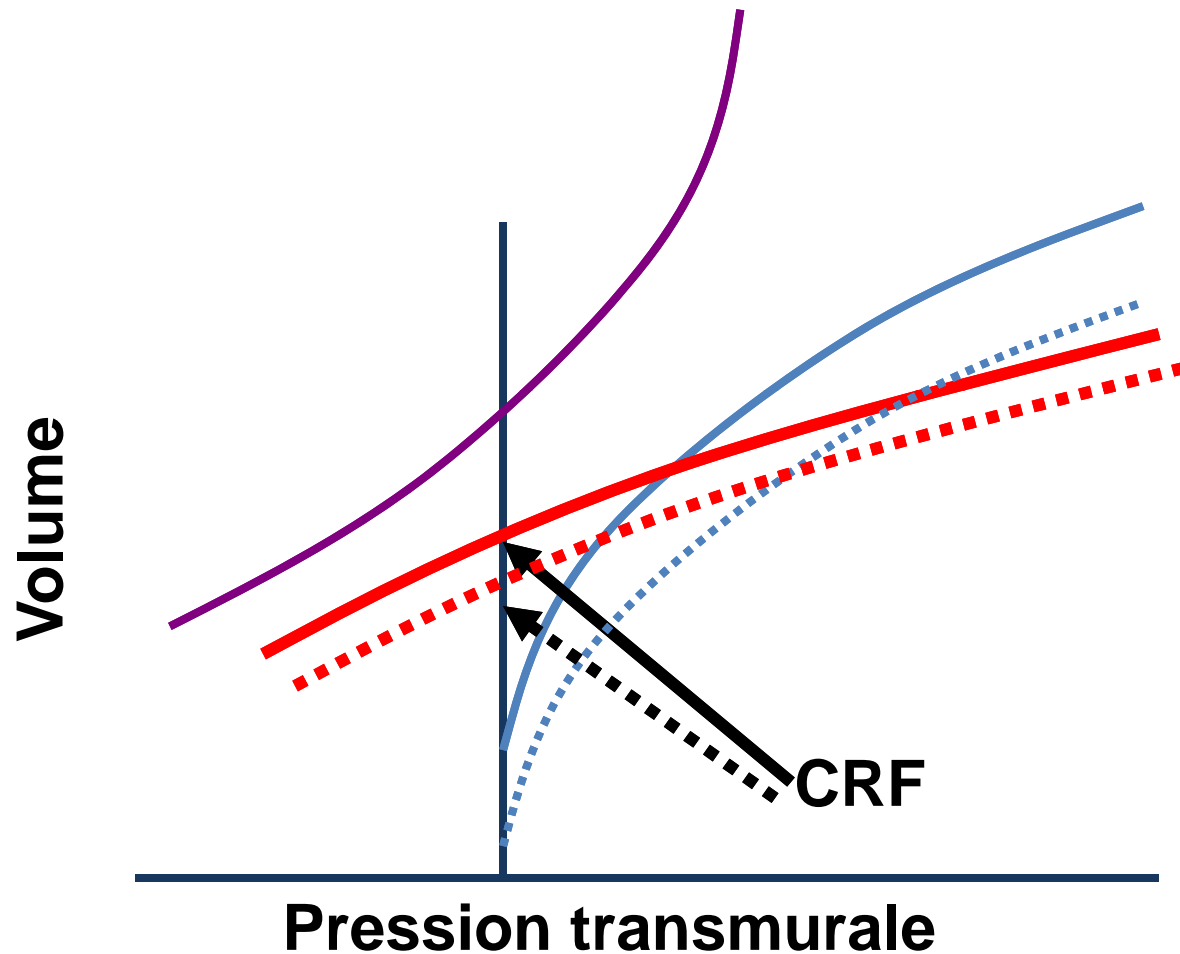
Succès du sevrage peu probable si compliance < 25 ml/cm H<sub>2</sub>O



# Mécanique du système respiratoire



# Mécanique du système respiratoire: ARDS



Le PEEP peut ramener la CRF à sa valeur initiale

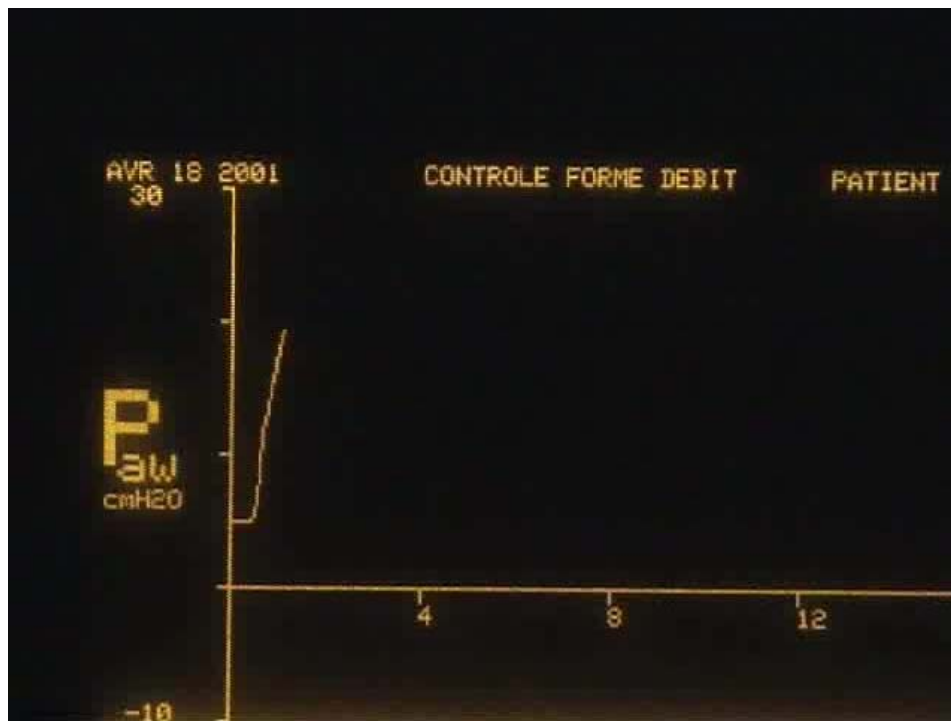


# Mécanique du système respiratoire

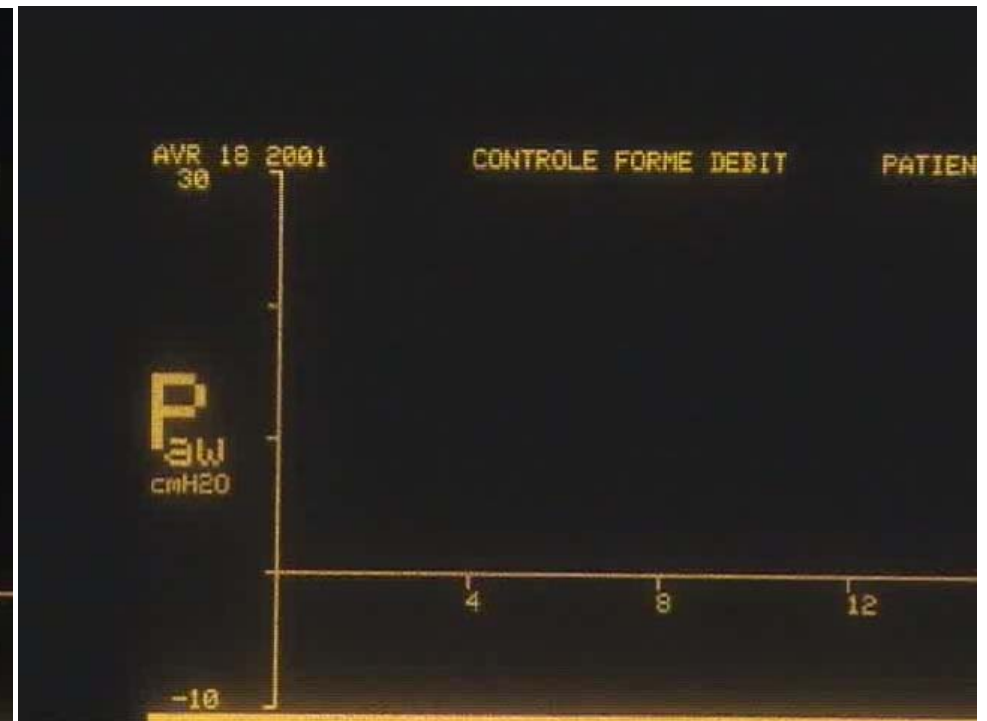
Simulateur: mode débit constant

Courbe pression-temps

Modification de la compliance



Compliance diminuée



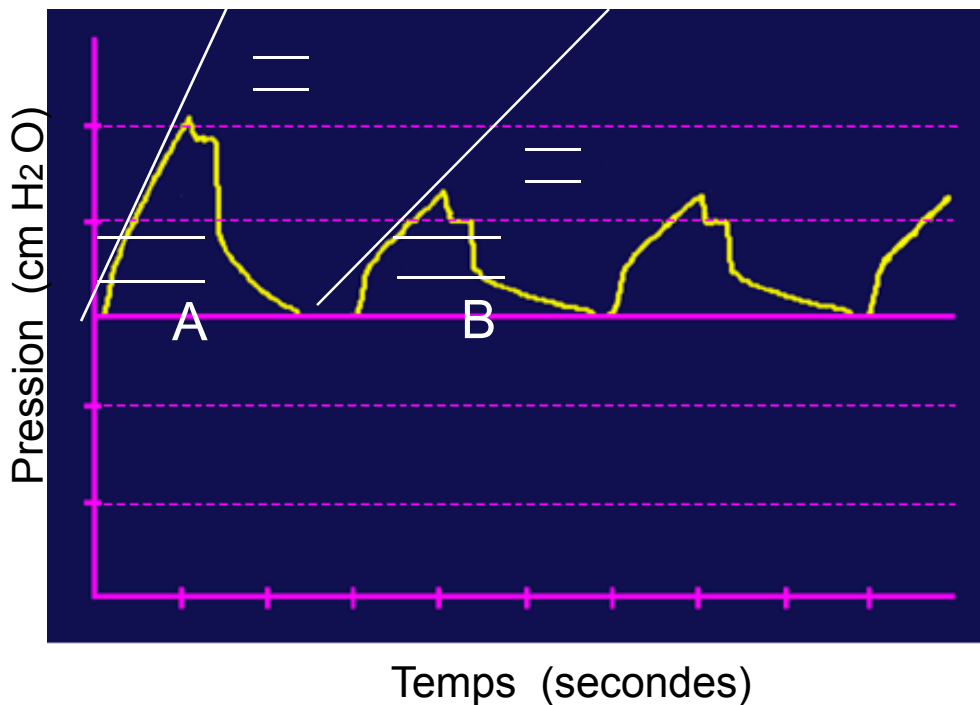
Compliance normale

# Courbe Pression-temps

## Mode à débit constant

---

### Changement compliance



Compliance diminuée

- Pente de la seconde partie plus raide qu'en 'B'
- P<sub>iP</sub> - P<sub>pause</sub> inchangée
- Première marche inchangée

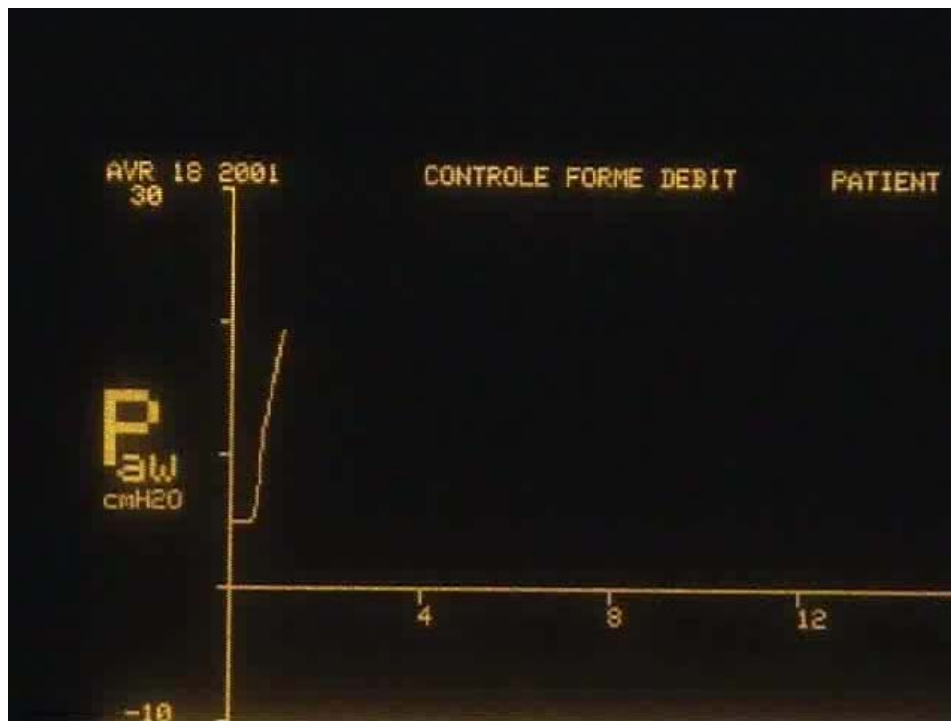
Paul Ouellet

# Mécanique du système respiratoire

Simulateur: mode débit constant

Courbe pression-temps

Modification de la compliance

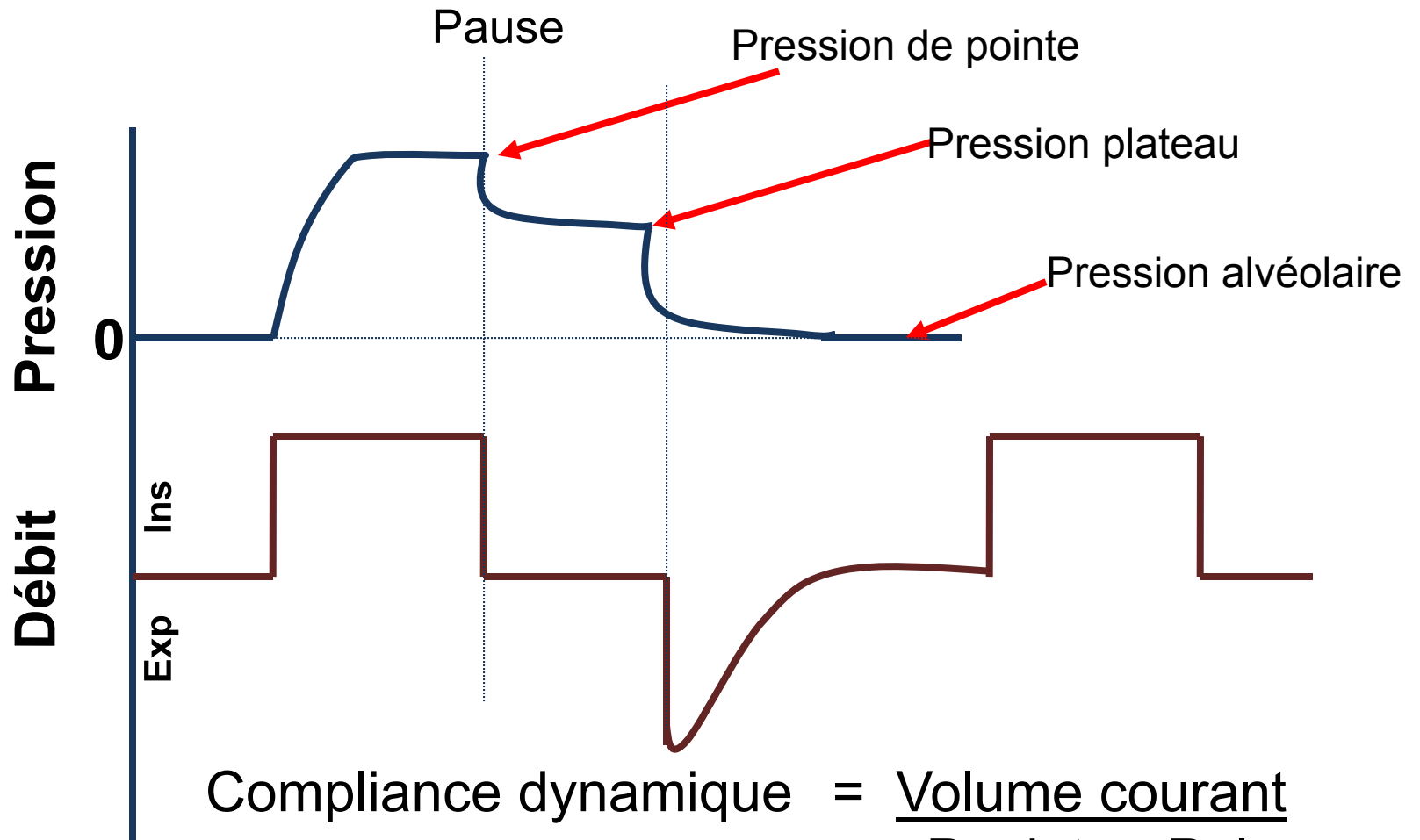


Compliance diminuée



Compliance normale

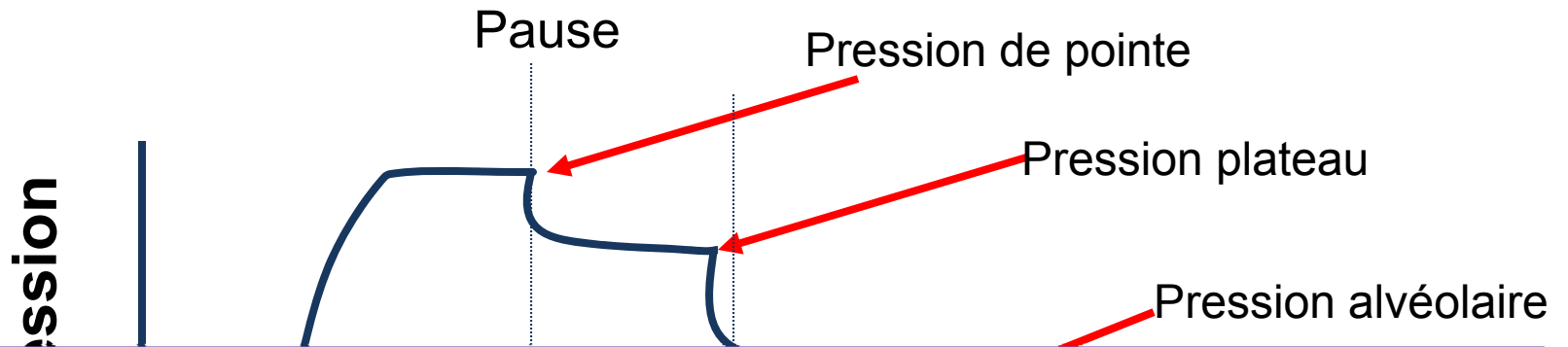
# Mécanique du système respiratoire



$$\text{Compliance dynamique} = \frac{\text{Volume courant}}{P_{\text{pointe}} - P_{\text{alv}}}$$

$$\text{Compliance statique} = \frac{\text{Volume courant}}{P_{\text{plateau}} - P_{\text{alv}}}$$

# Mécanique du système respiratoire



Pression plateau

1-Détermine l'effet hémodynamique

2-En ARDS  $< 30 \text{ cm H}_2\text{O}$

$$\text{Compliance dynamique} = \frac{\text{Volume courant}}{P_{\text{pointe}} - P_{\text{alv}}}$$

$$\text{Compliance statique} = \frac{\text{Volume courant}}{P_{\text{plateau}} - P_{\text{alv}}}$$




# Syndrome de Détresse Respiratoire Aigu



Pierre Aslanian, MD FRCPC  
Intensiviste, Hôpital Saint-Luc

# <http://www.ardsnet.org/>



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**User login**

Username: \*

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### NHLBI ARDS Clinical Network

Welcome to the NHLBI ARDS Clinical Network. For more information about the ARDS Clinical Network, please visit our [about](#) page.

#### Latest News

- Data from the FACTT (PA Catheter- Fluid Management Trial) to be made available July 1, 2007: POSTPONED
- Website back online!
- Website downtime
- Open Registration Closed
- Publications are back!
- ARMA Study data available

[more](#)

#### Public tools

- [Fluid Algorithm \(Composite and by Treatment Assignment\)](#)
- [Lower Tidal Volume / Higher PEEP Reference Card](#)
- [Predicted Body Weight Calculator](#)

### **INCLUSION CRITERIA: Acute onset of**

1.  $\text{PaO}_2/\text{FiO}_2 \leq 300$  (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

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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.

# Protocole: ARDS network

## Esophageal-Pressure-Guided Group

FiO <sub>2</sub>	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 <sub>Le<sub>xp</sub></sub>	0	0	2	2	4	4	6	6	8	8	10	10

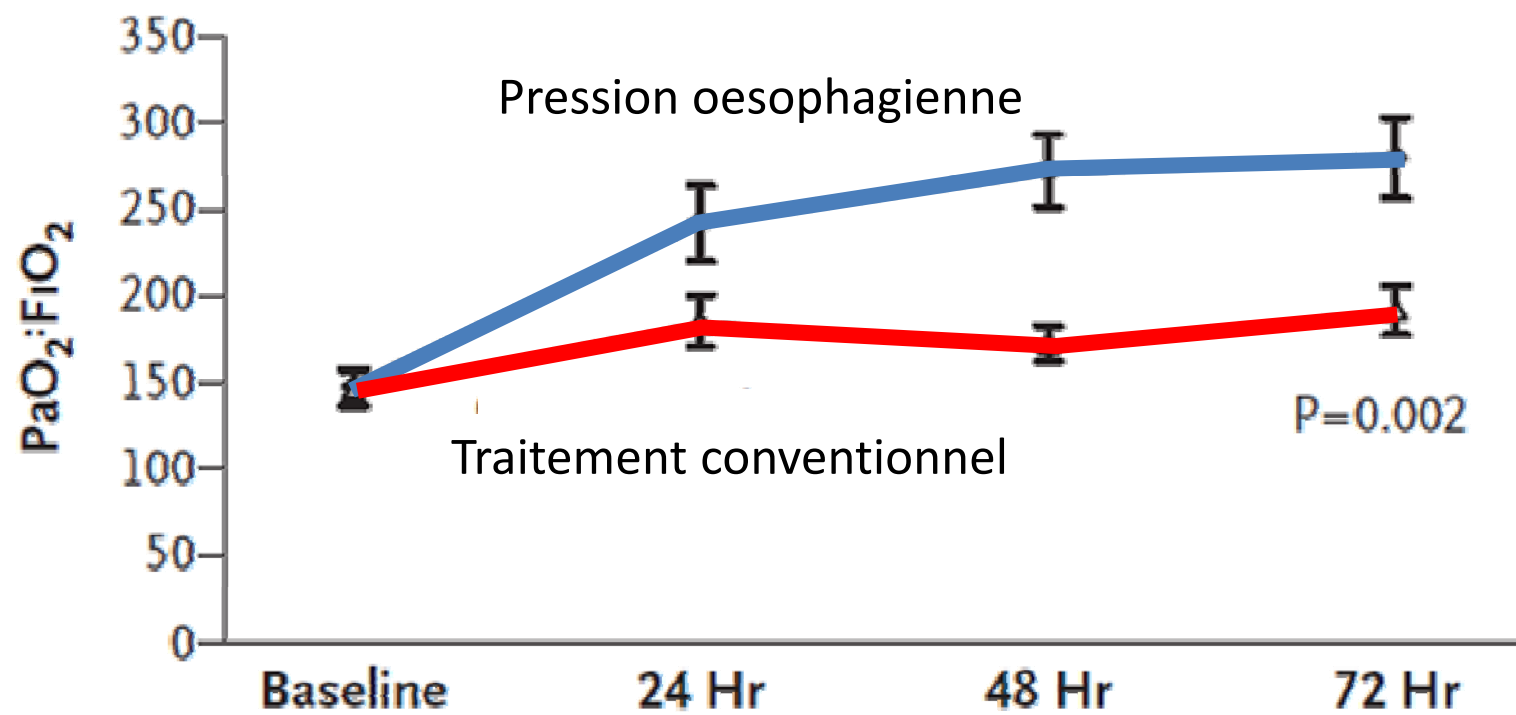
## Control Group

FiO <sub>2</sub>	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

# Arrêt de l'étude

“We stopped the study after 61 patients had been enrolled, because the planned interim analysis showed that it had reached the prespecified stopping criterion.”

