



# Hypoxémie persistante et échecs de sevrage du respirateur

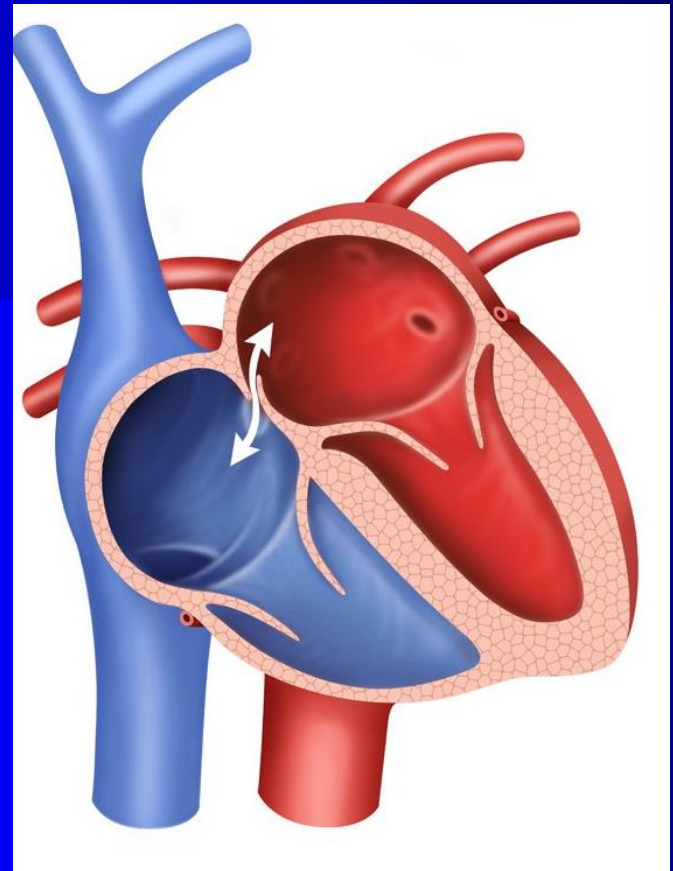
Prat Gwénaël  
Réanimation médicale  
[gwenael.prat@chu-brest.fr](mailto:gwenael.prat@chu-brest.fr)

- Préciser le rôle de l'échocardiographie dans l'exploration d'une hypoxémie inexpliquée
- Définir les critères diagnostiques de foramen ovale perméable et de shunt anatomique intrapulmonaire
- Discuter l'intérêt de l'échocardiographie dans le sevrage du ventilateur