“The PaO<sub>2</sub>:FiO<sub>2</sub> at 72 hours was 88 mm Hg higher in patients treated with mechanical ventilation with esophageal balloons than in control patients (95% confidence interval [CI], 78.1 to 98.3; P = 0.002).”



**Table 4. Clinical Outcomes.\***

<b>Outcome</b>	<b>Esophageal-Pressure-Guided (N = 30)</b>	<b>Conventional Treatment (N = 31)</b>	<b>P Value</b>
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.

# Par conséquent

- Dans un contexte d'une augmentation de pression abdominale, il est possible que l'utilisation d'une pression transmurale soit plus appropriée en terme d'ajustement du PEEP et d'oxygénation.



# Devrait-on ventiler avec volume de 6 ml par kg en SOP?

**Does a Protective Ventilation Strategy Reduce the Risk of Pulmonary Complications After Lung Cancer Surgery?: A Randomized Controlled Trial**

*Chest* March 2011 139:3 530–537;  
published ahead of print September 9, 2010,

RCT (n = 122)  
Meilleur ratio PaO<sub>2</sub>/FiO<sub>2</sub>  
Moins d'anomalies au RX poumons

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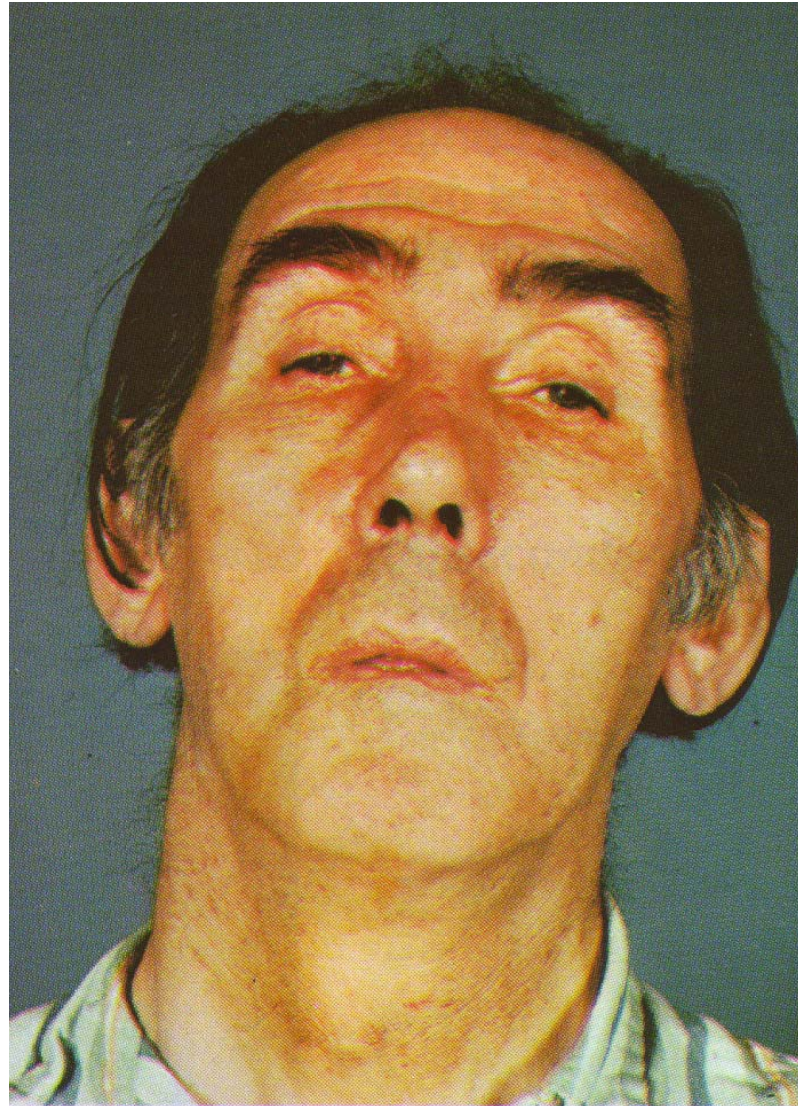
**Influence of Low Tidal Volume Ventilation on Time to Extubation in Cardiac Surgical Patients**

Sundar, Sugantha M.D.\*; Novack, Victor M.D., Ph.D.†; Jervis, Karinne M.D.‡; Bender, S. Patrick M.D.‡; Lerner, Adam M.D.§; Panzica, Peter M.D.§; Mahmood, Feroze M.D.§; Malhotra, Atul M.D.||; Talmor, Daniel M.D., M.P.H.#

Anesthesiology:  
May 2011 - Volume 114 - Issue 5 - pp 1102-1110

RCT (n = 149)  
Durée de ventilation plus courte aux SI  
Moins de ré-intubation

Pourquoi la compliance est diminuée après la séquence rapide chez ce patient?

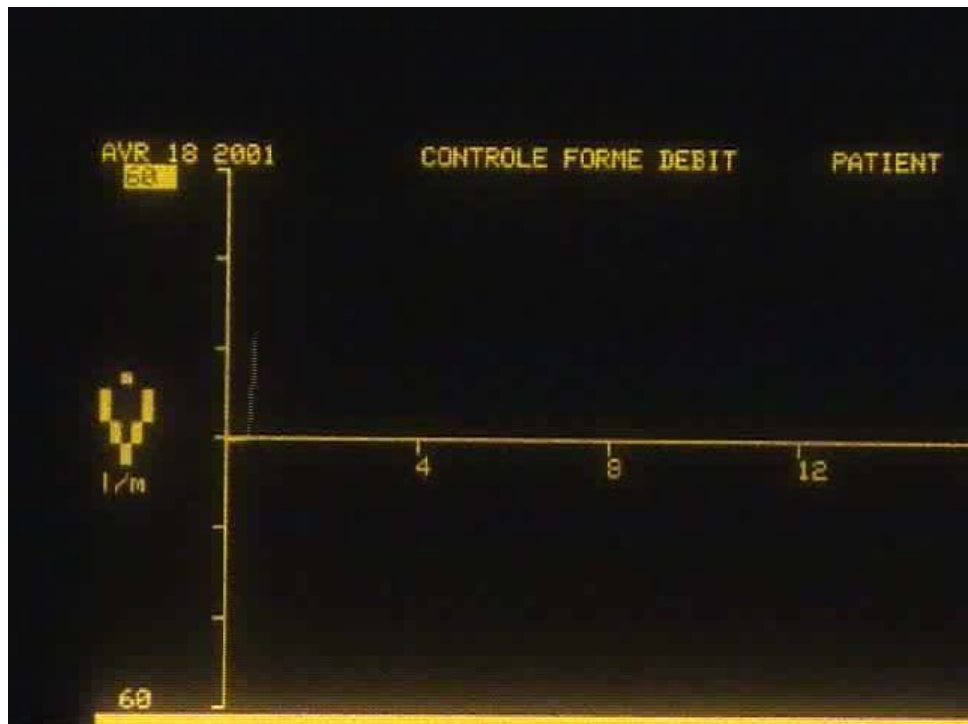


# Mécanique du système respiratoire

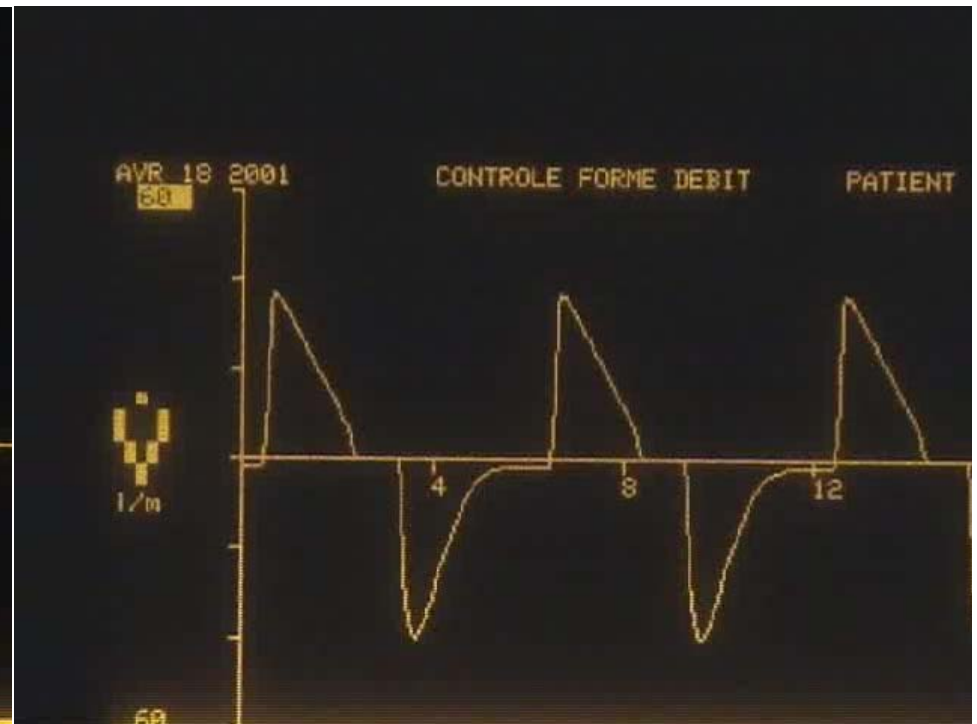
Simulateur: mode débit constant

Courbe débit-temps

Modification de la compliance



Compliance diminuée

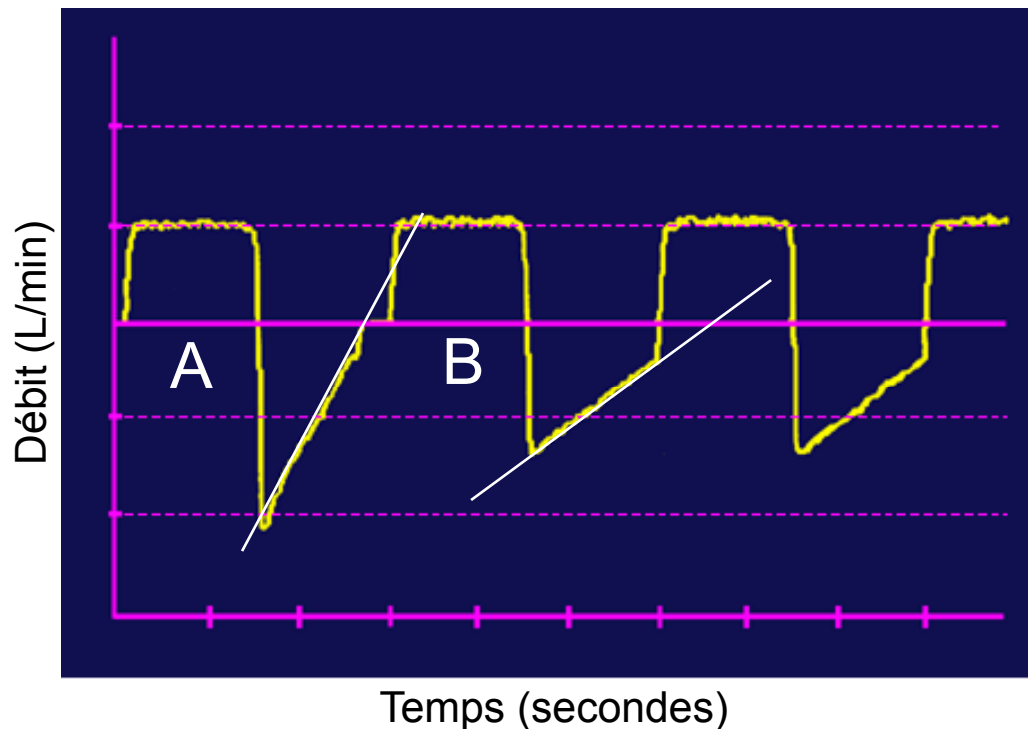


Compliance normale

# Courbe Débit-temps Mode à débit constant

Erreur car VPC

Changement compliance  
(Ti 50%)



A: Compliance réduite

- Retour rapide à la ligne de base
- Pente plus aigüe qu'en 'B'

B: Compliance normale

- Retour exponentiel à la ligne de base
- Temps expiratoire ne permet pas un débit fin expiration de zéro

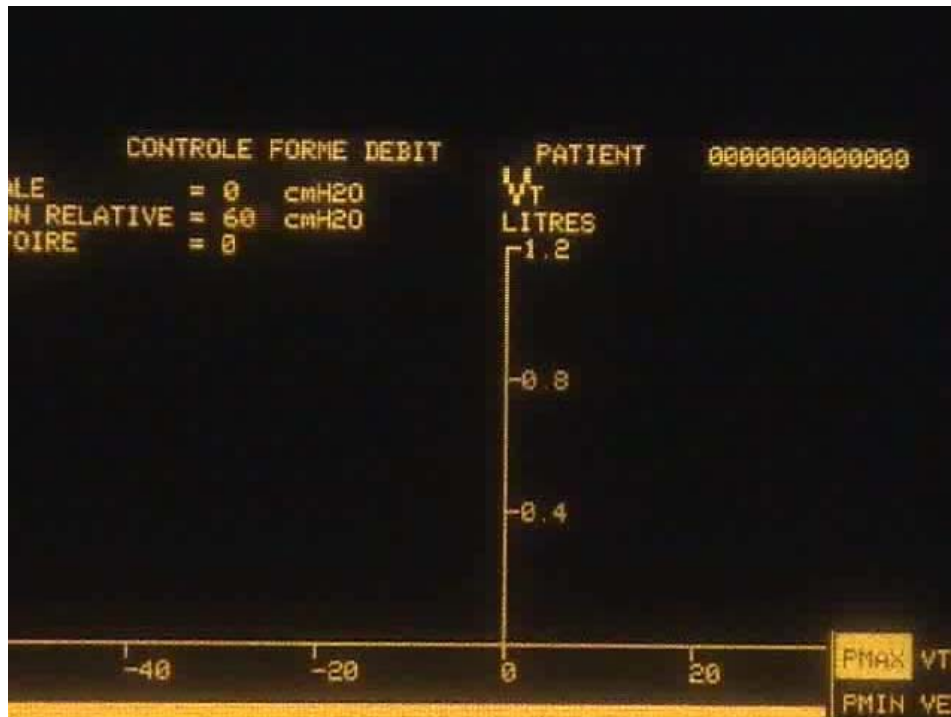
Paul Ouellet

# Mécanique du système respiratoire

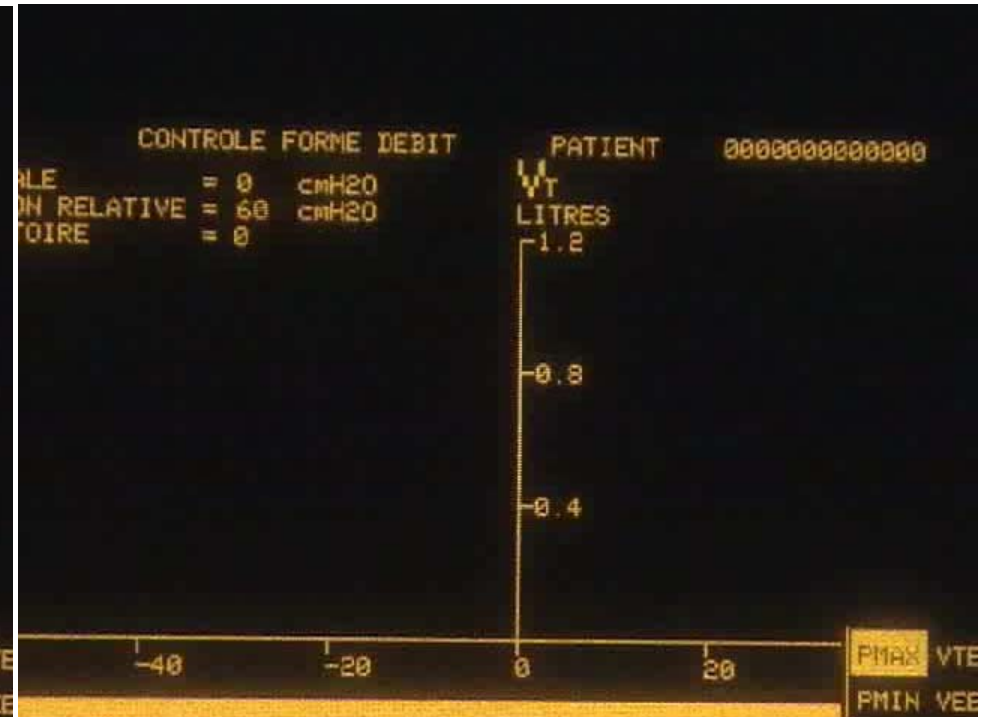
Simulateur: ventilation débit constant

Courbe pression-volume

Modification de la compliance



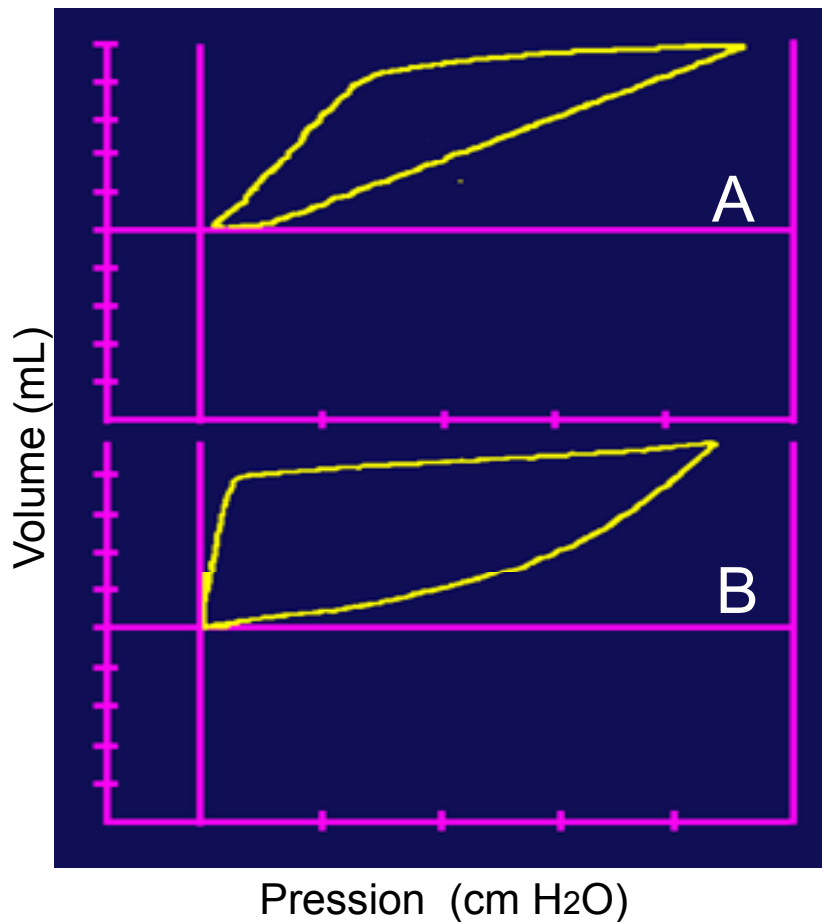
Compliance diminuée



Compliance normale

# Boucle Volume-pression

## Mode à débit constant



### Changement compliance

A: Compliance diminuée

- Point de déflexion expiratoire plus élevé sur l'axe de pression

B: Compliance normale

- Accroissement graduel jusqu'à PIP

# Femme de 62 ans

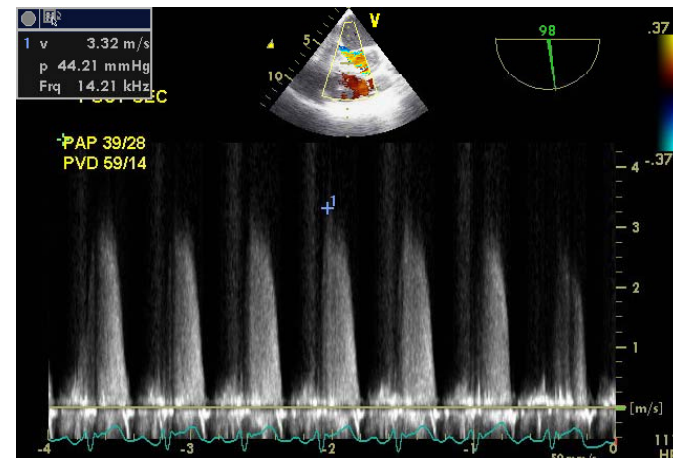
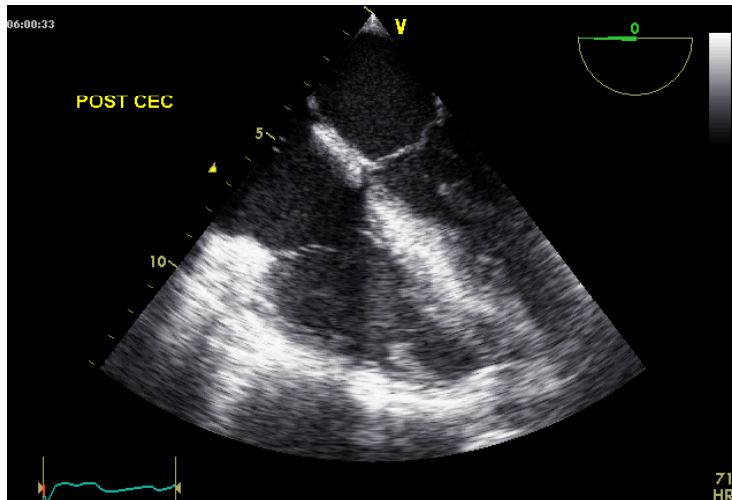
- Transfer HSC: choc, fibrillation
- Échec angioplastie
- BIA, dopamine, noradrenaline, intubée
- Parsonnet 50
- PAC X 2 et PMC X1



# VD post-CEC

## Pré-CEC

## Post-CEC

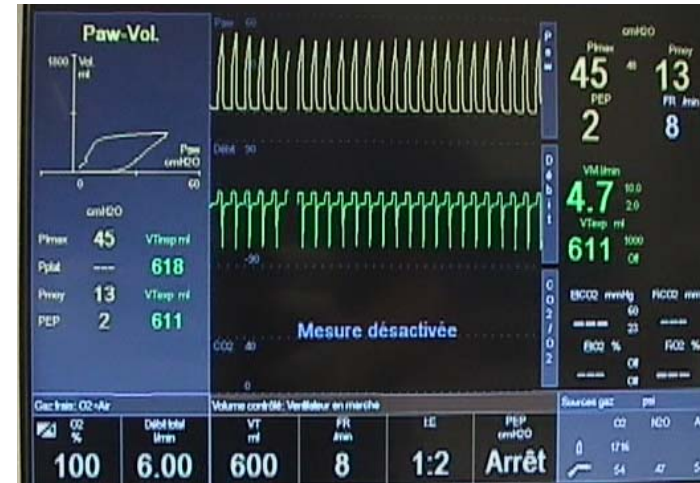




# ↑ Pressions de crête à la fermeture du thorax: que faire?

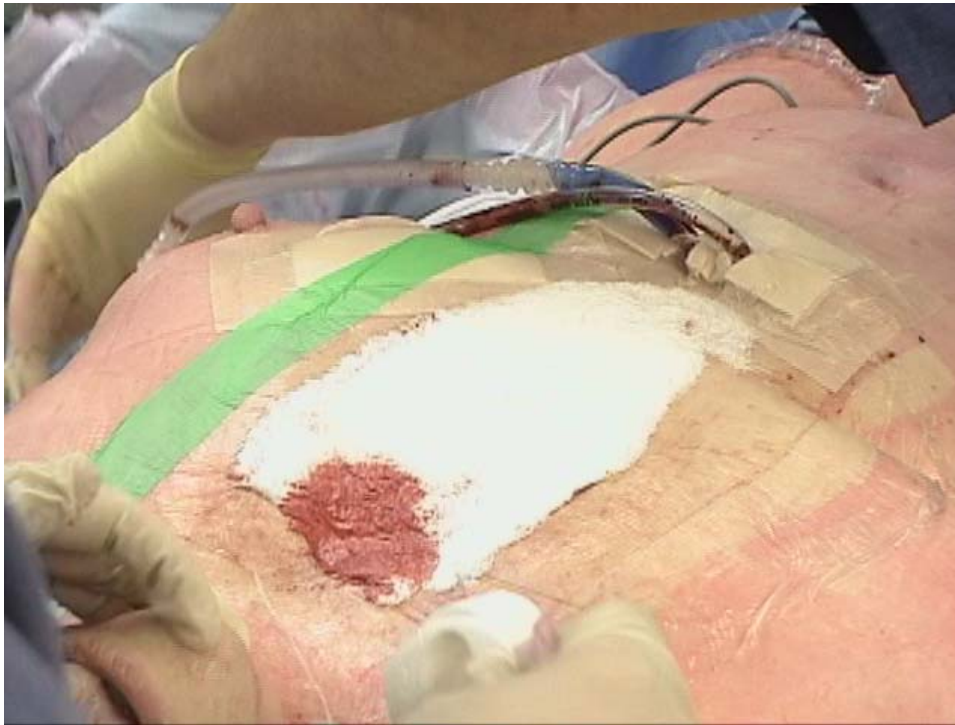
Pré-CEC

Post-CEC



Au même moment





# Ventilateurs de SOP vs de SI

54 patients avec ARDS ventilés par

1-Siemens 900C (SI)

2-Ohio d'anesthésie

## Résultats:

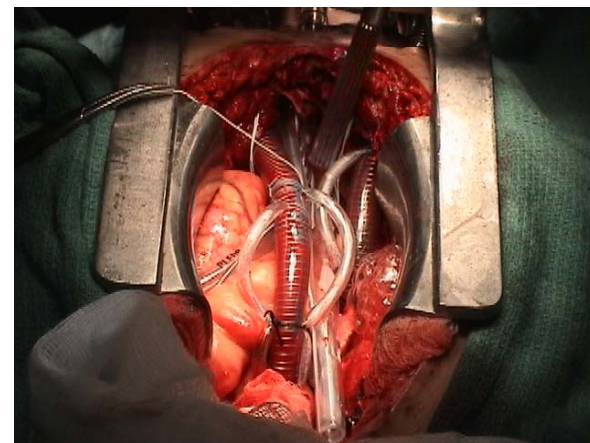
1-Diminution de 20-40% de  $PaO_2/FiO_2$  avec Ohio

2-Aucun changement avec Siemens

## Discussion:

Ventilateur de soins peut maintenir un débit inspiratoire en présence d'une ↓ de la Cp.

Le débit du ventilateur d'anesthésie chute en présence d'une ↓ de la Cp.



# **Ventilation mécanique sous anesthésie générale Peut-on faire mieux?**

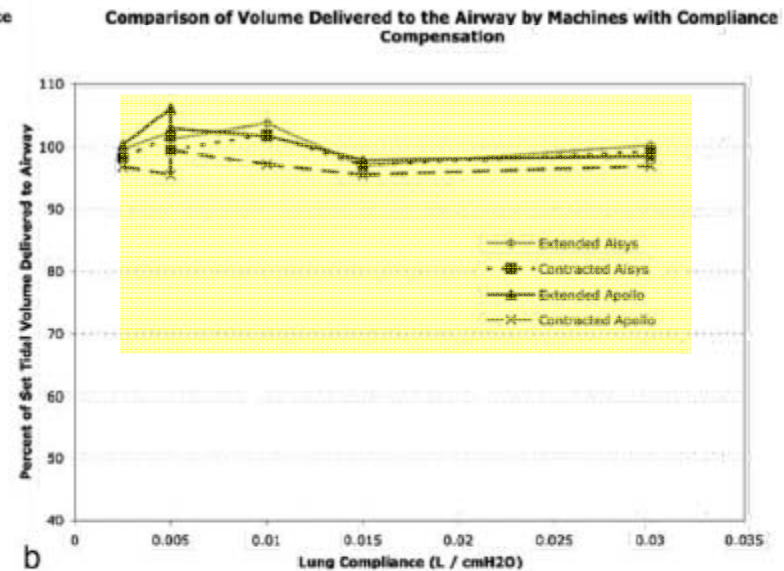
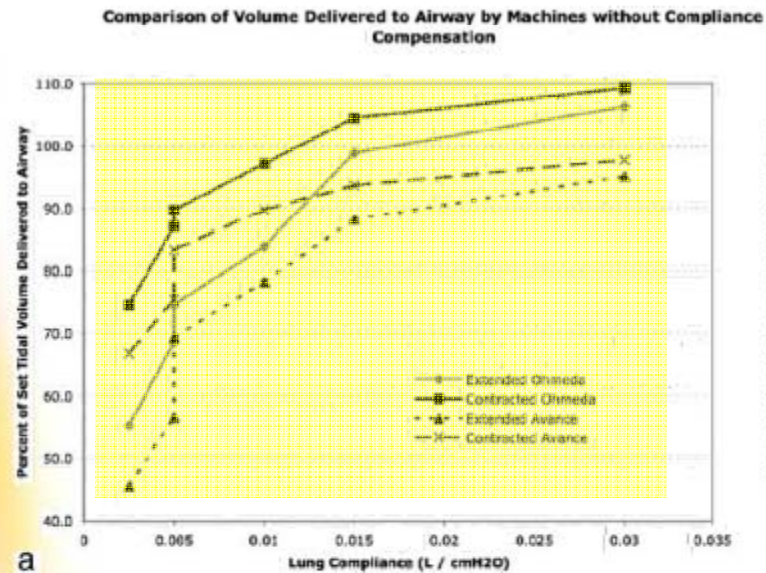
**Martin Lessard MD FRCPC  
Département d'anesthésie-réanimation  
CHA, Université Laval**



**Congrès annuel 2011**



# Y a-t-il un ventilateur plus performant?



Tous les ventilateurs des appareils de dernière génération sont également performants

# Homme de 69 ans

- IM inférieur aigu thrombolysé
- Anévrismes des 2 ostiums coronariens
- PAC PMC d'urgence
- Plasma et cryoprécipités en pré-CEC puis post-CEC (hématologie)
- Sortie de CEC facile soudain saturation 75% sans augmentation des pressions de pointe

# Diagnostique différentiel?

- TET endo-bronchique
- Bronchospasme
- «Pump lung»
- TRALI
- Shunt D-G

# Tube endotrachéal endobronchique?





# Ventilateur de SOP

## SOP

pH: 7.32  
PCO<sub>2</sub>: 24 mmHg  
PO<sub>2</sub>: 69 mmHg  
EB: + 0.9  
FiO<sub>2</sub>: 100%



PB-7200: VOI 700 PEEP 5

Ventilation haute fréquence

pH: 7.37  
PCO<sub>2</sub>: 44 mmHg  
PO<sub>2</sub>: 66 mmHg  
EB: + 0.5  
FiO<sub>2</sub>: 100%

pH: 7.44  
PCO<sub>2</sub>: 35 mmHg  
PO<sub>2</sub>: 262 mmHg  
EB: + 0.7  
FiO<sub>2</sub>: 100%

# Jet ventilation 15 minutes

ACT					
PAP/W	34/25	44/28	-	-	
PVC	20	27	-	-	
DC/IC		10.6/4.8			
pH	7.39				
pCO <sub>2</sub> /ETCO <sub>2</sub>	41	9	9	9	7
PO <sub>2</sub> /SpO <sub>2</sub>	52.4	100	100	100	100.
EB	40.8				
K+	4.1				
Hb/Ht	93/28				
GLYCÉMIE	1.1/1.1	10.1/4.2	8.8		

# Bilan hémo pré-CEC

T (cm)= 180  
PDS(Kg)= 100.00  
PCAP= 18  
(15:18)  
PVC= 19  
(15:18)  
DC= 5.1  
(15:15)  
FC= 59  
PA MOY= 73  
AP MOY= 23

VS= 86  
RVS= 847  
RVP= 78  
WSVG= 65  
WSVD= 5  
IC= 2.3  
39  
IRVS= 1855  
IRVP= 171  
IWSVG= 30  
IWSVD= 2  
S.C.= 2.19

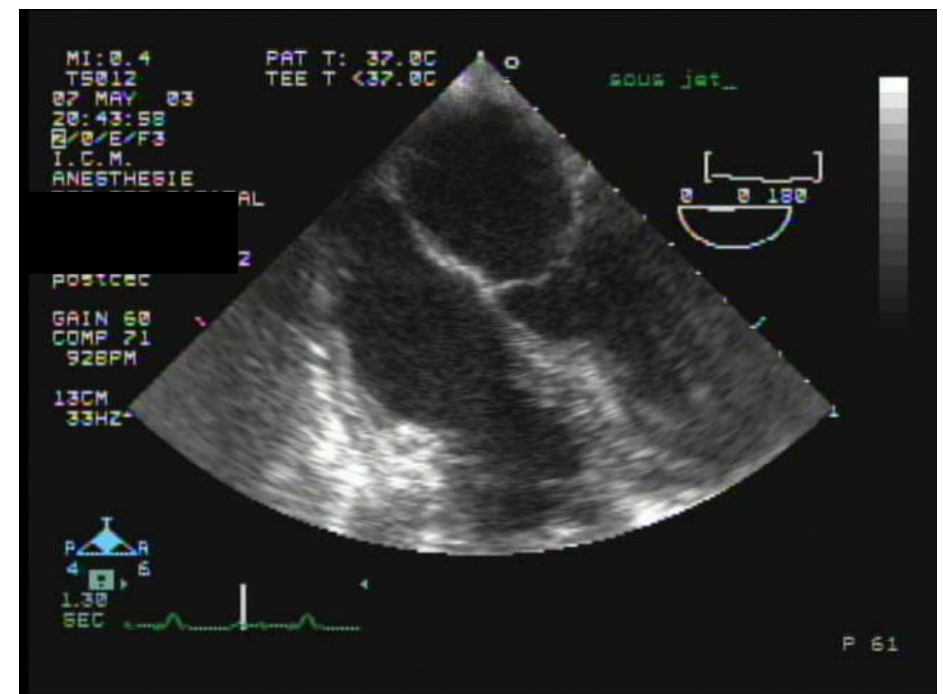
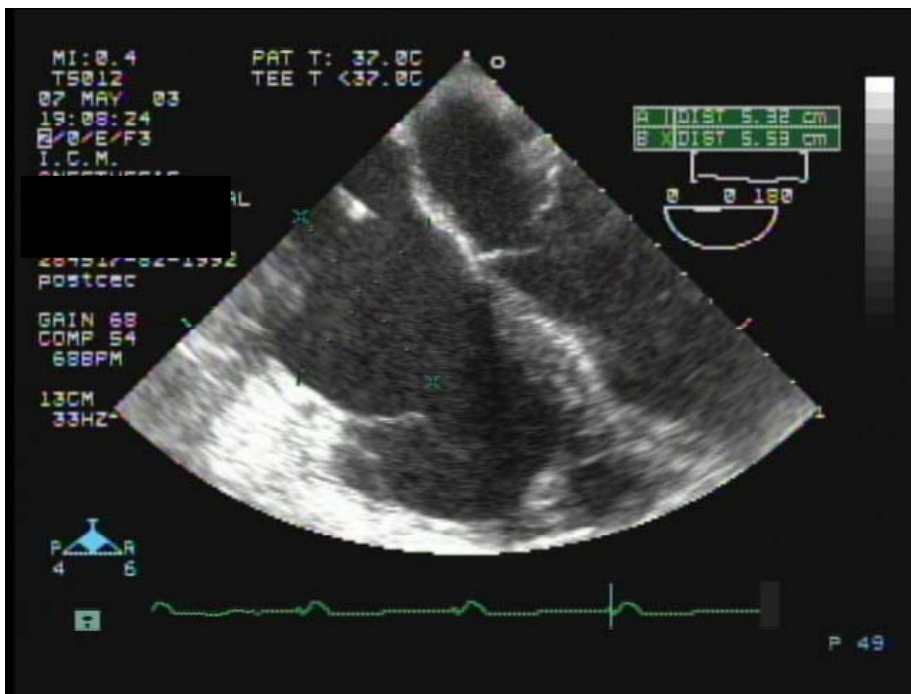
# Bilan hémo post-CEC

T (cm)=	180	VS=	66
PDS(Kg)=	100.00	RVS=	1156
PCAP=	21	RVP=	89
(18:49)		WSVG=	53
PVC=	15	WSVD=	10
(18:49)			
DC=	4.5	IC=	2.1
(18:49)			30
FC=	68	IRVS=	2532
PA MOY=	80	IRVP=	195
AP MOY=	26	IWSVG=	24
		IWSVD=	5
		S.C.=	2.19

# Bilan hémo post-CEC + jet

Γ (cm)=	180	VS=	133
MS(Kg)=	100.00	RVS=	589
PCAP=	21	RVP=	98
(20:38)		WSVG=	142
PYC=	22	WSVD=	22
(20:38)			
DC=	10.6	IC=	4.8
(20:38)			61
FC=	80	IRVS=	1290
MOY=	100	IRVP=	215
MP MOY=	34	IWSVG=	65
		IWSVD=	10
		S.C.=	2.19

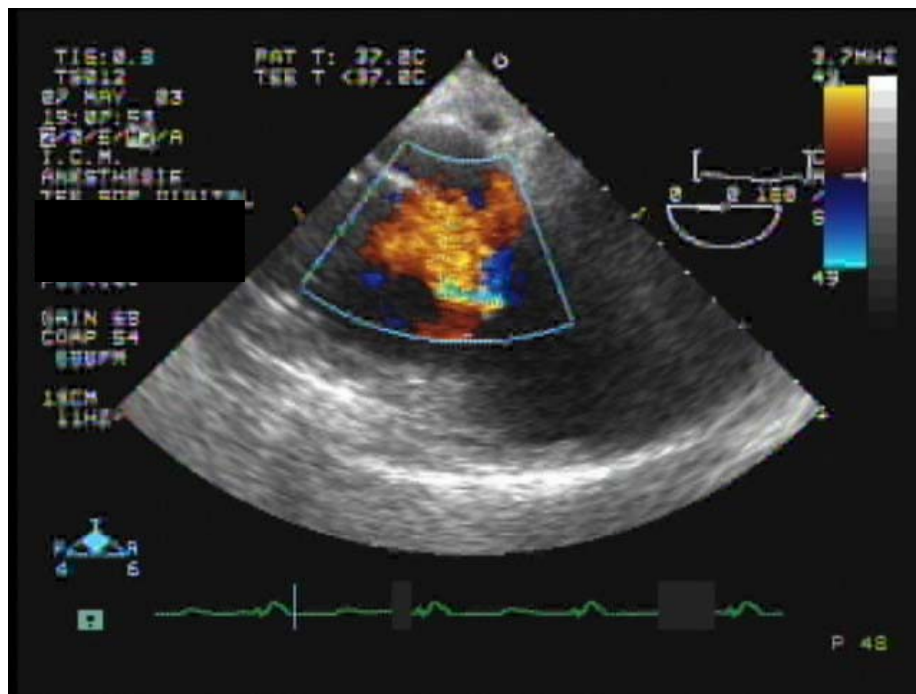
# Ventricule droit post CEC



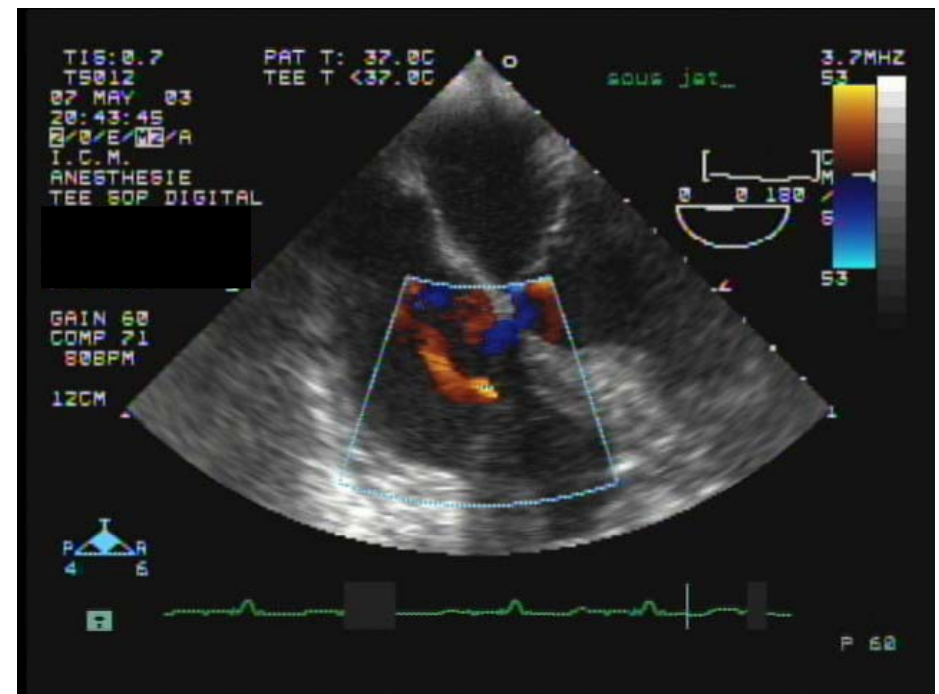
Ventilation conventionnelle

Ventilation par jet

# Régurgitation tricuspidiennne post CEC



Ventilation conventionnelle

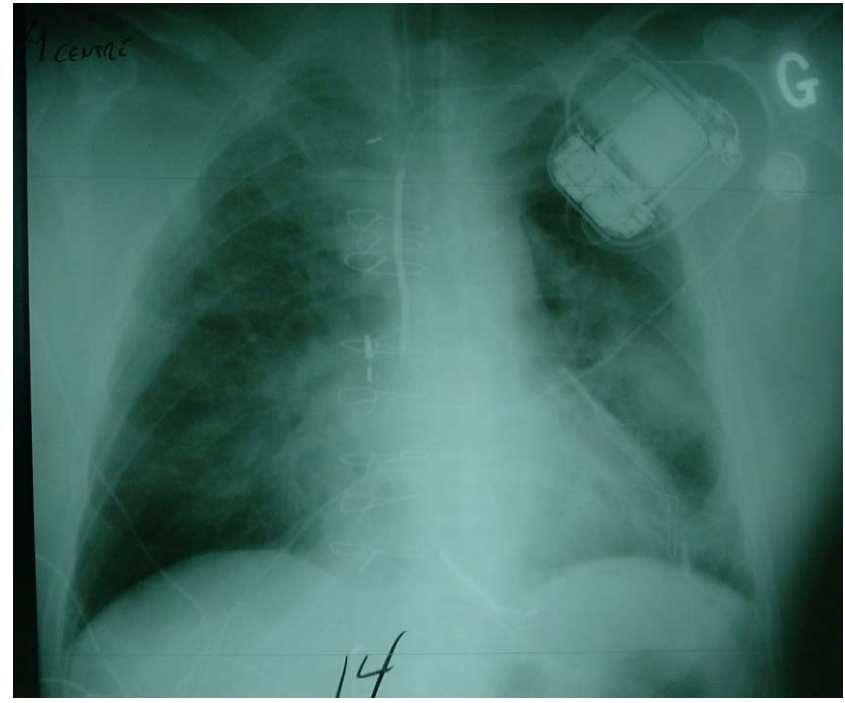


Ventilation par jet

# Effet sur échanges gazeux



Soins intensifs



Post jet ventilation



# Recrutement alvéolaire



Pression contrôlée

Ventilation  
haute fréquence

# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire
  - Compliance
  - Résistance
  - Auto-PEEP
  - Ratio I:E



Dr Claude Poirier

Laboratoires d'exploration  
fonctionnelle et respiratoire

Centre Hospitalier Universitaire de  
Montréal

**Quand l'exercice  
en vaut la peine...**

## Le Patient Bronchospastique

Tudor Costachescu, M.D.