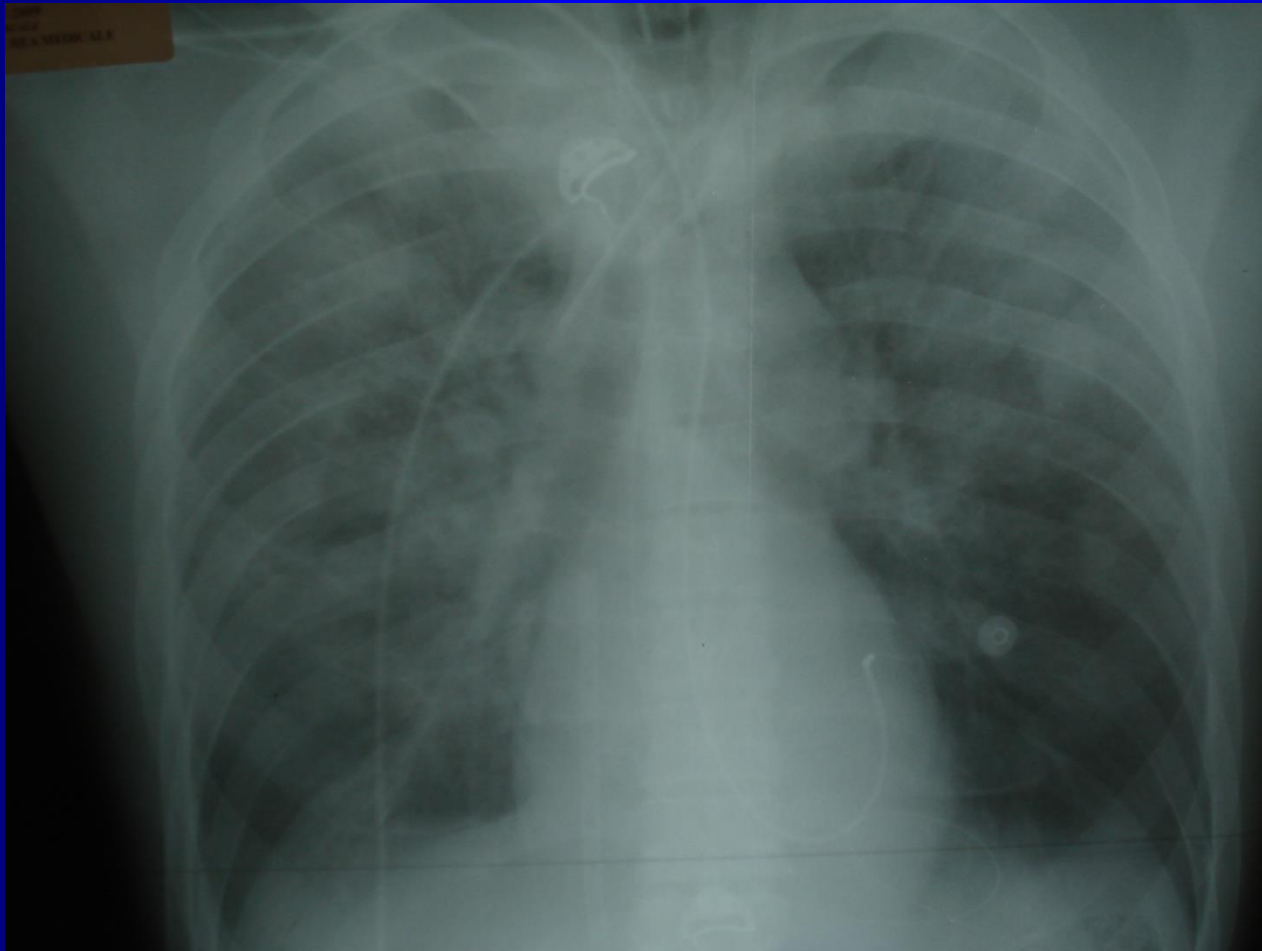
# 1/Rôle de l'échocardiographie dans l'exploration d'une hypoxémie inexpliquée