# Résistance

$$\text{Résistance} = \frac{\Delta \text{Pression}}{\text{Débit}}$$

$\eta$  = viscosité  
 $l$  = longueur  
 $r$  = rayon  
 $\rho$  = densité  
 $f$  = friction

$$\text{Résistance (laminaire)} = \frac{8 \eta l}{\pi r^4}$$

$$\text{Résistance (turbulent)} = \frac{(\text{Débit})^2 \rho f l}{4 \pi^2 r^5}$$

Résistance inspiratoire et expiratoire?  
Compliance dynamique

# Résistance

$$\text{Résistance} = \Delta \frac{\text{Pression}}{\text{Débit}}$$

$$\text{Résistance} = \Delta \frac{(\text{Vol/compliance})}{\text{Débit}}$$

## **Facteurs:**

1-Différence de pression (Pext-Pint)

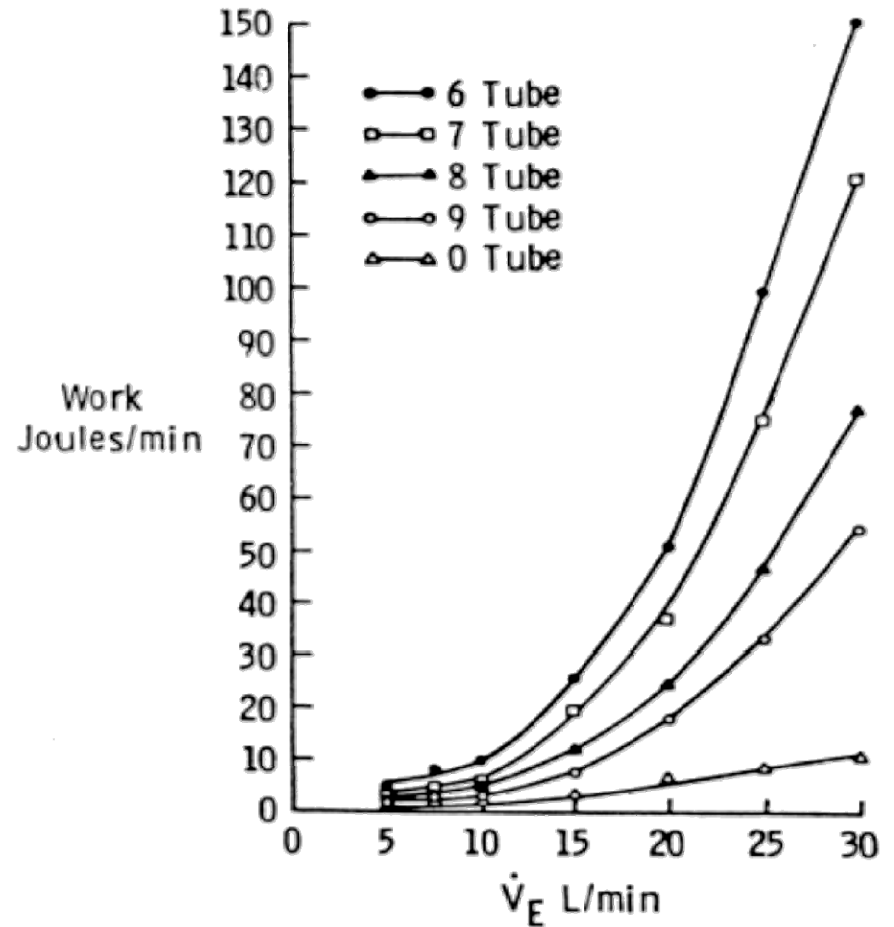
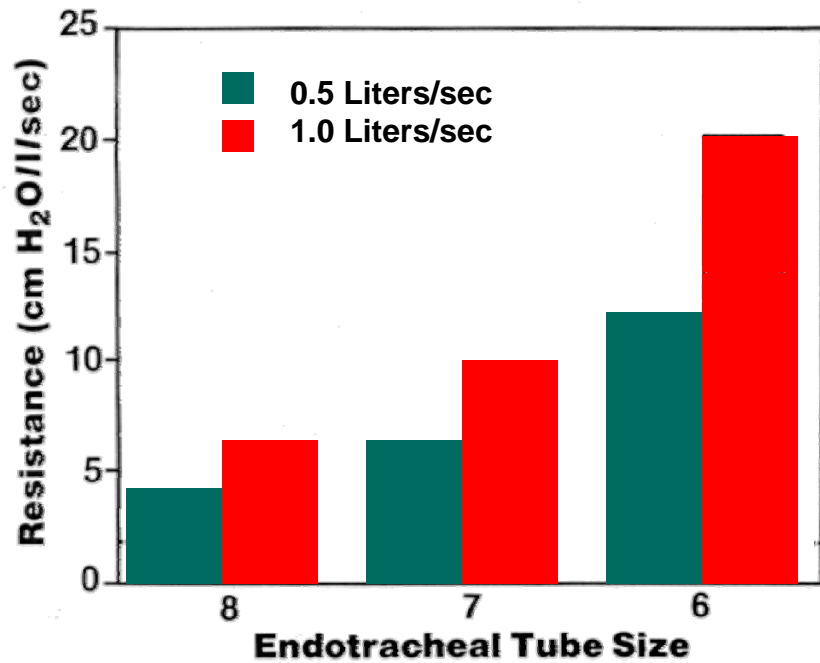
$$P_{\text{int}} = TET (\text{long} + \text{dim}, VRS, VRI)$$

2-Volume

3-Compliance: influence Tau

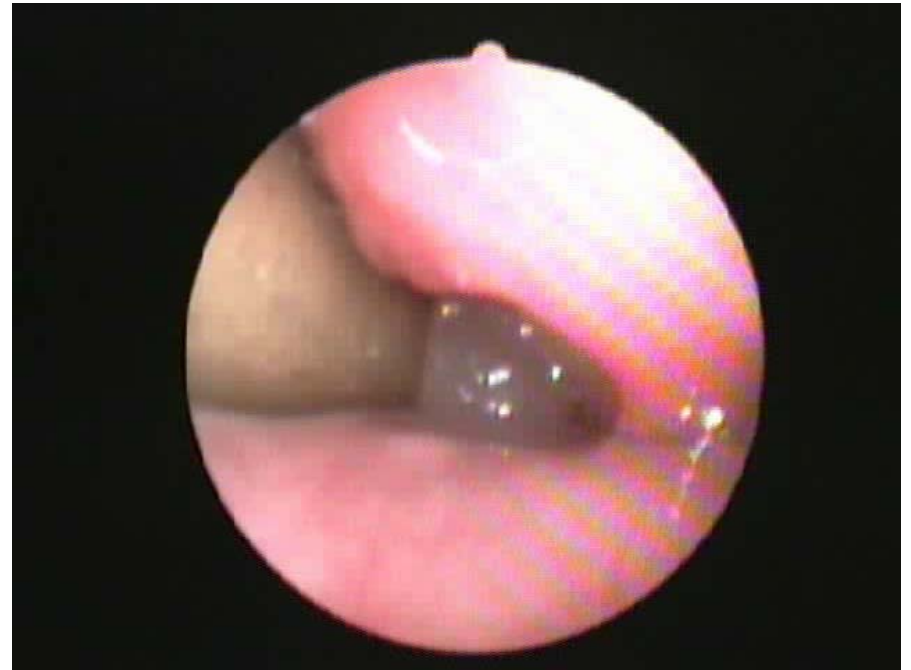
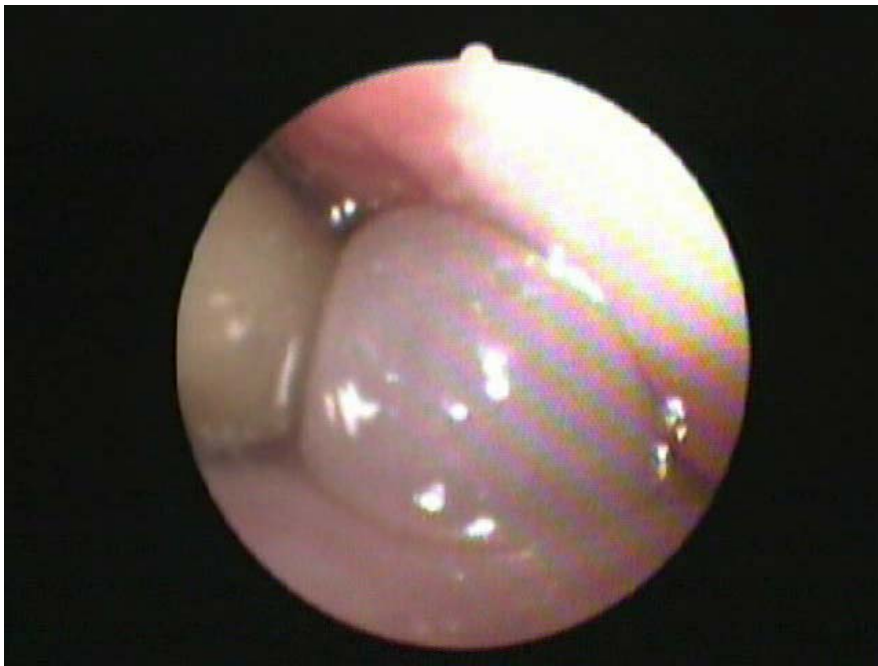
4-Débit

# Résistance et tube endotrachéal

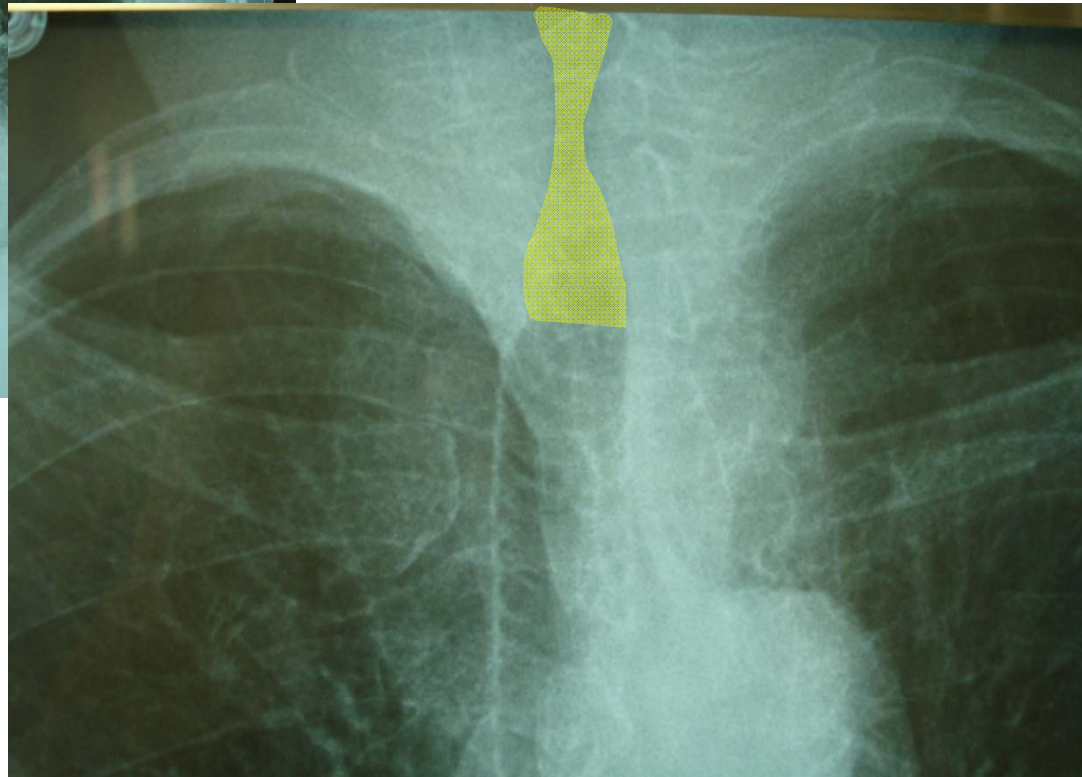
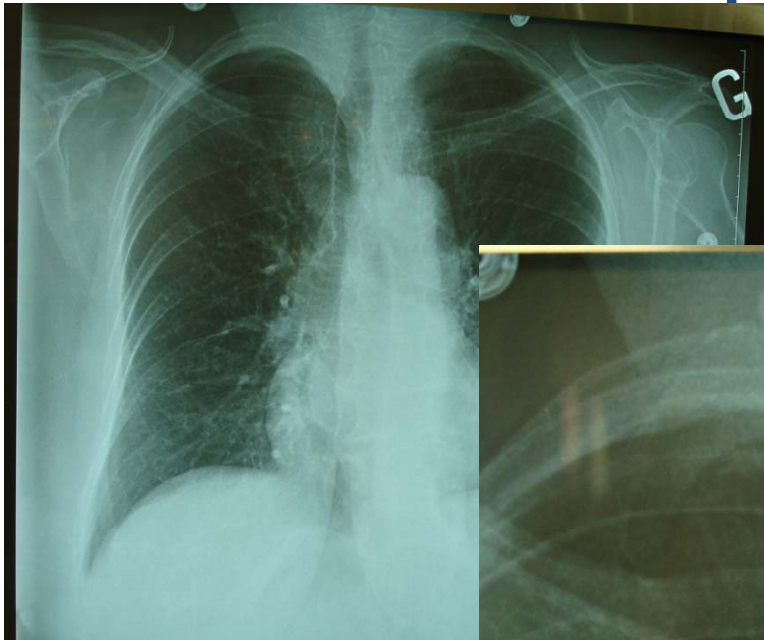


L'aide inspiratoire minimale = 15 – (taille du TET)

# Autre cause de résistance: stridor post-exubation



# Autre cause de résistance: stridor post-exubation



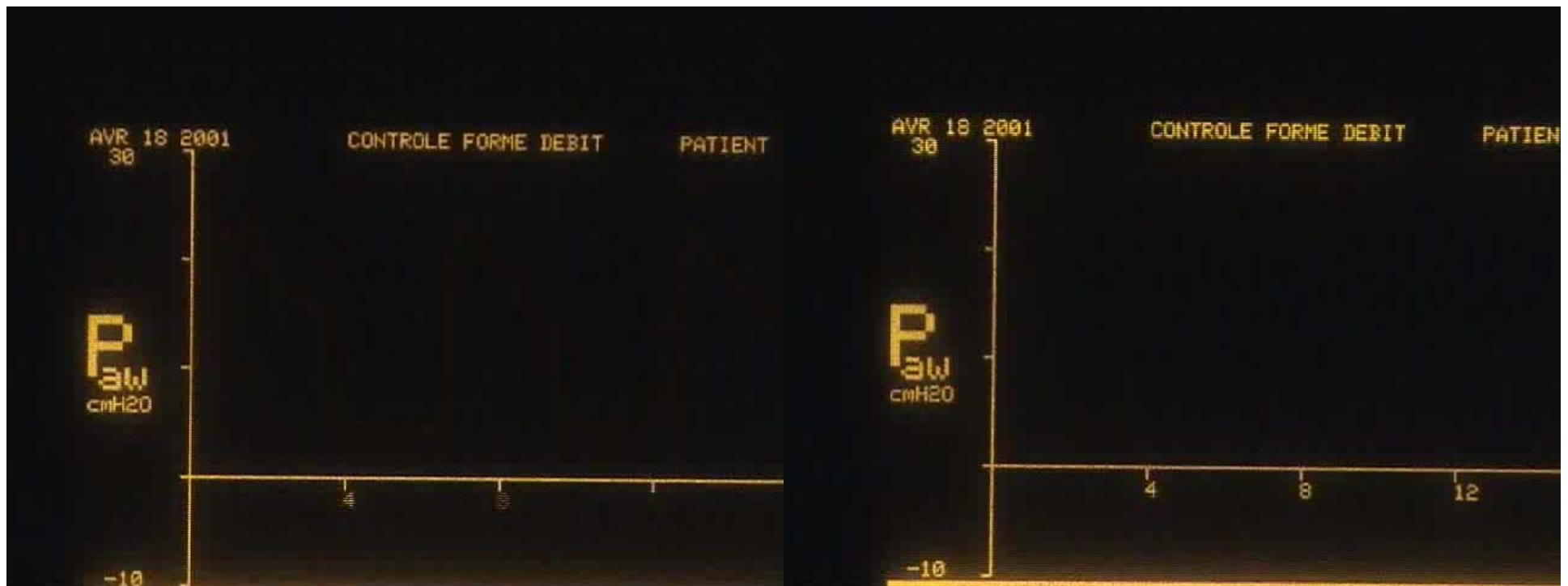


# Mécanique du système respiratoire

Simulateur: mode débit constant

Courbe pression-temps

Modification de la résistance



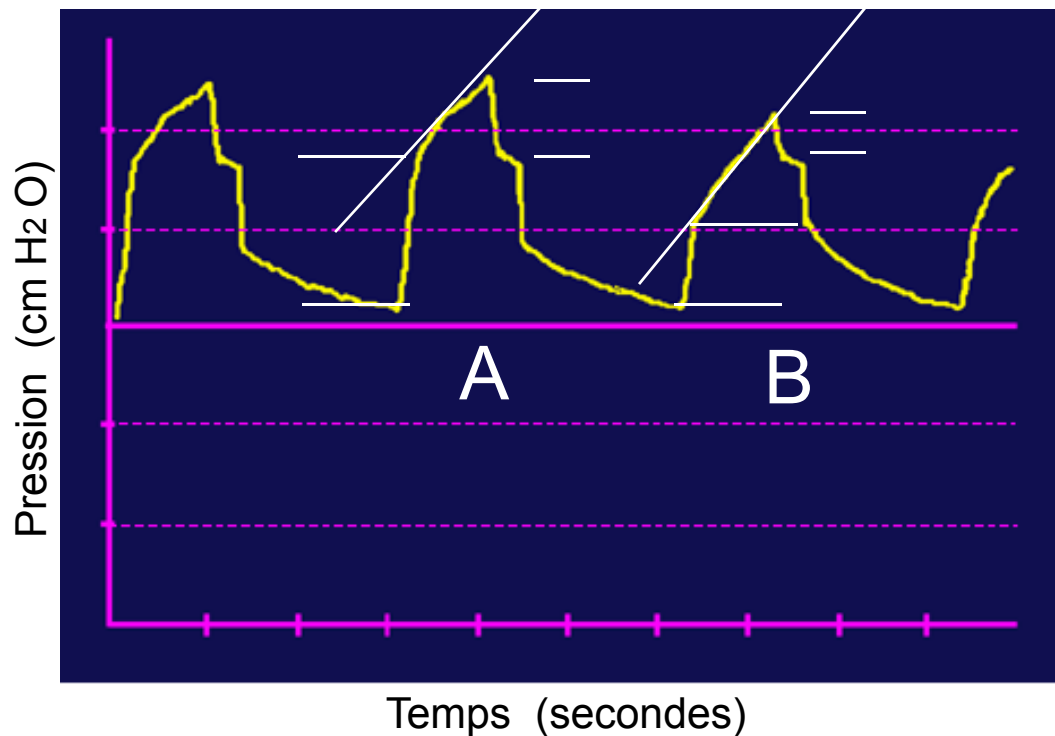
Résistance augmentée

Résistance normale

# Courbe Pression-temps

## Mode à débit constant

Changement résistance

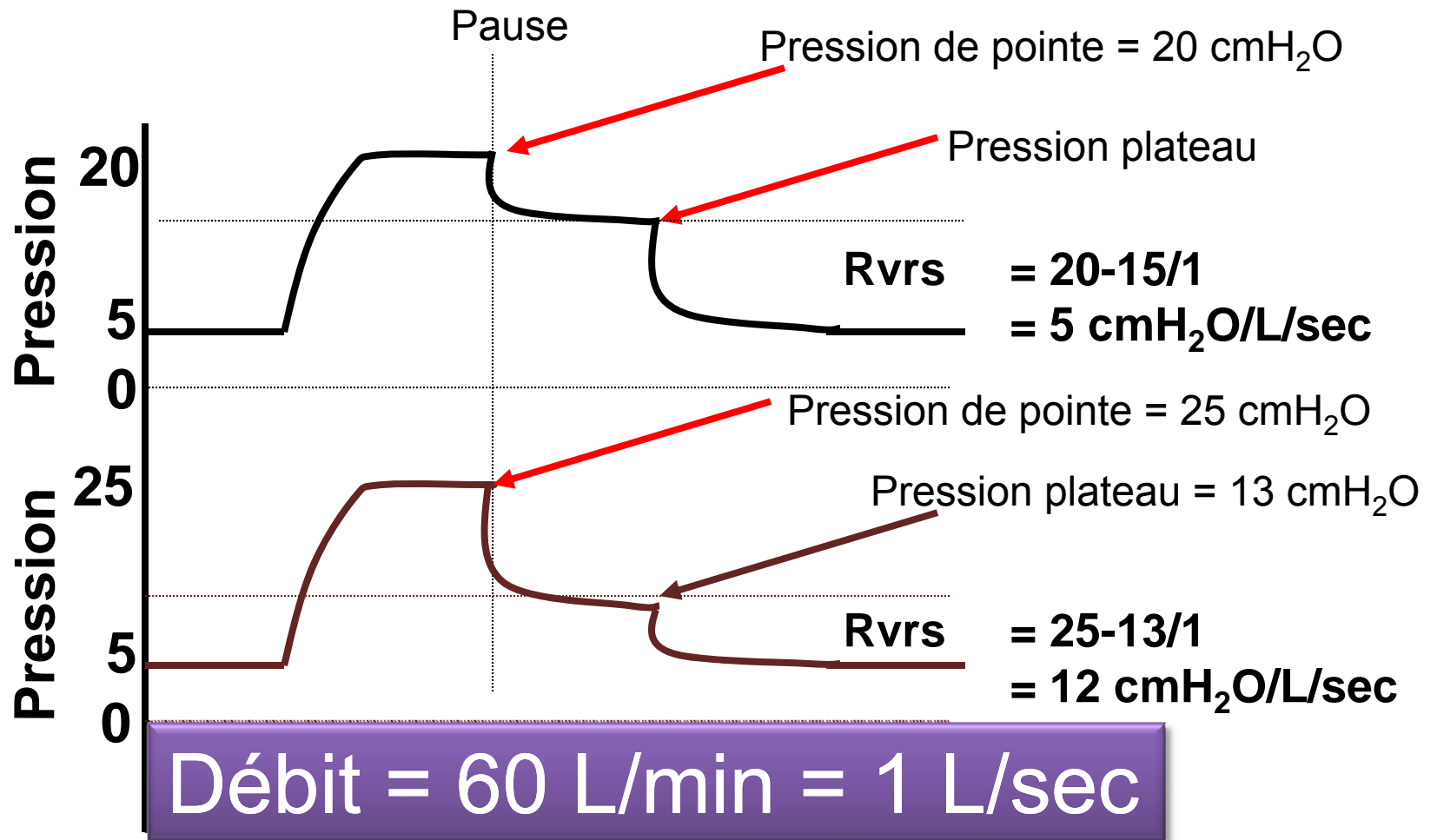


A: Résistance accrue

- PIP - P<sub>pause</sub> accrue
- Première marche accrue
- Pente de la seconde portion inchangée

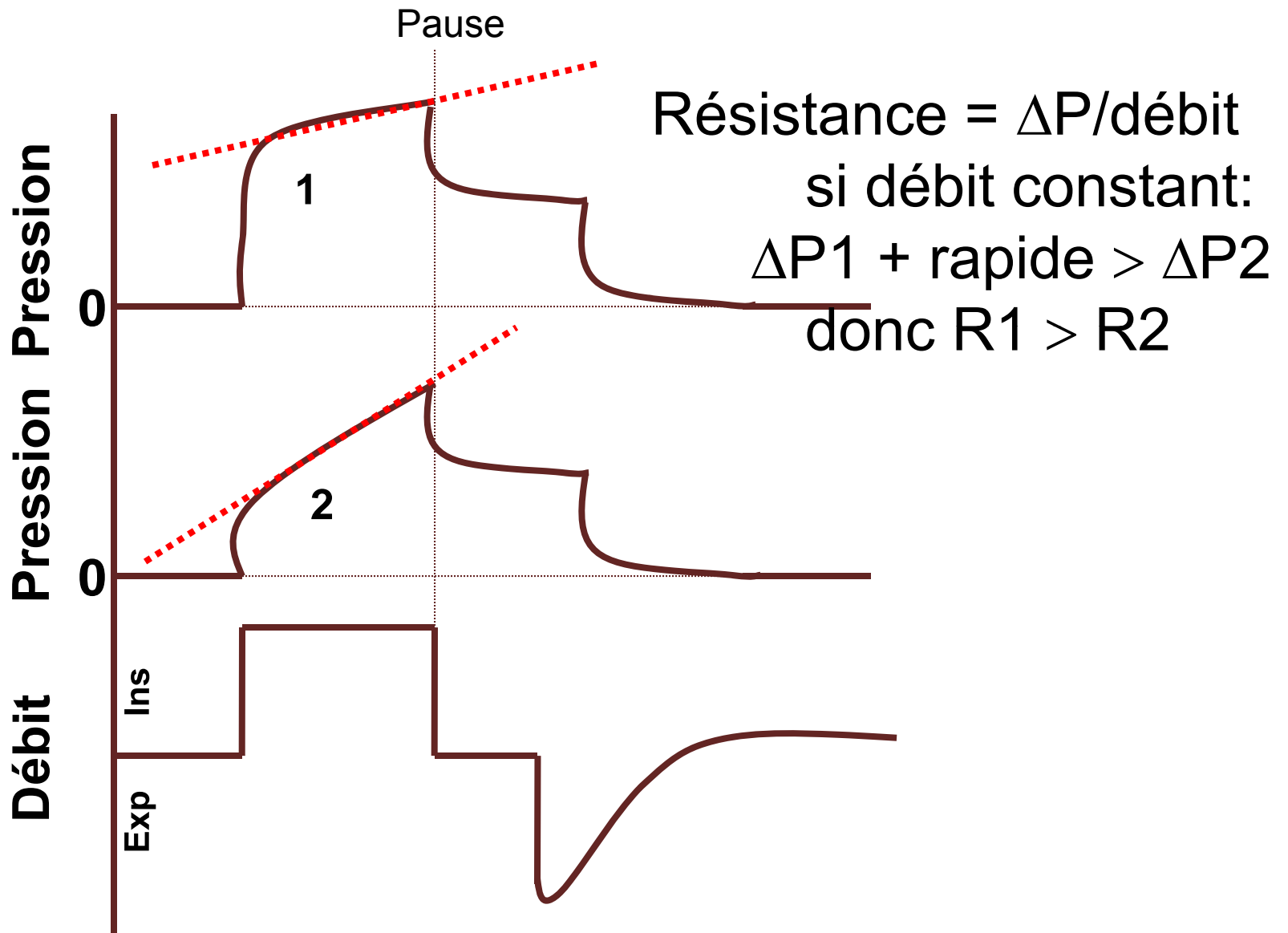
Paul Ouellet

# Résistance



La ↓ de la P<sub>pointe</sub> - P<sub>plateau</sub> = mesure de l'efficacité des bronchodilatateurs  
Résistance acceptable sous ventilation mécanique = 15 cmH<sub>2</sub>O/L/sec

# Quel patient a la résistance la plus élevée?

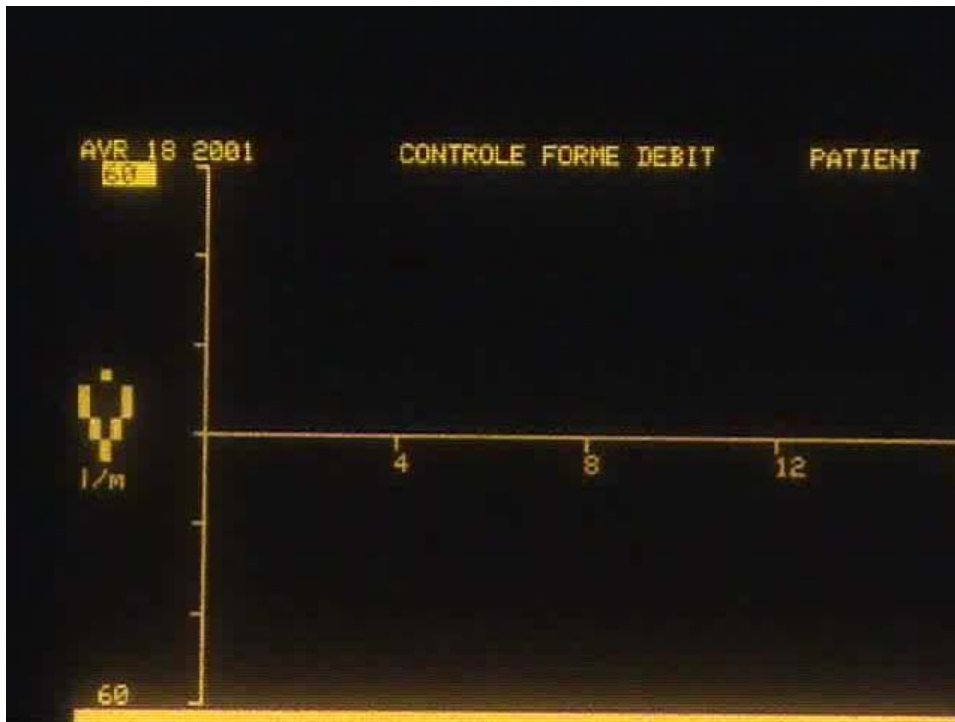


# Mécanique du système respiratoire

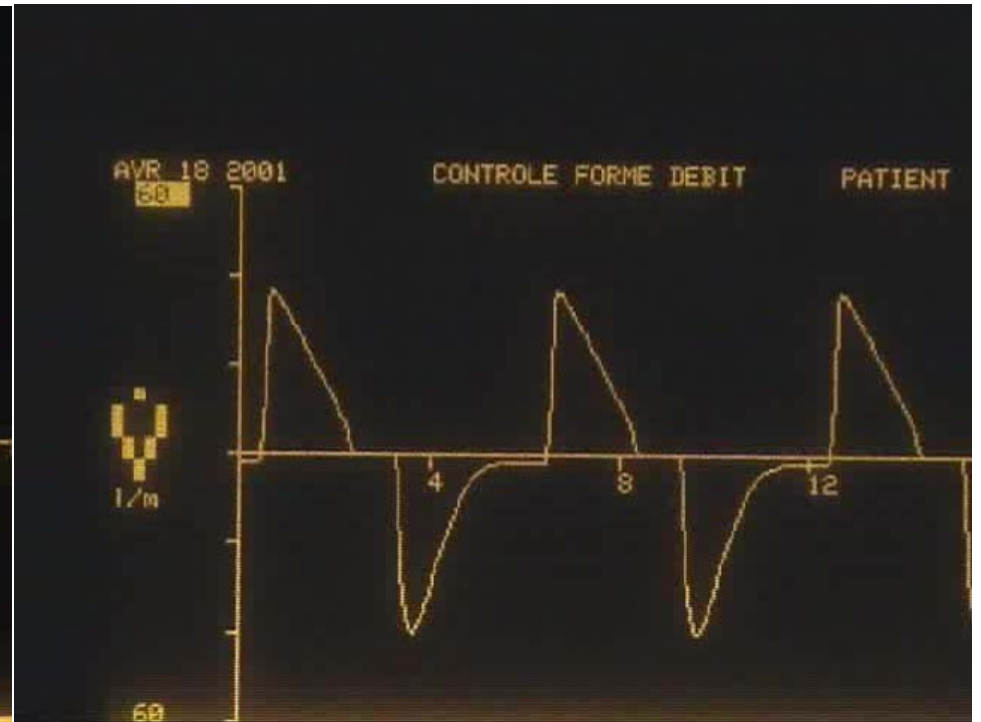
Simulateur: mode débit constant

Courbe débit-temps

Modification de la résistance



Résistance augmentée

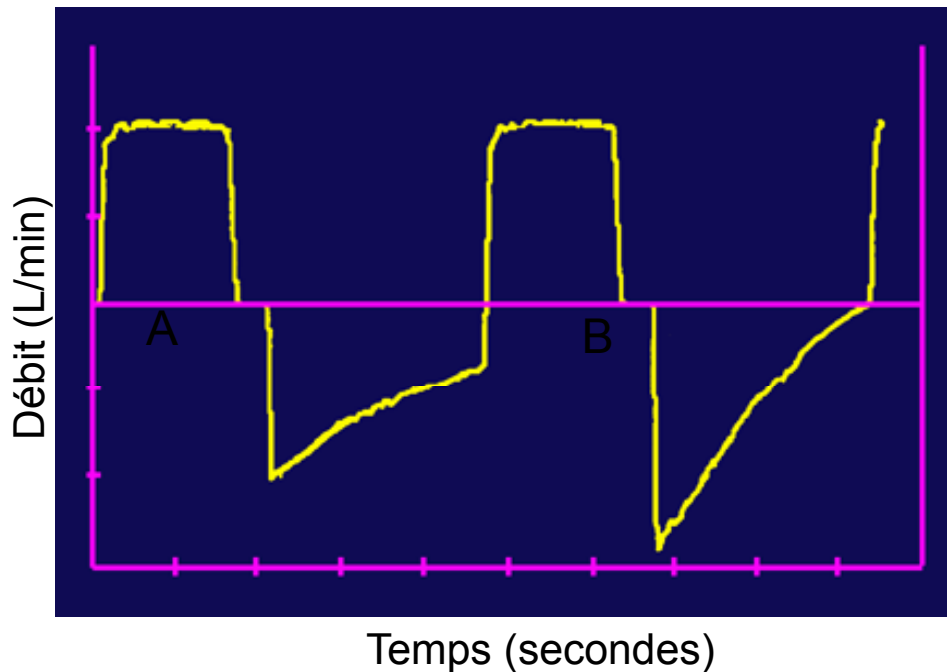


Résistance normale

# Courbe Débit-temps Mode à débit constant

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Changement résistance



A: Résistance accrue

- Retour linéaire et lent vers la ligne de base

B: Résistance normale

- Retour exponentiel vers la ligne de base

# Mécanique du système respiratoire

Simulateur: mode débit constant

Courbe pression-volume

Modification de la résistance



Résistance augmentée

Résistance normale

# Homme de 64 ans: résection myocardique septale?



Début de la procédure



Fin de la procédure

Baisse de la résistance et du travail



# Monitoring respiratoire

## Plan

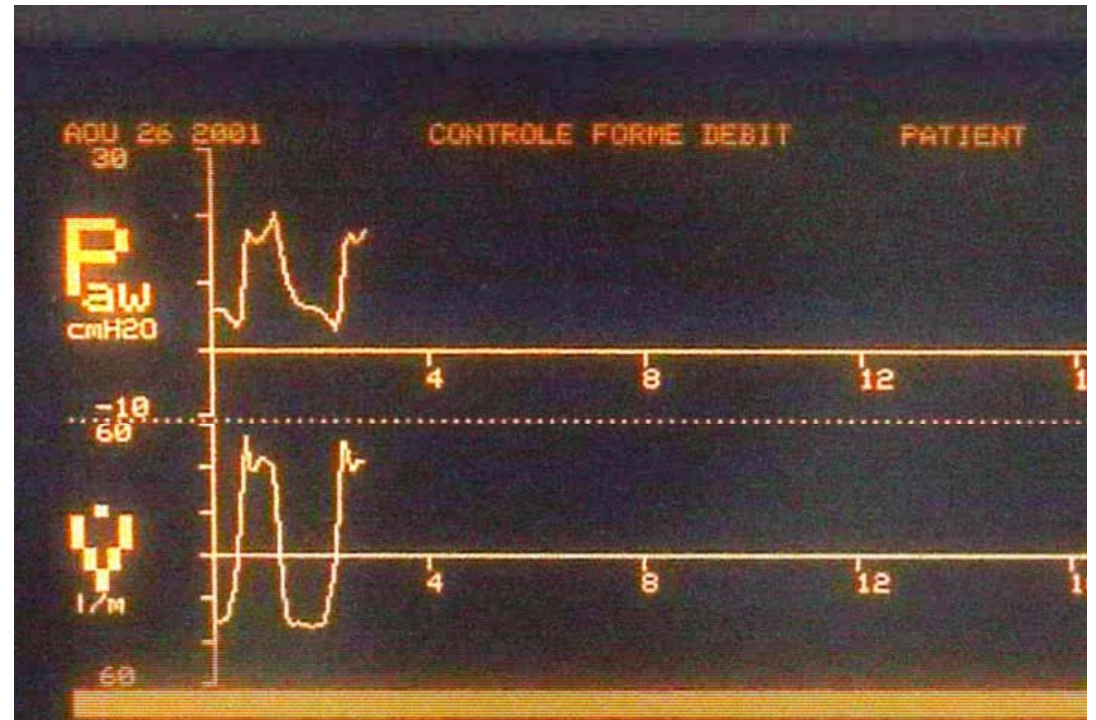
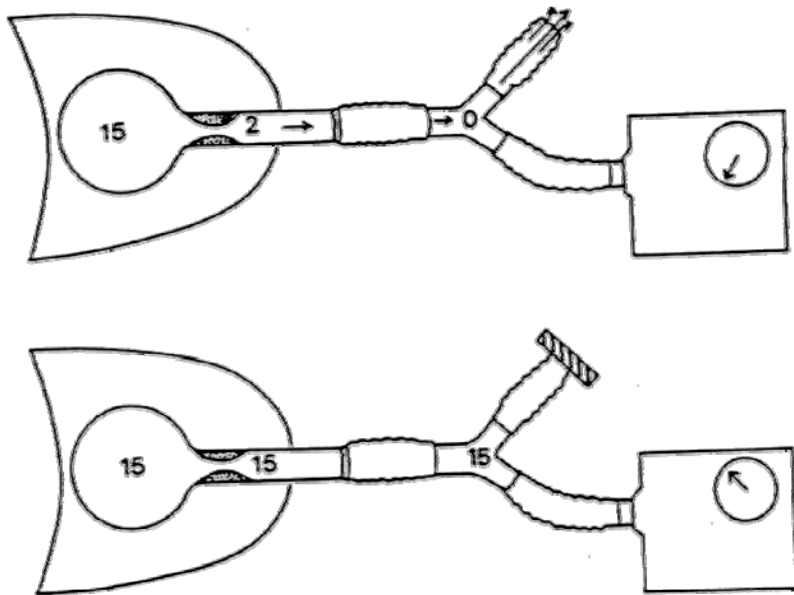
- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire
  - Compliance
  - Résistance
  - Auto-PEEP
  - Ratio I:E

# Auto-PEEP

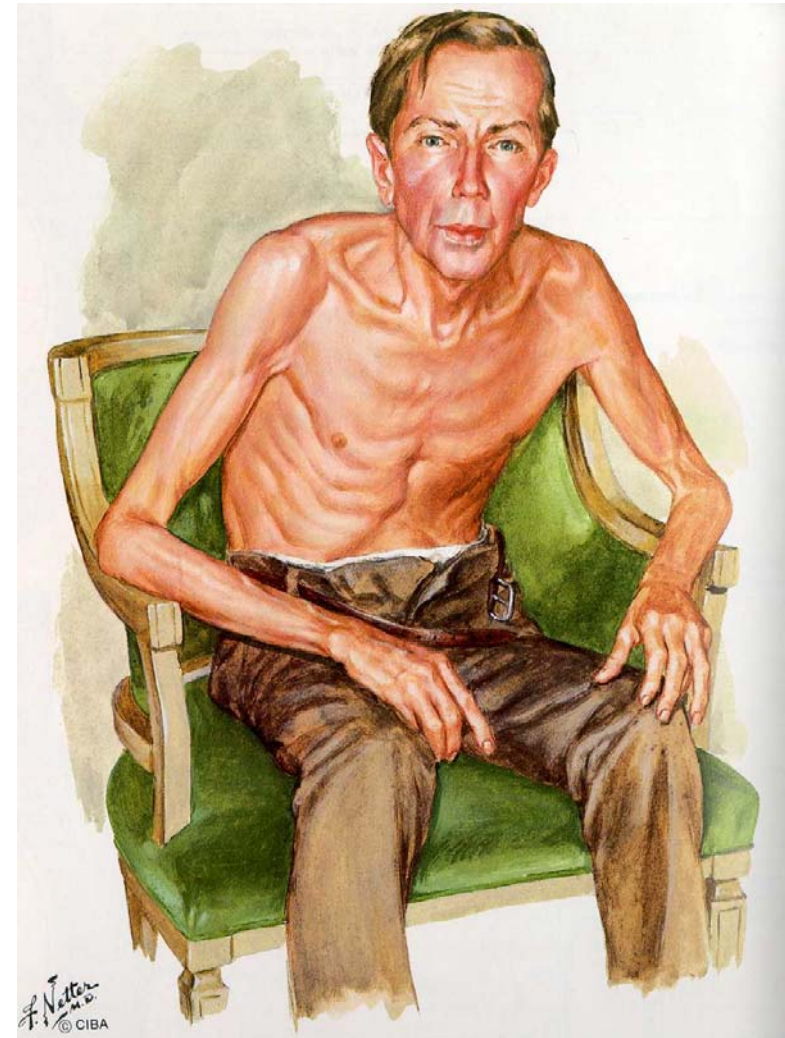
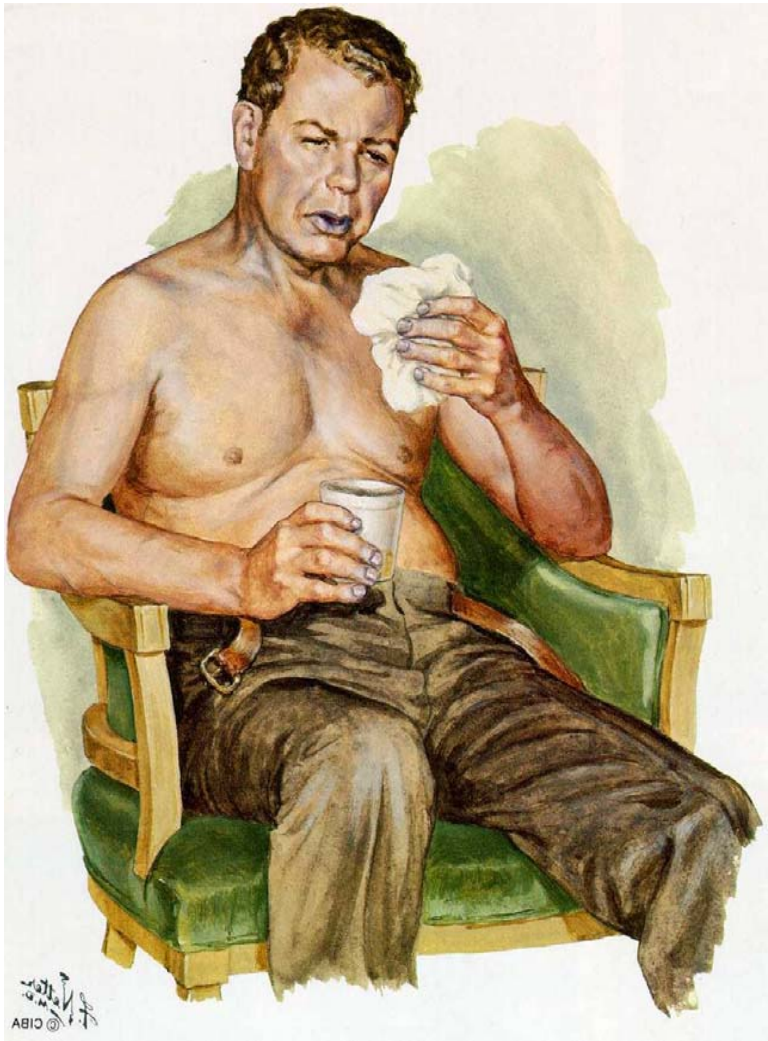


# Mécanique du système respiratoire

## Auto-PEEP

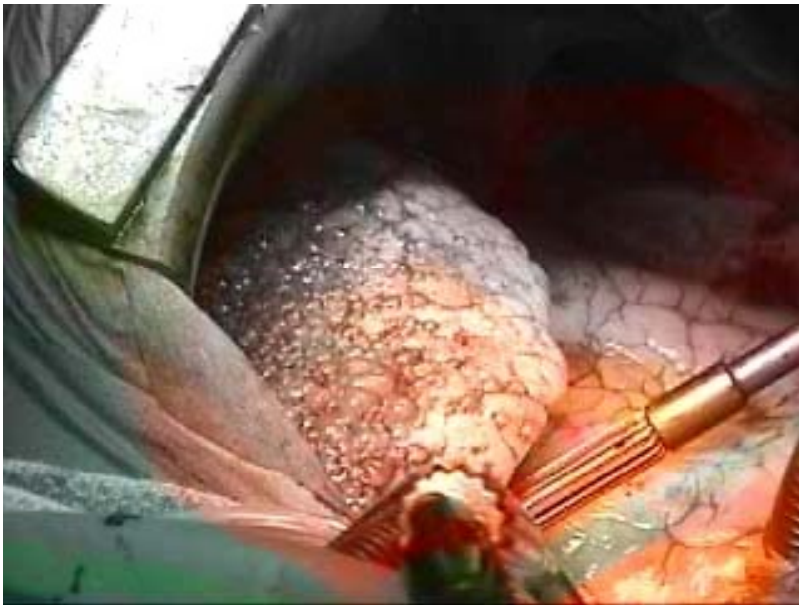


# Auto-PEEP: le plus à risque?



# Sévérité de la maladie et TFP

- Homme fumeur avec test de fonction pulmonaire normales
- Avant pontages



# Implication clinique de l'auto-PEEP

1-Augmente le travail respiratoire lors de l'initiation d'une ventilation spontanée