# 1. Définir les critères diagnostiques de foramen ovale perméable et de shunt anatomique intrapulmonaire



# Pourquoi ce patient est il hypoxémique?



VAC

Vt 500

Fr 19/min

Pplat: 27

PEP 6

FiO<sub>2</sub> 100%

PHILIPS

20/07/2009

11:16:54

ITm0.6 IM 1.0

S7-2omni/ETO

CI 39Hz  
14cm

C3

2D  
61%  
C 54  
P Arrêt  
HPên

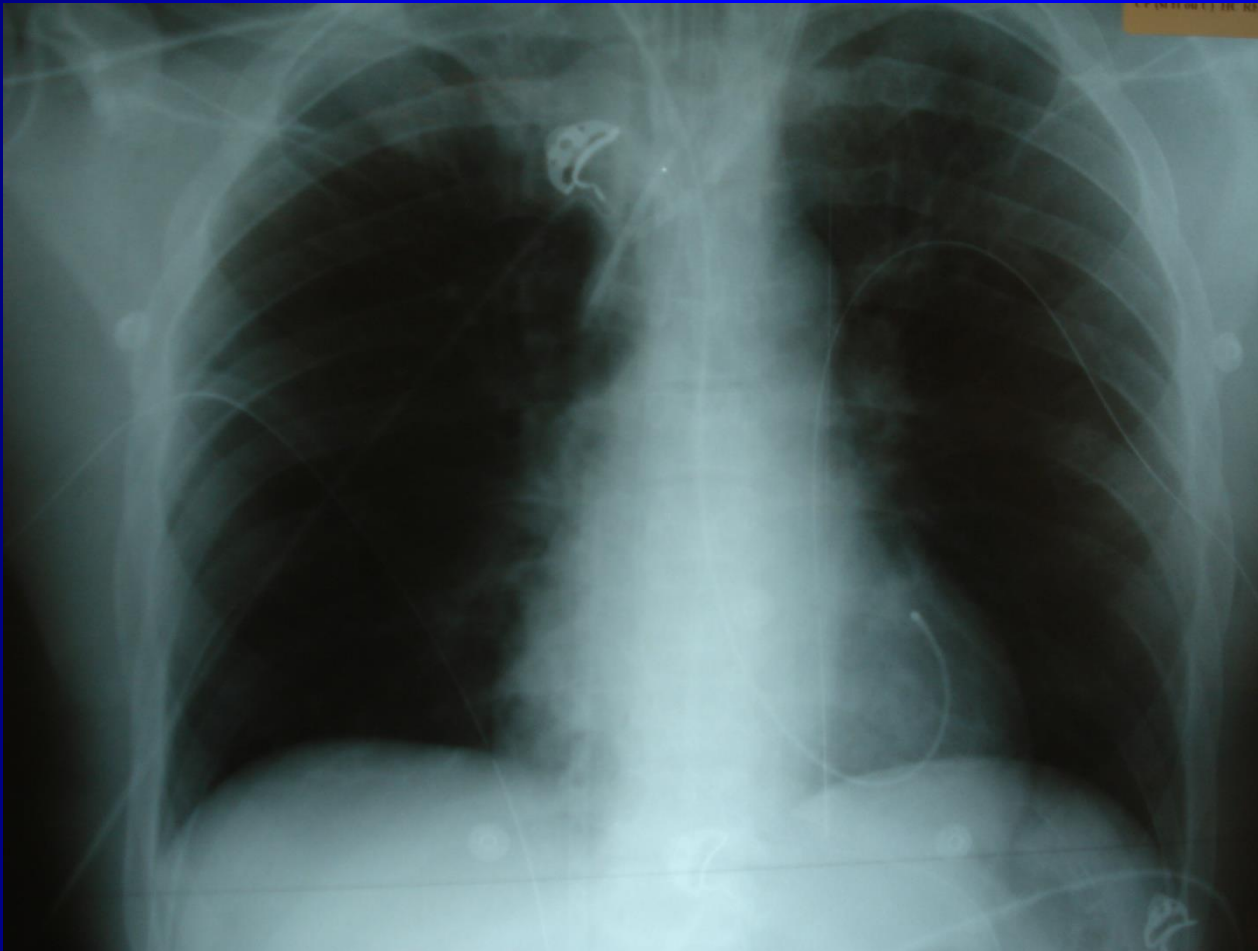


JPEG

79 bpm

PHILIPS T PAT: 37.0C  
:TO< 36.6C

# Après drainage



VAC

Vt 500

FR 19

PEP 6

Plat 21

FiO2 50%

Drain Dt: 2200cc

Drain G: 2510cc

# Hypovolémie →→hypoxémie





# Embolie pulmonaire → hypoxémie



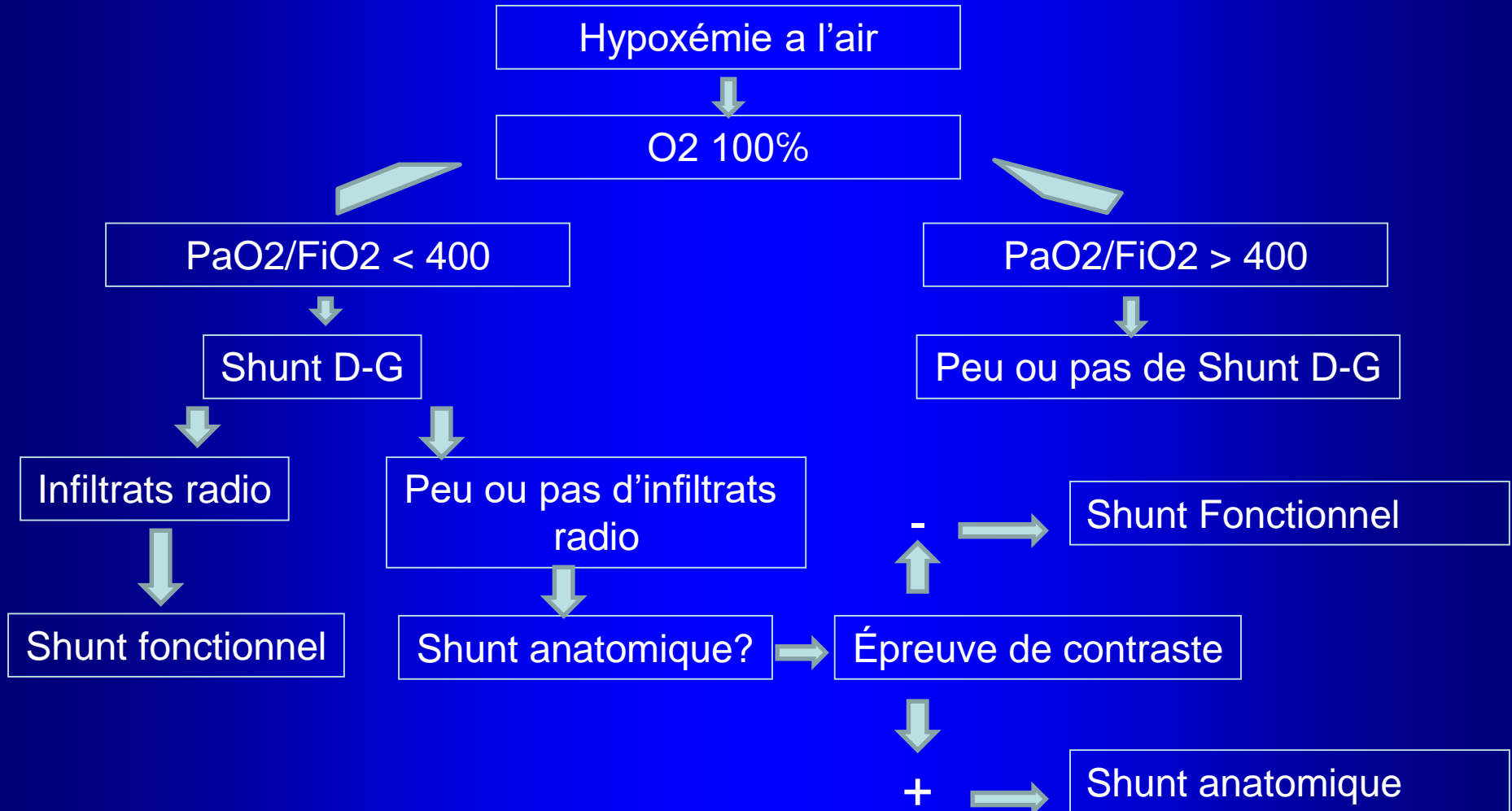
# Condensation alvéolaire → hypoxémie





POURQUOI FAIRE SIMPLE QUAND  
ON PEUT FAIRE COMPLIQUÉ?!

# Démarche diagnostique face a une hypoxémie



Diagnostic  
échographique  
d'un FOP

# Étape 1 a la recherche d'un shunt D-G (FOP)

En 2D: ETT: coupe 4 cavités apicale ou sous costale



# Étape 1 a la recherche d'un shunt D-G (FOP)

En 2D: ET0: 4 cavités 0 ou vue bicavale 90



# Étape 1 a la recherche d'un shunt D-G (FOP)

- Recherche défaut de coaptation
- Cartographie couleur centrée sur fosse ovale





# Étape 2: épreuve de contraste

- Cathéter périphérique / voie fémorale (de preference)
- 2 seringues luer lock, un robinet
- Gélatine, sérum physio (9,5ml) + 1 ml d'air
- Méthode de sensibilisation: Valsalva, toux, VM, PEP



# Étape 2: épreuve de contraste

Quantification du shunt:

- Grade I < 5 microbulles
- Grade II entre 6 et 25 microbulles
- Grade III > 25 microbulles
  