2-Diminue le retour veineux

3-Peut causer une pseudo- dissociation électro-mécanique

*Auto-PEEP during CPR. An « occult » cause of electromechanical dissociation.*

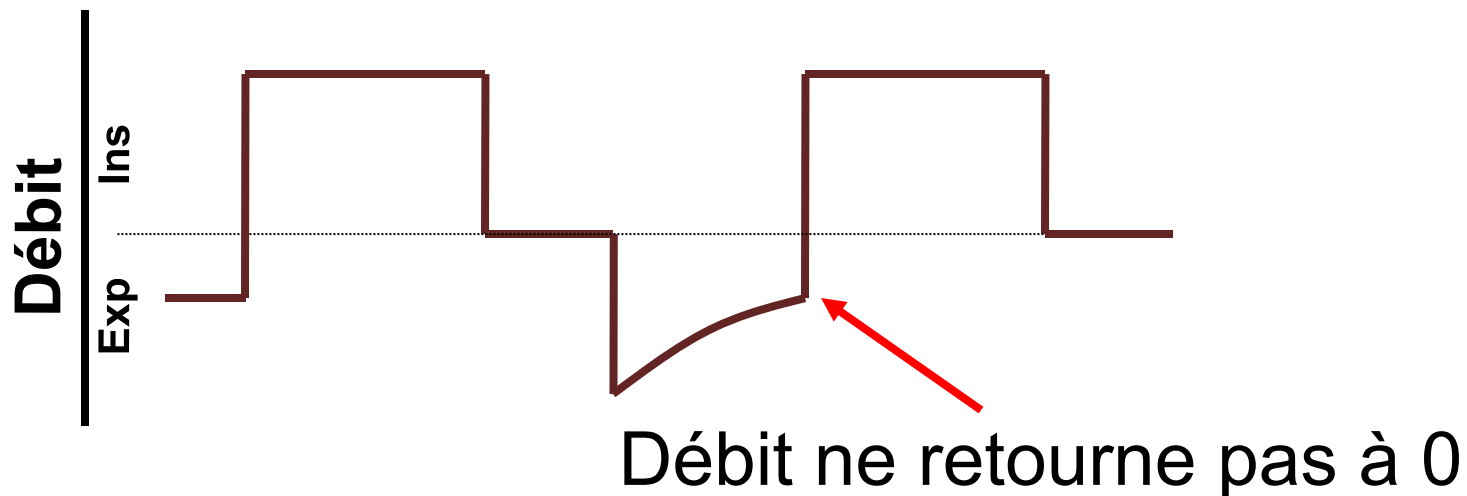
Paul L. Rogers et al. Chest 1991;99:492-3

## Comment traiter l'auto-PEEP?

Rx: fréquence, ratio I:E, débit inspiratoire, PEEP, He

# Méthodes de mesure de l'Auto-PEEP

- 1-Pression mesurée par obstruction de la sortie expiratoire en fin d'expiration
- 2-Observation de la pression négative nécessaire pour déclencher un débit
- 3-Quantité de PEEP nécessaire pour augmenter les pressions de pointe
- 4-Présence d'un débit expiratoire lors de la prochaine respiration
- 5-Mesure de la pression esophagienne



# Monitoring respiratoire

## Plan

- Échange gazeux
- Charge et capacité du système respiratoire
- Mécanique du système respiratoire
  - Compliance
  - Résistance
  - Auto-PEEP
  - Ratio I:E



# Ratio I:E

Quel débit inspiratoire est nécessaire pour donner un volume courant de 1000 ml avec un ratio I:E de 1:2 à une fréquence de 10/minute?

1-Fréquence de 10/minute = 1 cycle par 6 seconde

2-I:E 1:2 = 2 secondes en inspiration

4 secondes en expiration

3-Volume donné en inspiration: 1000 ml/2 secondes

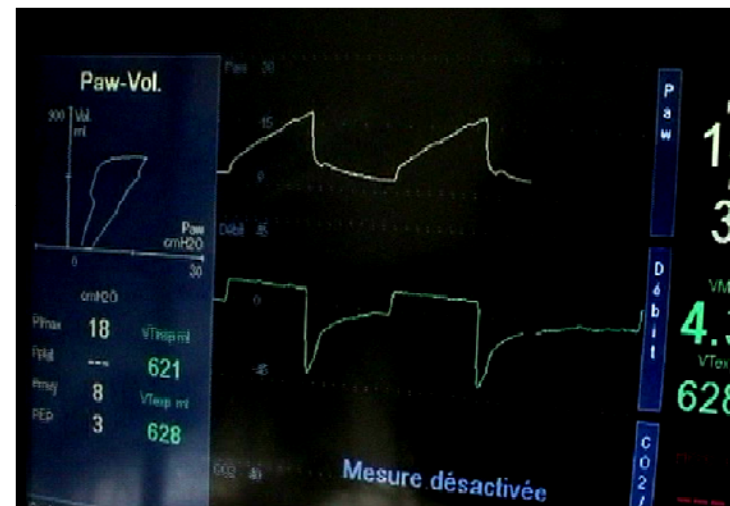
= 500 ml/secondes

= 30 litres/minutes (0.5L X 60 sec)

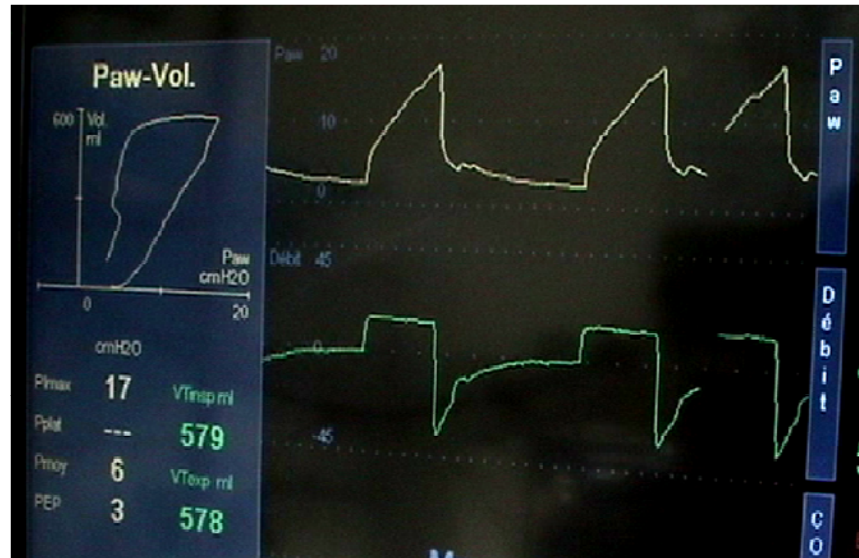
Si on augmente le ratio I:E,

il faut augmenter le débit inspiratoire et alors?

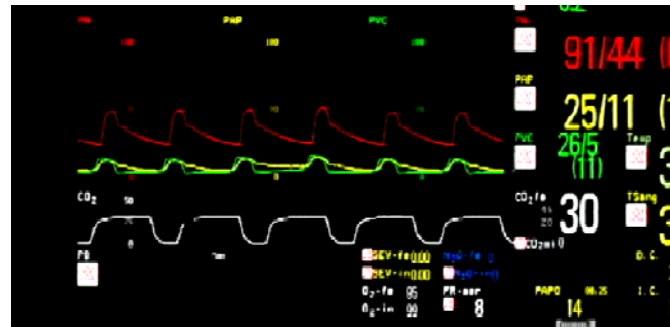
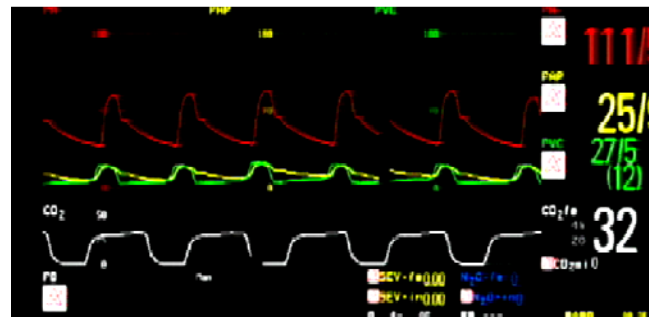
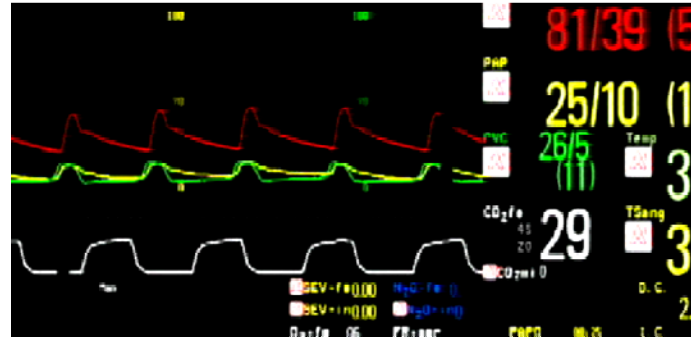
# Mécanique du système respiratoire



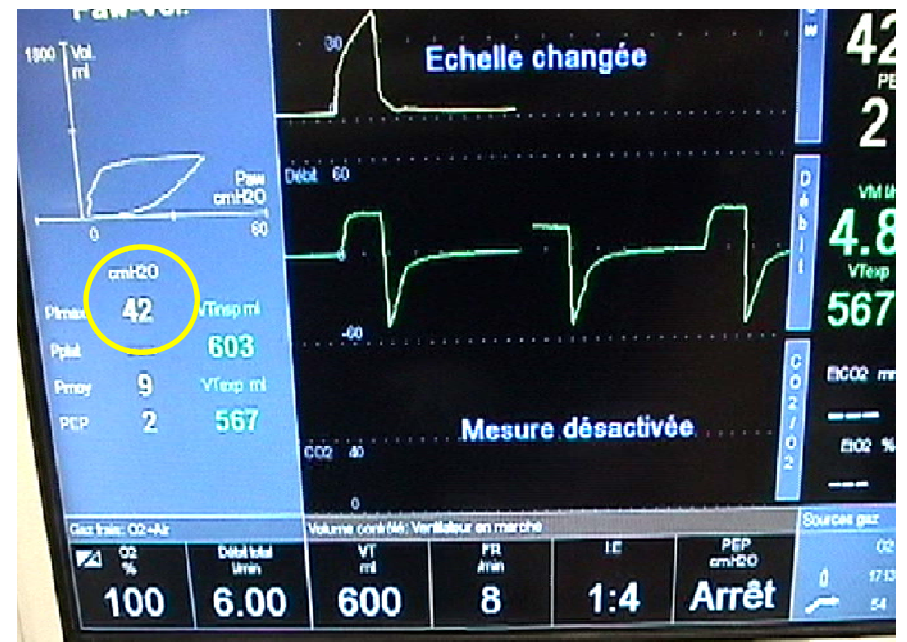
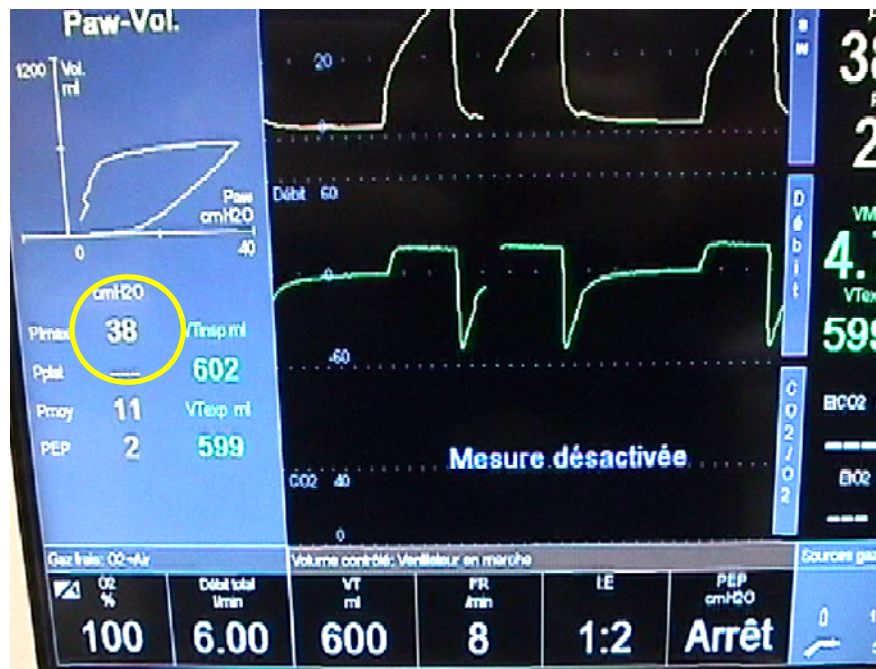
# Mécanique du système respiratoire



# Mécanique du système respiratoire

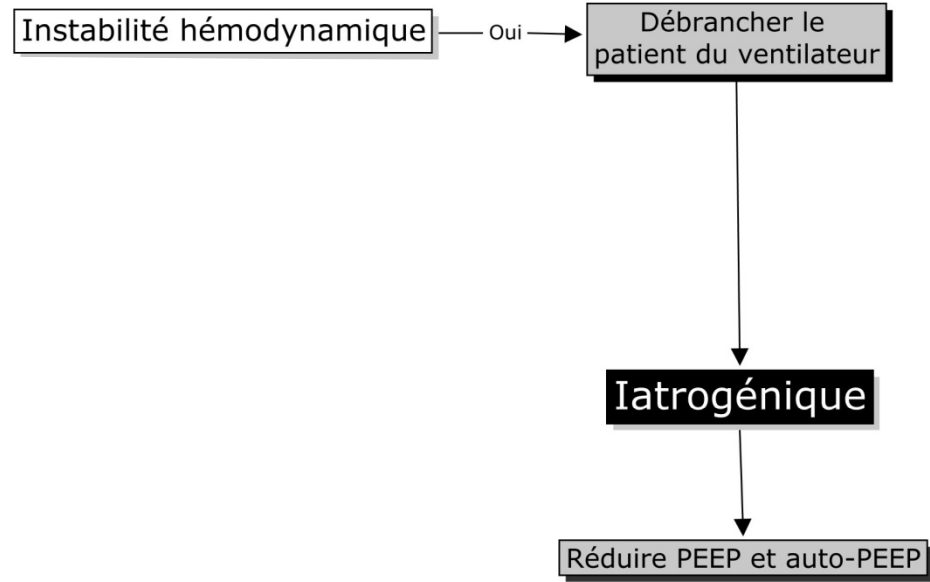


# Mécanique du système respiratoire

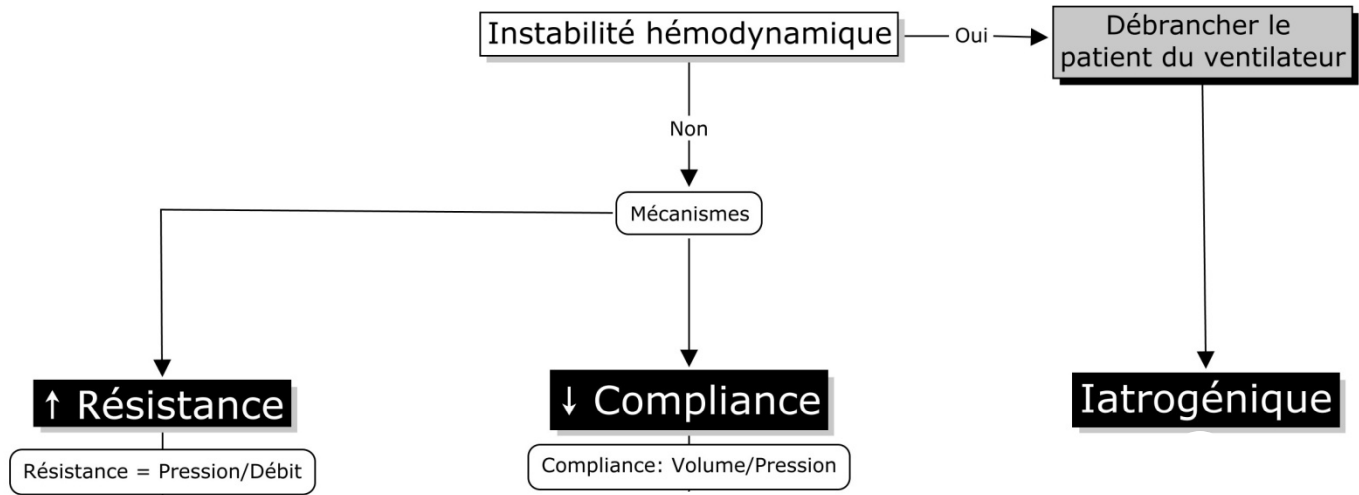


Si on augmente le ratio à 1:4?

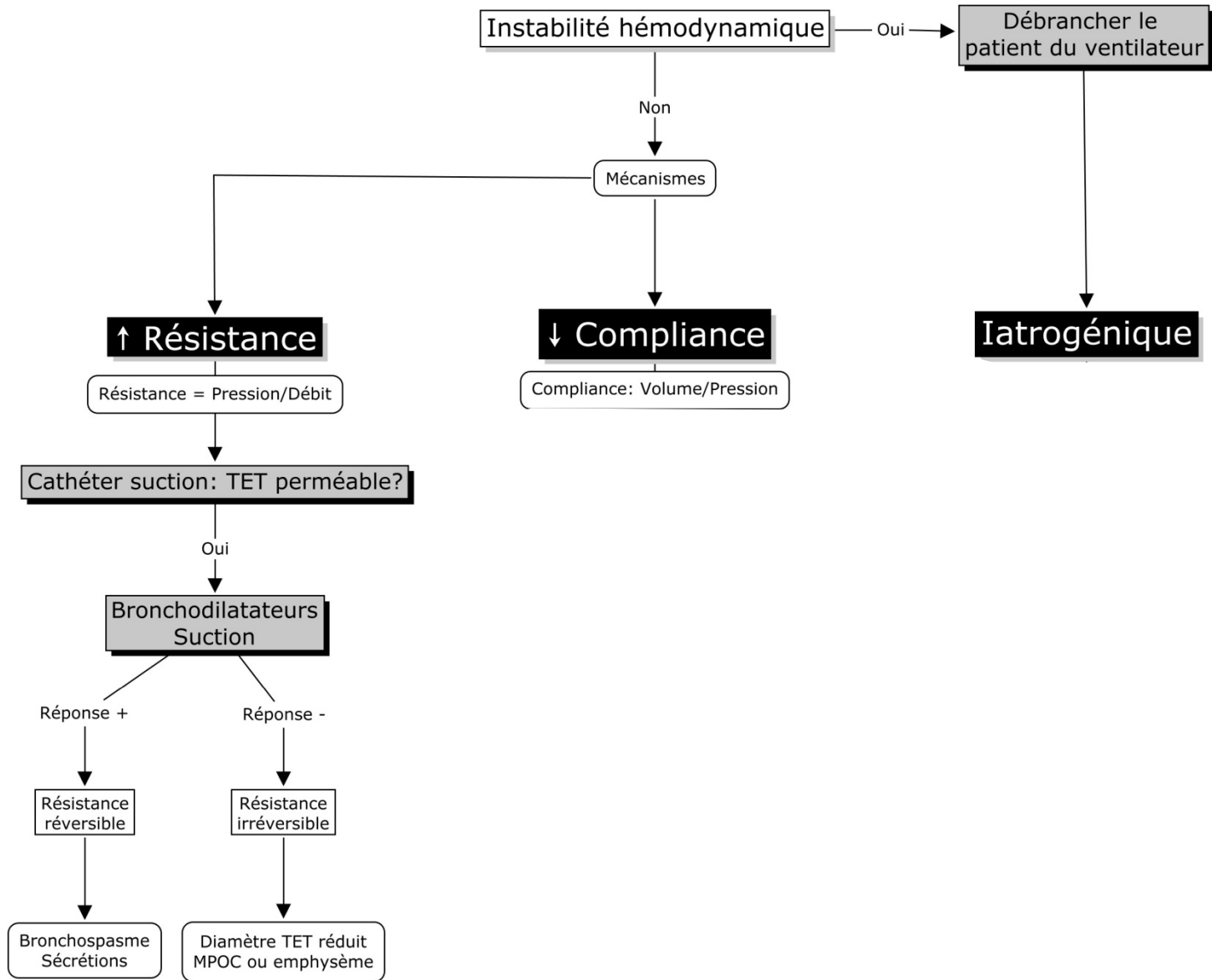
# ↑ Pressions VRS



# ↑ Pressions VRS

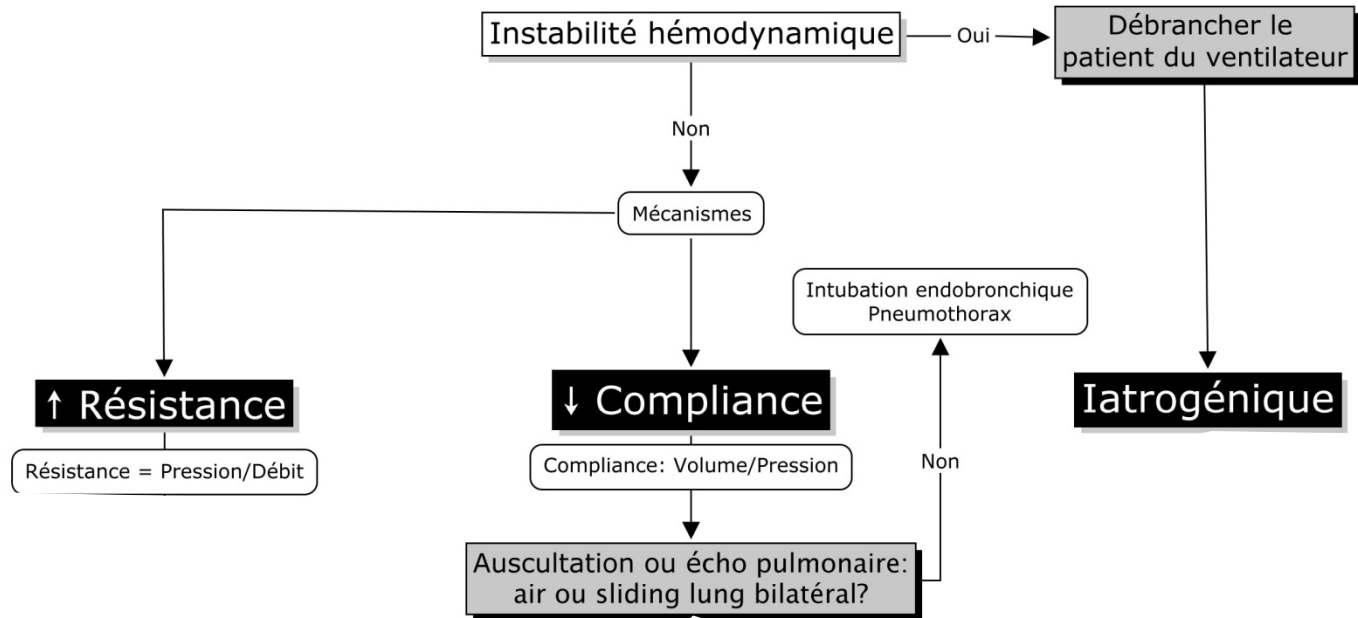


# ↑ Pressions VRS

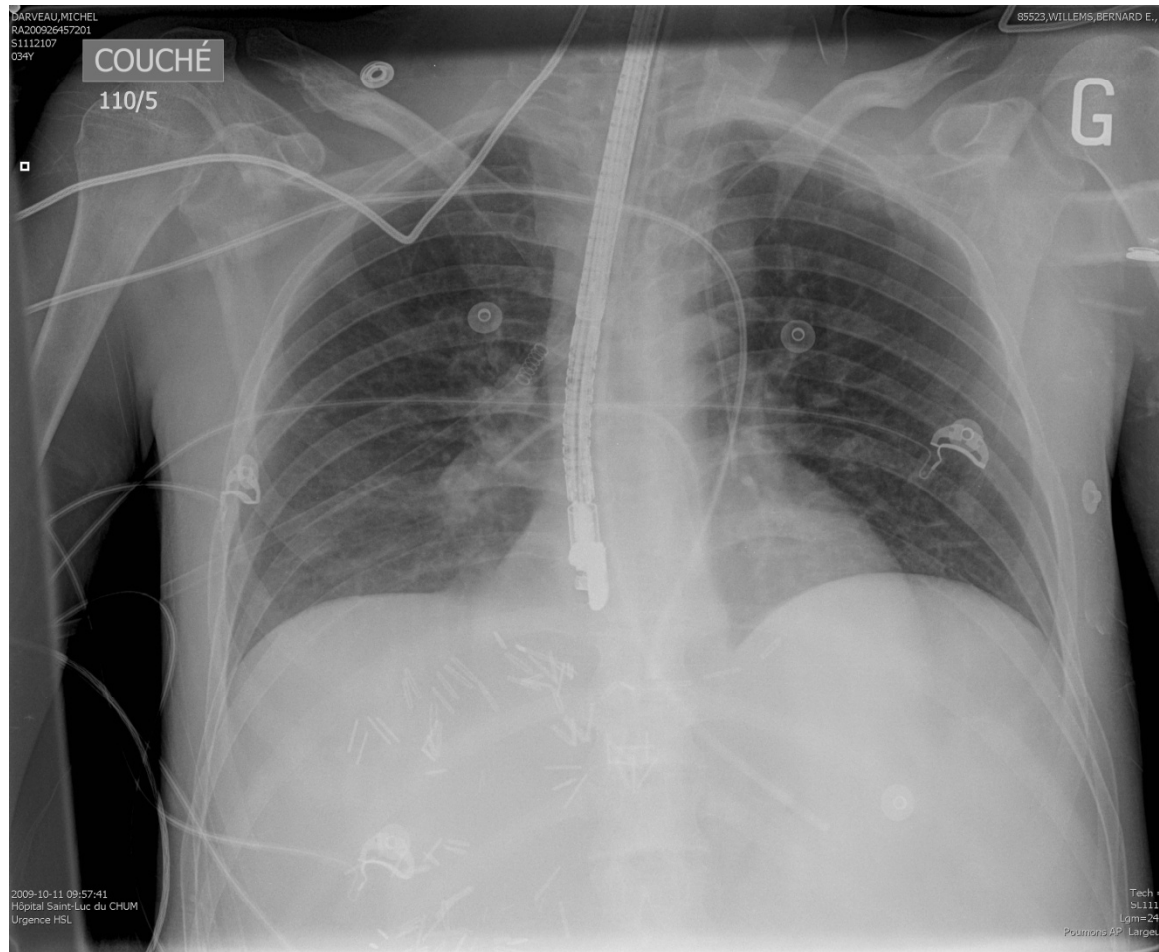




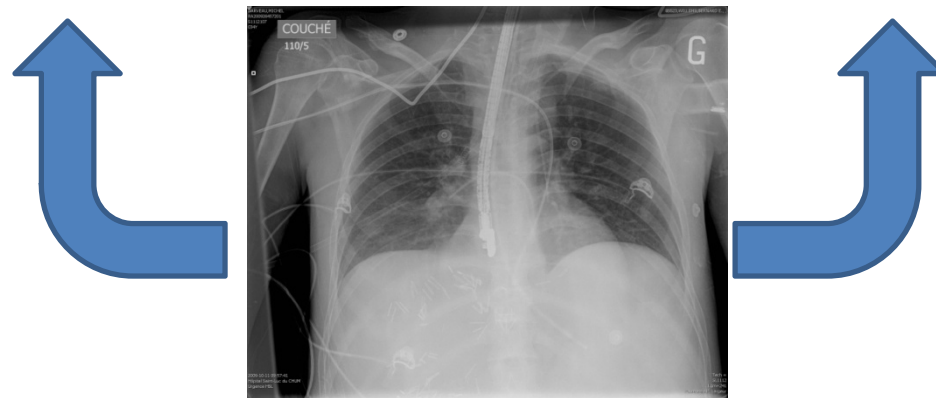
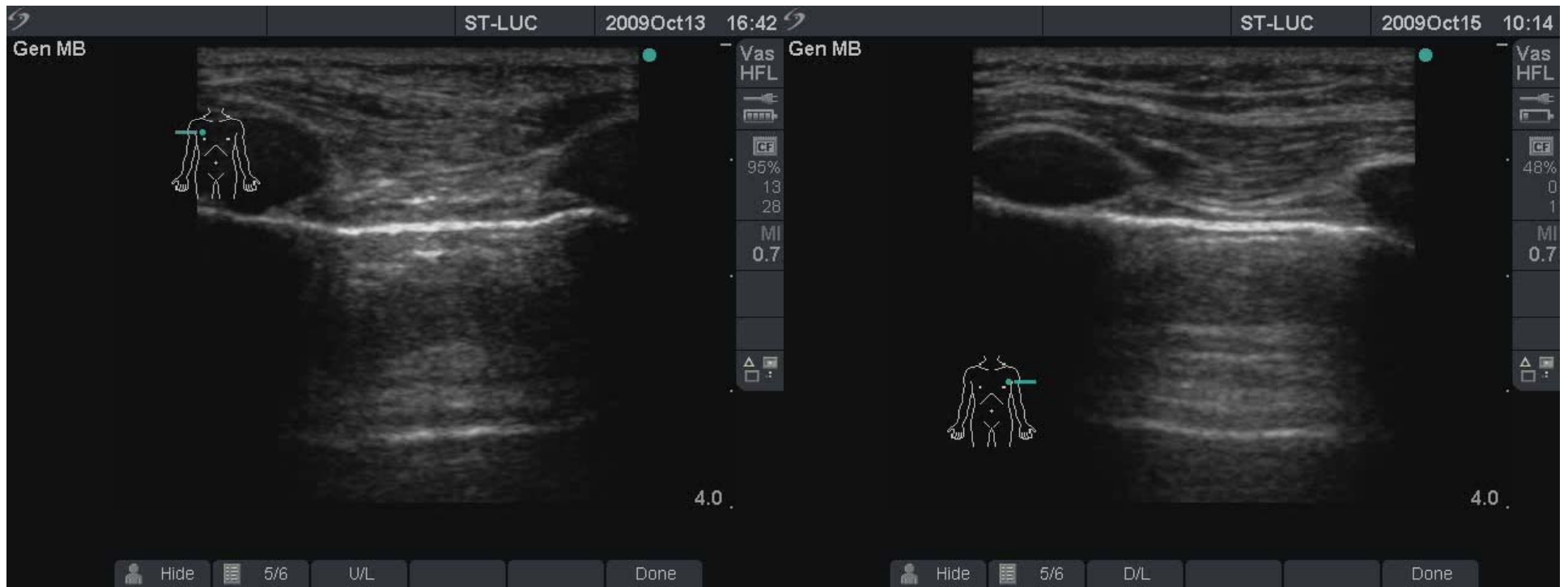
# ↑ Pressions VRS



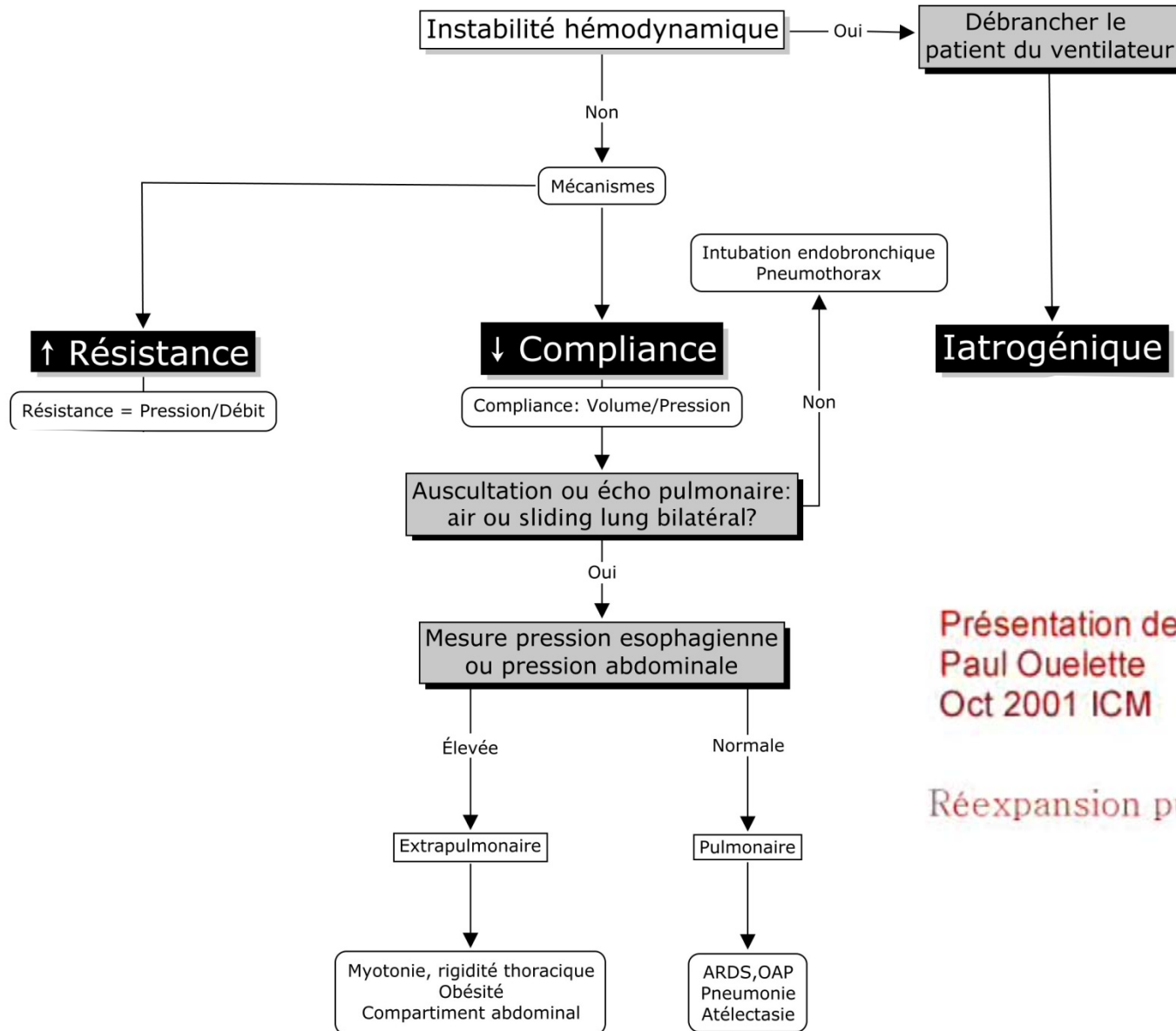
♂ de 42 ans post-greffe de foie



# ♂ de 42 ans post-greffe de foie: désaturation

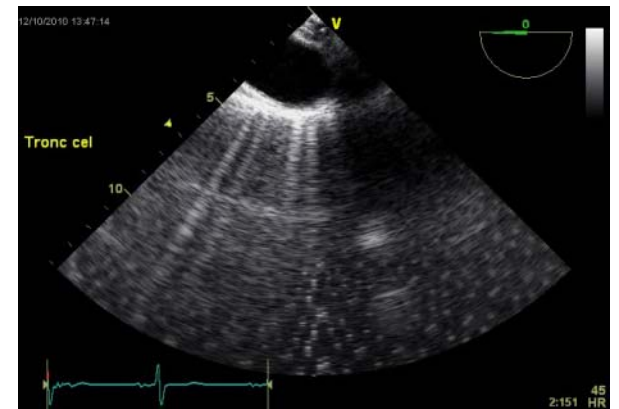
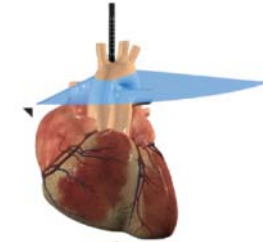
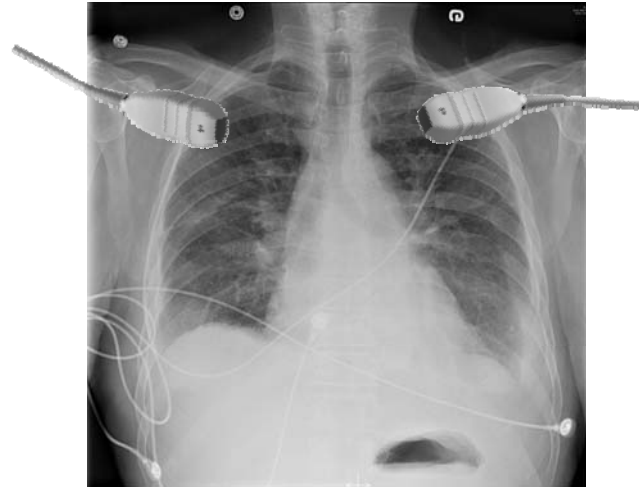