- Passage immédiat (<3 bttmts card): FOP
- Passage retardée (> 3 bttmts): SIP

PHILIPS

28/10/2008 13:13:42

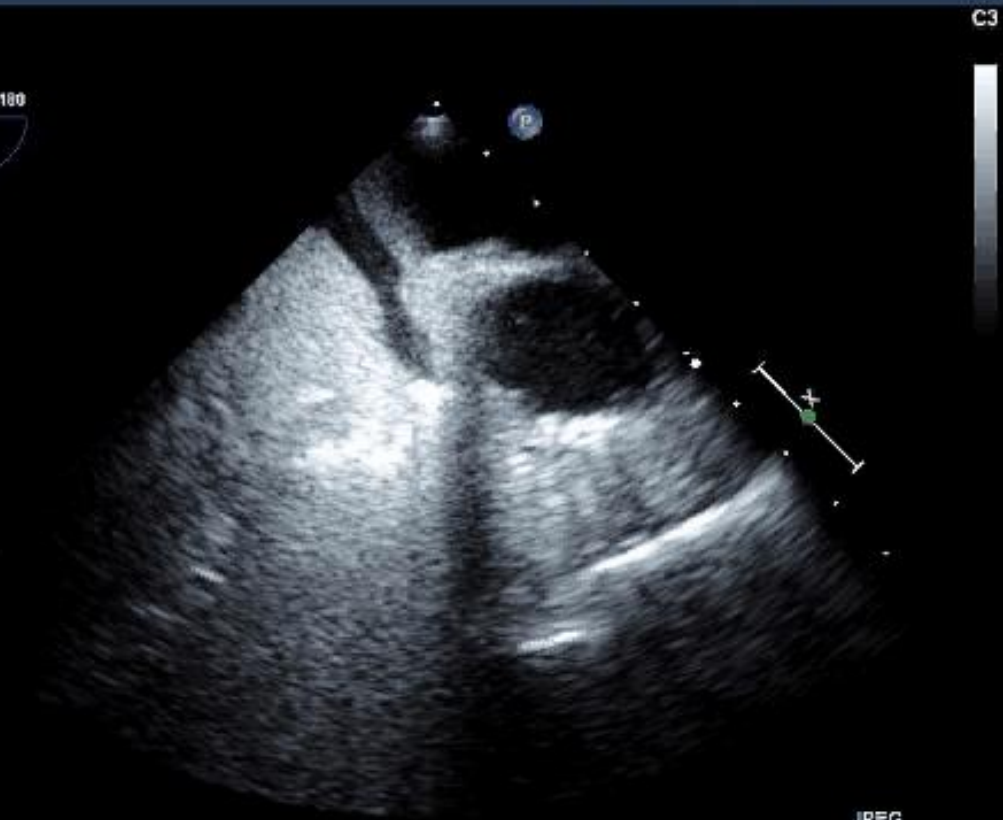
ITm0.6 IM 1.0

S7-2omni/ETO

CI 39Hz  
10cm

C3

2D  
51%  
C 54  
P Arrêt  
HPén



JPEG

PHILIPS T PAT: 37.0C  
ETO < 36.3C

72 bpm

PHILIPS

16/11/2009

16:43:52

ITm0.6 IM 1.0

S7-2omni/ETO

CI 39Hz  
12cm

C3

2D

53%  
C 54  
P Arrêt  
HPén



JPEG

123 bpm

PHILIPS  
T PAT: 37.0C  
TO: 37.9C

# Fréquence du FOP

	<b>Patients (n)</b>	<b>Fréquence (%)</b>	<b>Circonstance</b>
Hagen Mayo clinic 1984	965	27	Autopsie
Kasper Lancet 1992	85	39	EP massive
Siostrzonek JACC 1992	150	5 si IC G 29 si pas IC G	
Jaffre AA 1992	33	9	ASA 1 au bloc
Fisher Chest 1995	1000	9	AVC / AIT

# Facteurs favorisant augmentation des pressions droites

- HTAP
- Embolie pulmonaire
- SDRA

# Effets de la ventilation mécanique avec PEP sur le shunt intracardiaque droit-gauche par un foramen ovale perméable

*Ann Fr Anesth Réanim*, 1995 ; 14 : 387-392

Effects of mechanical ventilation with PEEP on right-to-left intracardiac shunting from a patent foramen ovale

J.M. VÉDRINNE, S. DUPERRET, P. GRATADOUR, C. BARTHÉLÉMY, J. MOTIN

- *Objectif:* recherche de FOP / avec et sans PEP
- *Patients:* 49 patients VM IRA P/F < 250
- *Méthodes:* PEP 0 et PEP 10 FiO<sub>2</sub> 100%
- *Résultats:* 11 FOP sur 49

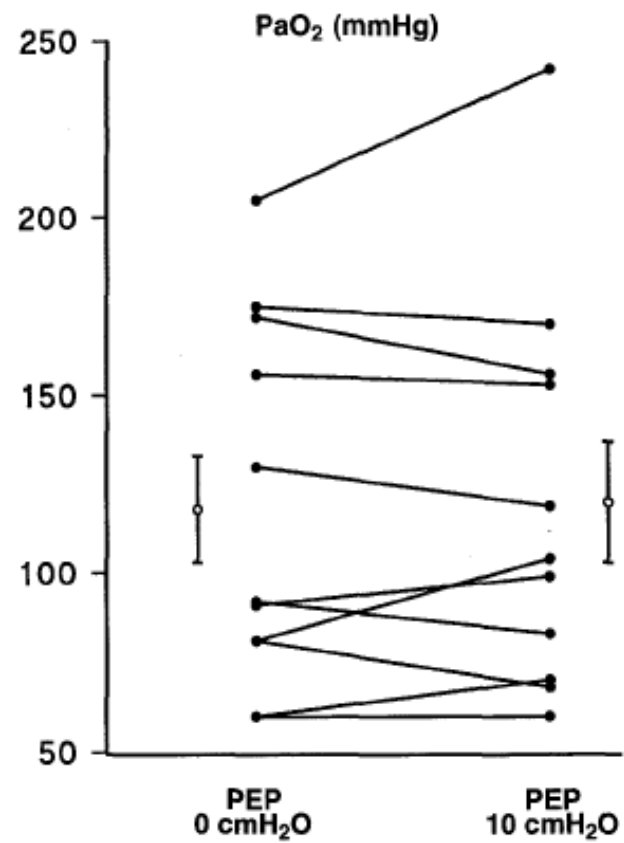


Fig. 3. — Evolutions individuelles de la PaO<sub>2</sub> (mmHg) dans le Groupe FOP.

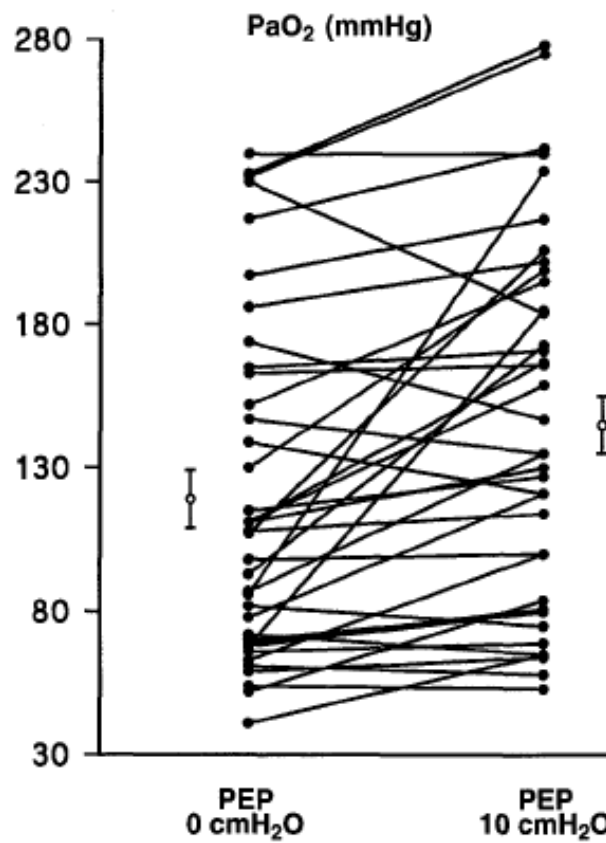


Fig. 4. — Evolutions individuelles de la PaO<sub>2</sub> (mmHg) dans le Groupe FOC.

PaO <sub>2</sub>	PEP 0	PEP 10
FOP +	118±15	120±17
FOP -	119±10	145±10



## Effets de la ventilation mécanique avec PEP sur le shunt intracardiaque droit-gauche par un foramen ovale perméable

Effects of mechanical ventilation with PEEP on right-to-left intracardiac shunting from a patent foramen ovale

J.M. VÉDRINNE, S. DUPERRET, P. GRATADOUR, C. BARTHÉLÉMY, J. MOTIN

- *Conclusion:* rechercher un FOP par ETO si hypoxémie non expliquée par anomalie V/P ou hypovolémie
- Si FOP présent et aggravé avec PEP incite à éviter la PEP et débiter le sevrage

# Positive End-Expiratory Pressure Increases the Right-to-Left Shunt in Mechanically Ventilated Patients with Patent Foramen Ovale

*Ann Intern Med.* 1993;119:887-894.