# ↑ Pressions VRS



Présentation de:  
Paul Ouelette  
Oct 2001 ICM

Réexpansion pulmonaire

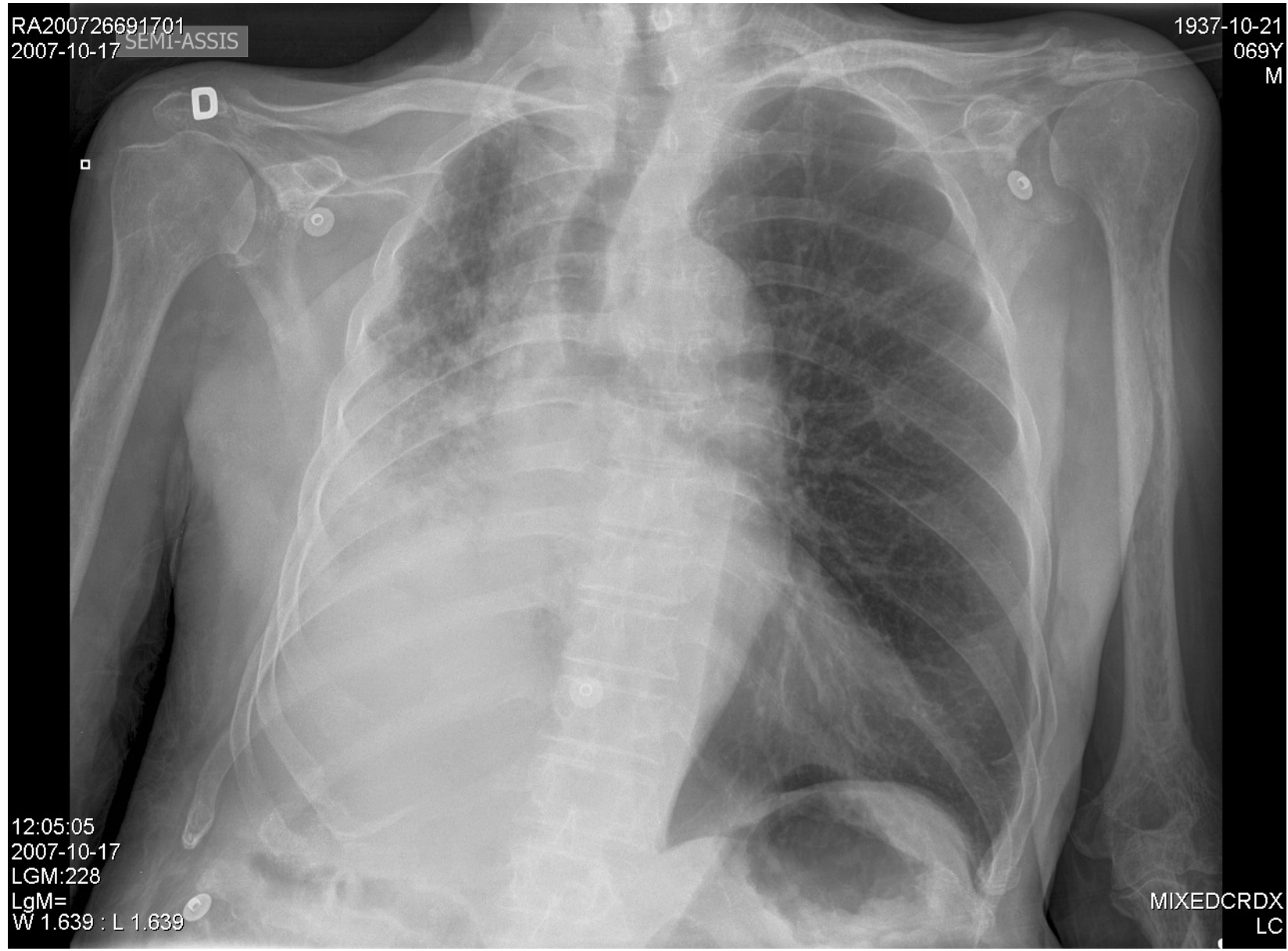


RA200726691701  
2007-10-17 SEMI-ASSIS

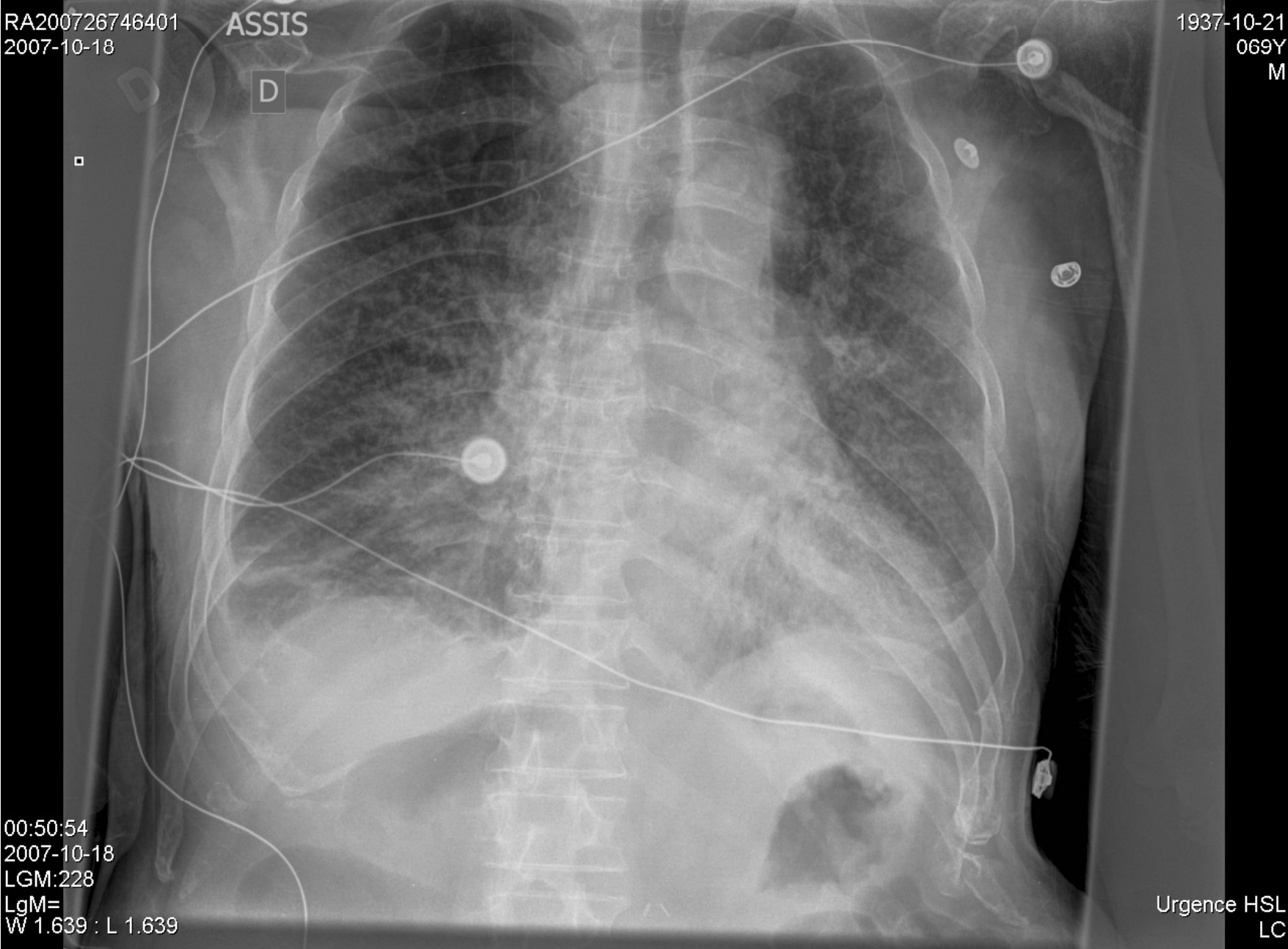
1937-10-21  
069Y  
M

12:05:05  
2007-10-17  
LGM:228  
LgM=  
W 1.639 : L 1.639

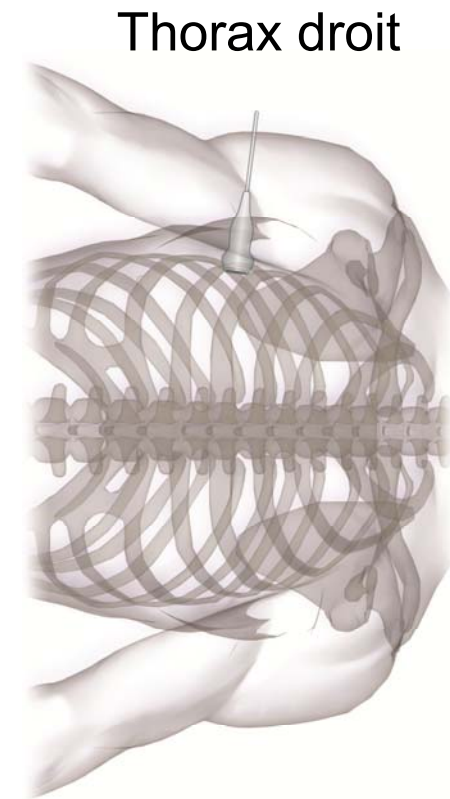
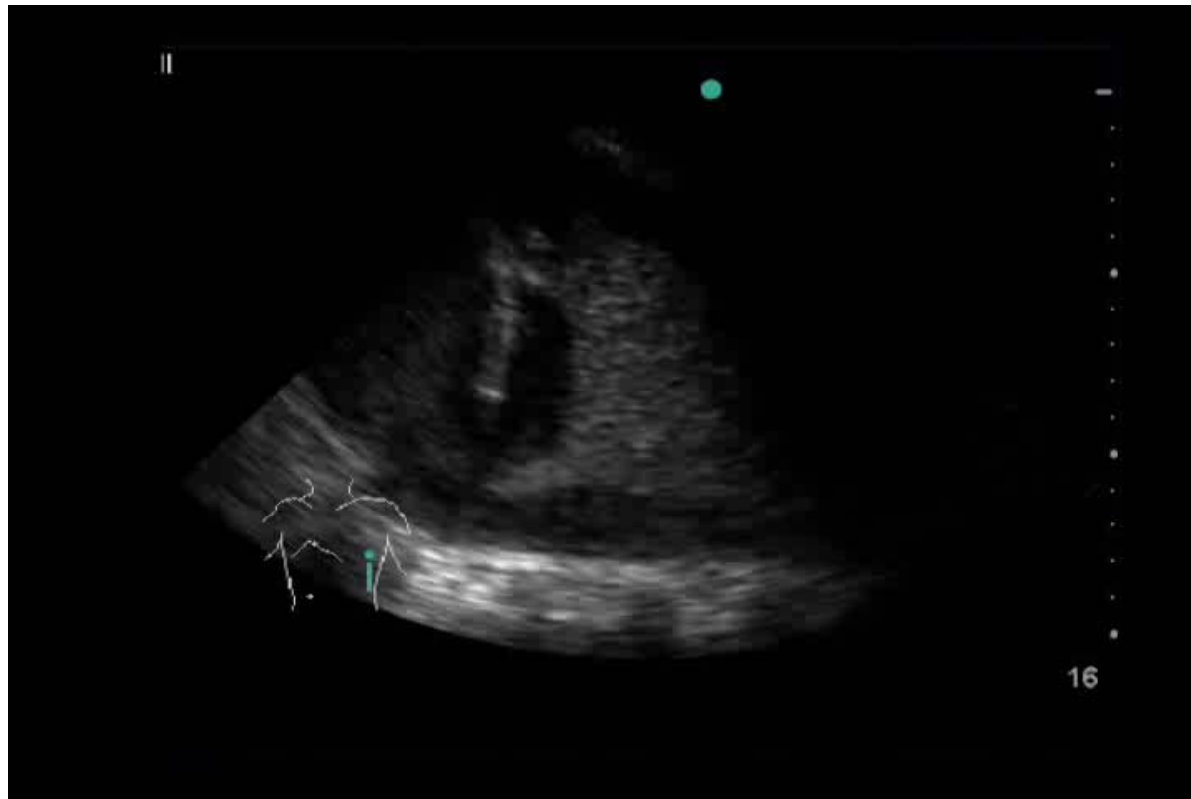
MIXEDCRDX  
LC



# Post-bronchoscopie

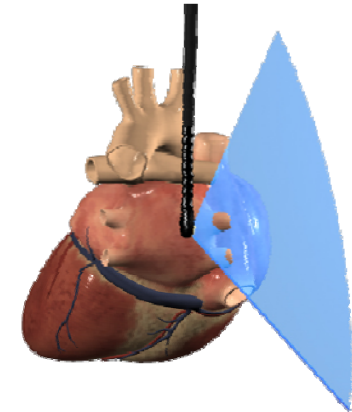
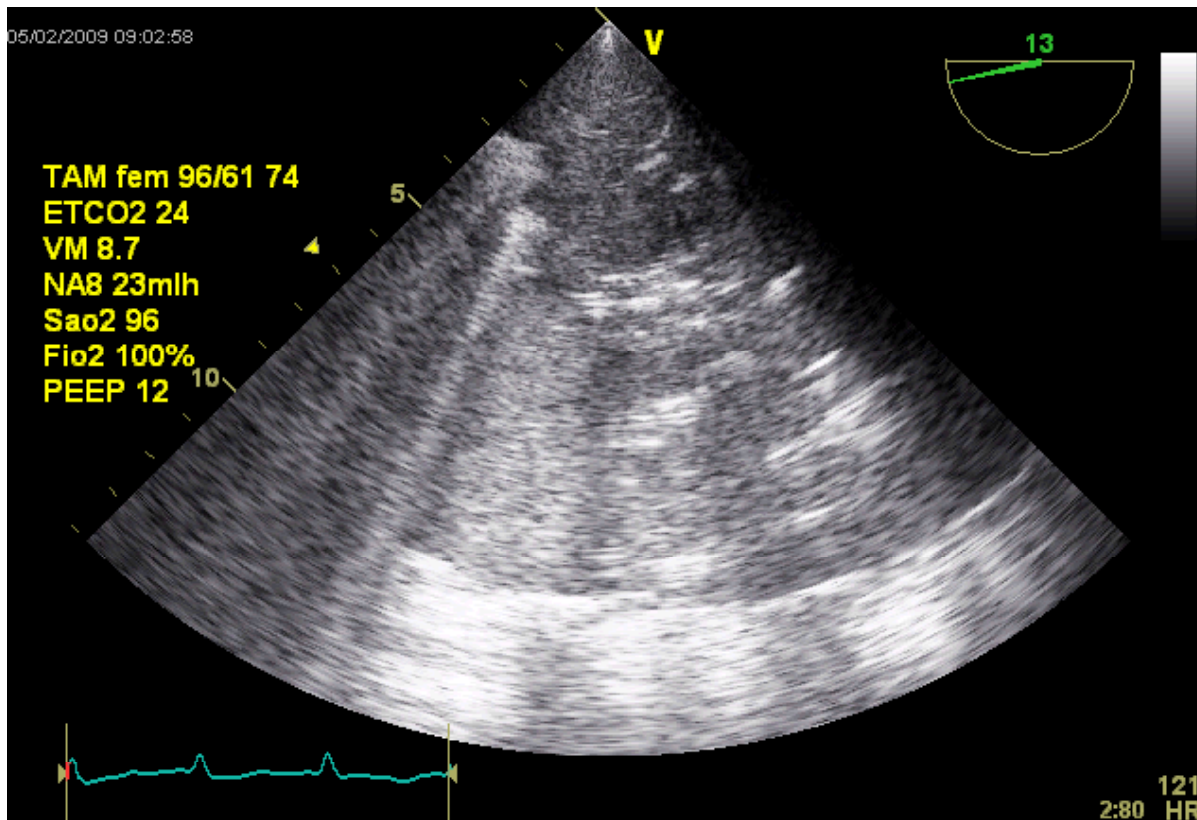


# Atélectasie ou pneumonie?

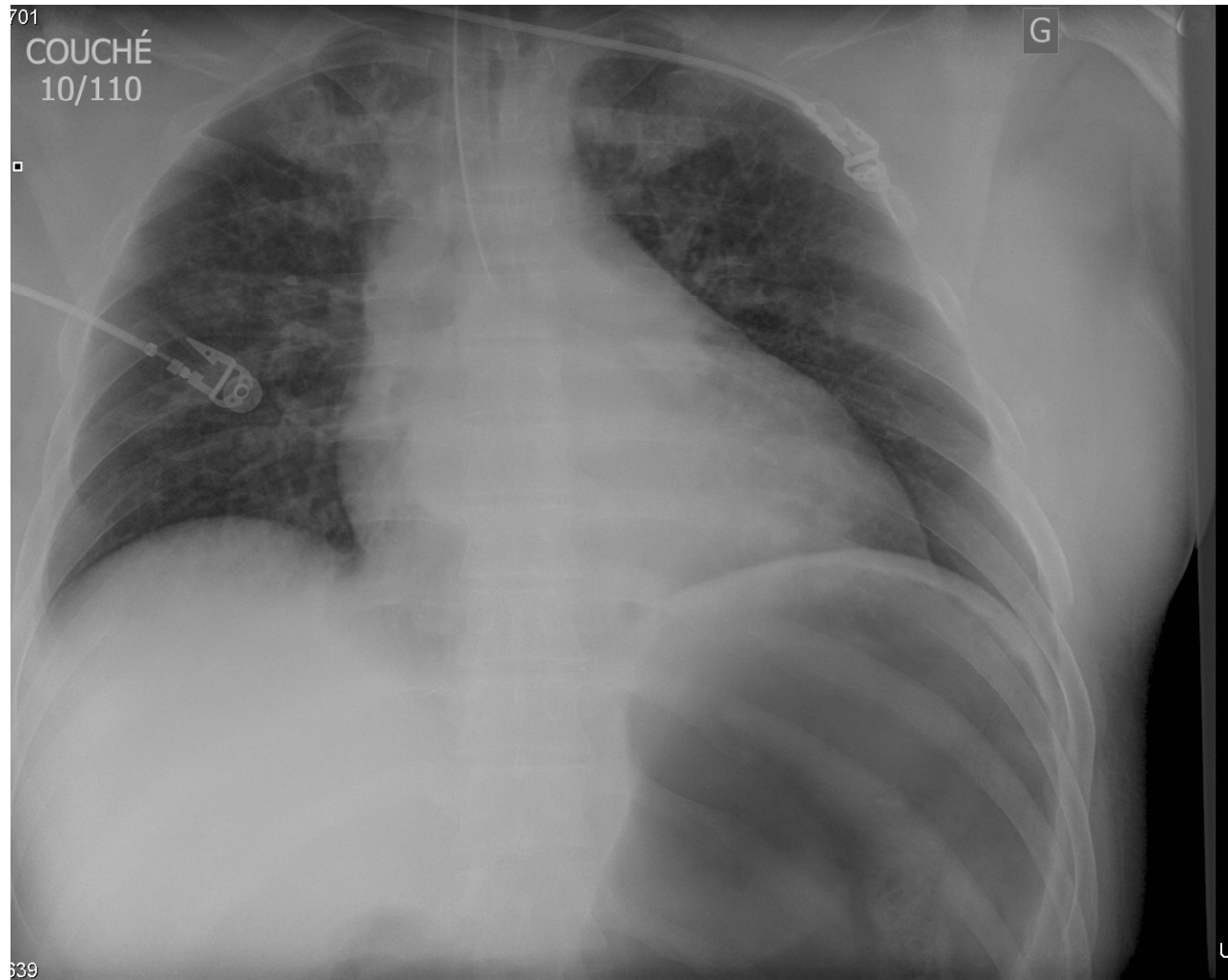




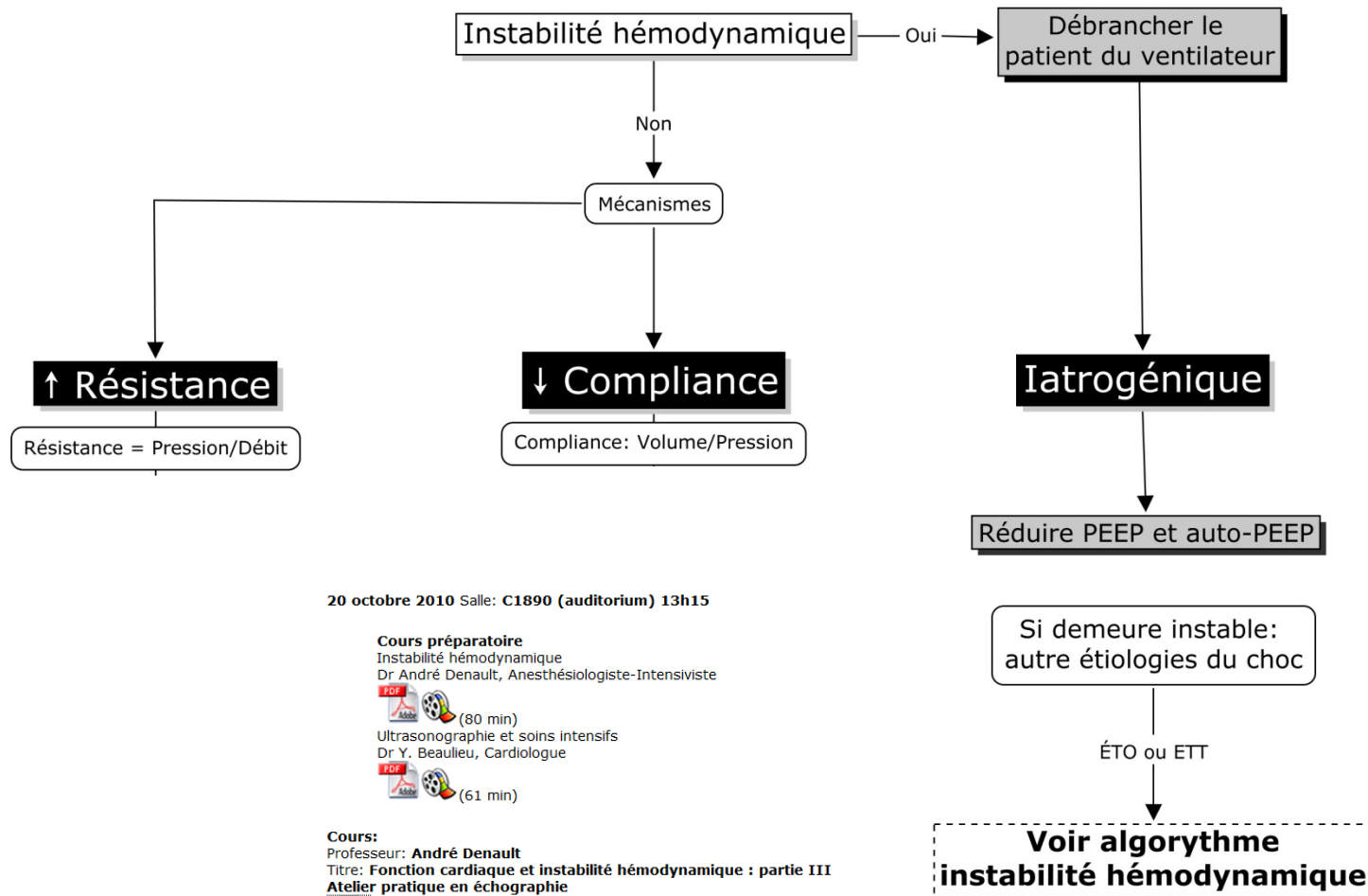
♀ de 58 ans instable après greffe hépatique



# Pression VRS $\uparrow$ et hypotension rebelle post intubation difficile!



# ↑ Pressions VRS



20 octobre 2010 Salle: C1890 (auditorium) 13h15

## Cours préparatoire

Instabilité hémodynamique  
Dr André Denault, Anesthésiologiste-Intensiviste



(80 min)

Ultrasonographie et soins intensifs  
Dr Y. Beaulieu, Cardiologue



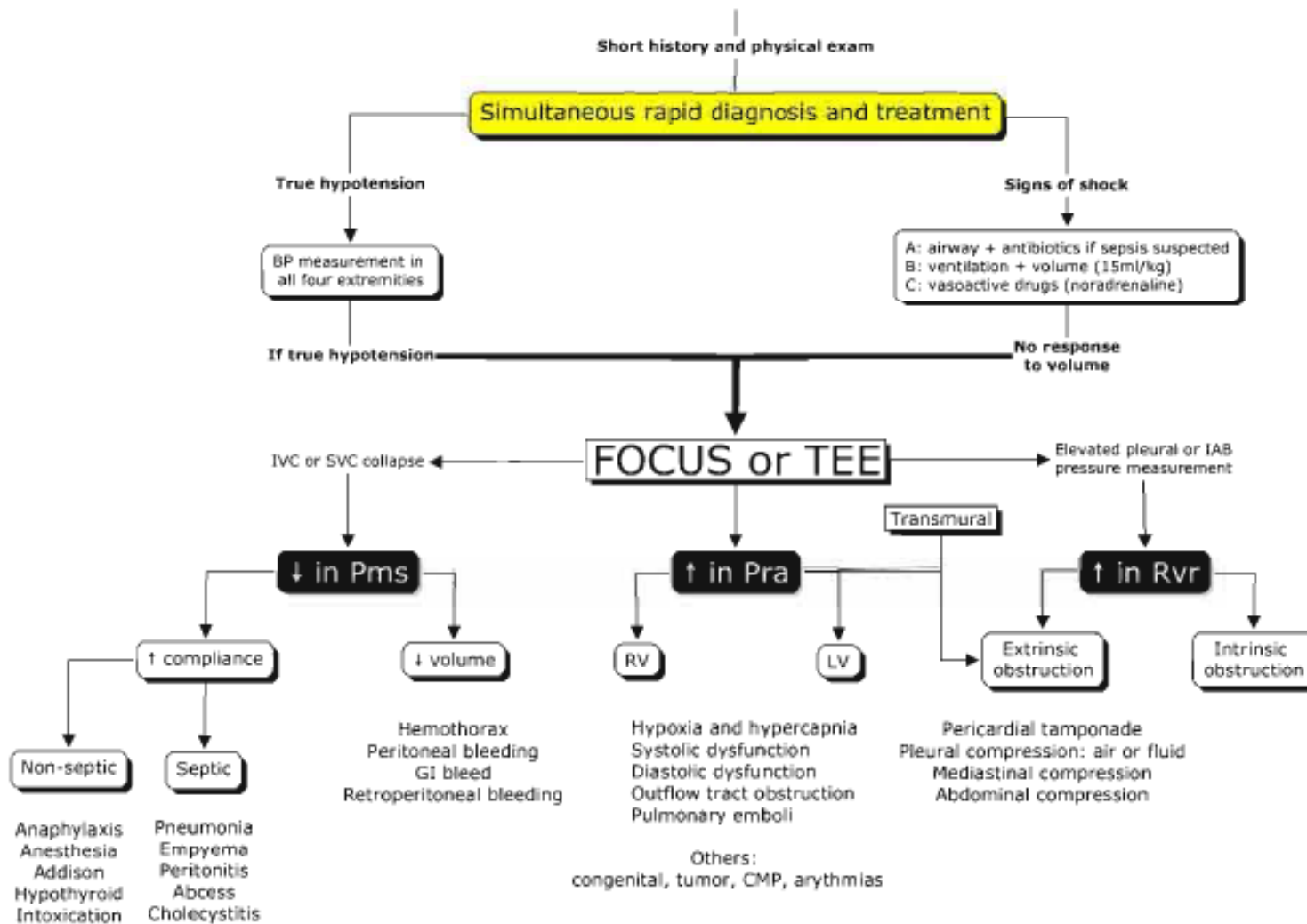
(61 min)

## Cours:

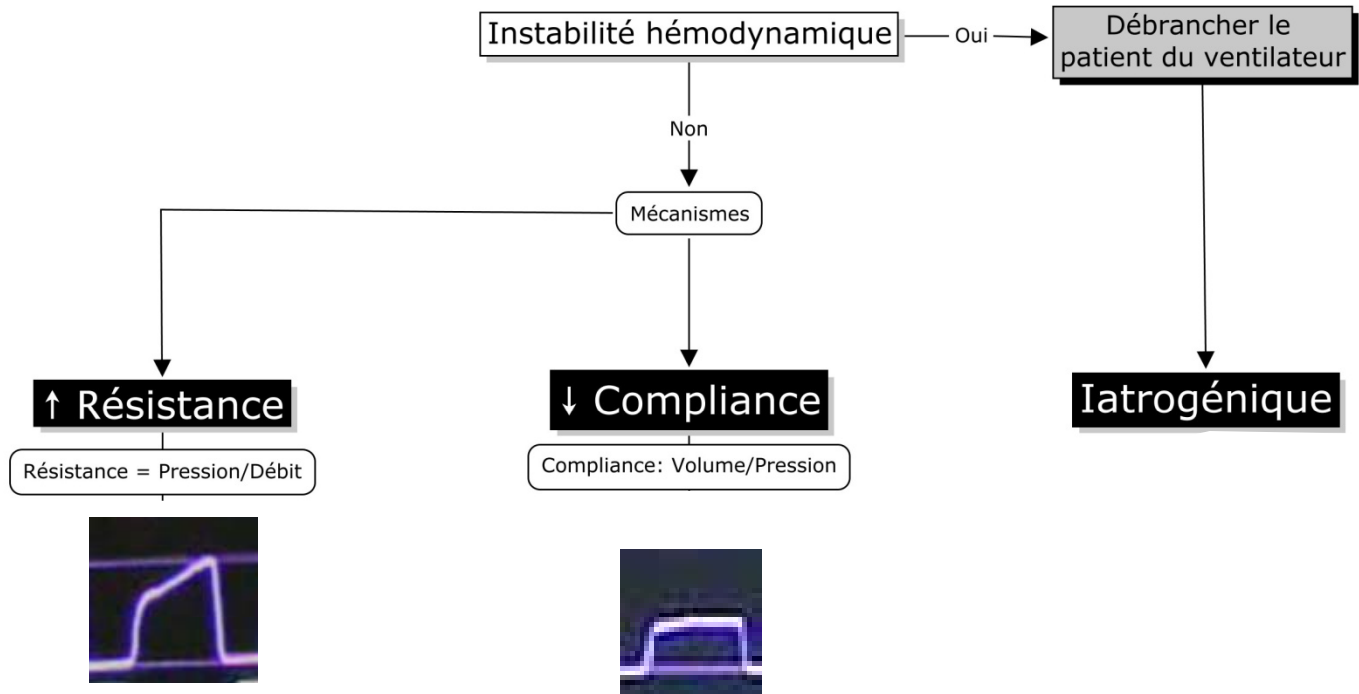
Professeur: **André Denault**  
Titre: **Fonction cardiaque et instabilité hémodynamique : partie III**  
**Atelier pratique en échographie**



# Hemodynamic instability



# ↑ Pressions VRS



# En résumé

- Rôle de l'anesthésiologiste: expert dans le maintien du « A » et du « B »
- Évaluation du résultat de la ventilation mécanique: oxygénation et ventilation
- Si difficulté d'oxygénation ou de ventilation: saisir le mécanisme: compliance ou résistance vs  $TO_2/VO_2$  et compétence
- Apprendre le langage du ventilateur



Denis Babin M.Sc. Env.  
Assistant de recherche  
Inhalothérapeute



Alain Deschamps  
MD FRCPC PhD

Remerciements