Bibiana Cujec, MD; Petr Polasek, MD; Irvin Mayers, MD; and David Johnson, MD

- *Objectif:* évaluer effet de la PEP quand FOP
- *Patients:* 46 patients VM IRA FiO<sub>2</sub> > 50%  
avec PEP > 5
- *Méthodes:* PEP 0 et PEP 10 FiO<sub>2</sub> 100%, recherche d'un FOP et calcul du shunt
- *Résultats:* 7 FOP sur 46

# Positive End-Expiratory Pressure Increases the Right-to-Left Shunt in Mechanically Ventilated Patients with Patent Foramen Ovale

Bibiana Cujec, MD; Petr Polasek, MD; Irvin Mayers, MD; and David Johnson, MD

**Table 2. Hemodynamic and Blood Gas Variables in the Presence and Absence of Positive End-Expiratory Pressure\***

Variables	Patent Foramen Ovale Present, <i>n</i> = 7		No Patent Foramen Ovale, <i>n</i> = 39	
	PEEP, <i>cm H<sub>2</sub>O</i>		PEEP, <i>cm H<sub>2</sub>O</i>	
	0	10	0	10
Arterial $P_{O_2}$ , <i>mm Hg</i>	122	117	181	225†
Arterial saturation, %	97	97	98	99‡
Alveolar-arterial oxygen gradient, <i>mm Hg</i>	505	509	442	398†
Mixed venous $P_{O_2}$ , <i>mm Hg</i>	38	36	42	41
Mixed venous saturation, %	67	67	73	72
Shunt fraction, %	28	32§	30	25†
Central venous pressure, <i>mm Hg</i>	10	11	11	12
Mean systemic blood pressure, <i>mm Hg</i>	83	80	81	79
Heart rate, <i>beats/min</i>	106	100	99	100
Cardiac index, indicator dilution, <i>L/min per m<sup>2</sup></i>	2.6	2.4	2.7	2.6
Cardiac index, echocardiography, <i>L/min per m<sup>2</sup></i>	2.2	2.3	2.8	2.7

# Positive End-Expiratory Pressure Increases the Right-to-Left Shunt in Mechanically Ventilated Patients with Patent Foramen Ovale

Bibiana Cujec, MD; Petr Polasek, MD; Irvin Mayers, MD; and David Johnson, MD

- *Conclusion:*

FOP: cause commune d'absence d'amélioration de l'oxygénation chez le patient VM

Quand ajout d'une PEP sur FOP: majoration du shunt D-G

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

**(Crit Care Med 2010; 38:1786–1792)**

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

- Etude monocentrique, prospective
- 203 patients SDRA
- Objectif Principal: prévalence FOP
- Objectifs secondaires:
  - Effet de la PEP
  - Effets du DV
  - Effets du NO
  - Influence du FOP sur oxygénation durant titration PEP
  - Influence du FOP sur devenir des patients

# Résultats

	No Moderate-to-Large Shunting Through a Patent Foramen Ovale (N = 164)	Moderate-to-Large Shunting Through a Patent Foramen Ovale (N = 39)	<i>p</i>
Respiratory settings, mean $\pm$ sd <sup>a</sup>			
Tidal volume, mL/kg	6.5 $\pm$ 1.0	6.7 $\pm$ 1.2	.36
Respiratory rate, beats per min	26 $\pm$ 5	26 $\pm$ 5	.57
Positive end-expiratory pressure, cm H <sub>2</sub> O	10 $\pm$ 3	11 $\pm$ 4	.31
Plateau pressure, cm H <sub>2</sub> O	23 $\pm$ 5	23 $\pm$ 5	.38
Compliance, mL/cm H <sub>2</sub> O	34 $\pm$ 14	36 $\pm$ 18	.08
Blood gases, mean $\pm$ sd <sup>b</sup>			
Pao <sub>2</sub> /Fio <sub>2</sub> ratio, mm Hg	114 $\pm$ 45	122 $\pm$ 58	.64
Paco <sub>2</sub> , mm Hg	44 $\pm$ 12	44 $\pm$ 13	.58
pH	7.32 $\pm$ 0.11	7.30 $\pm$ 0.12	.26
Lactate, mmol/L	2.2 $\pm$ 2.7	2.6 $\pm$ 2.5	.28

# Résultats

	No Moderate-to-Large Shunting Through a Patent Foramen Ovale (N = 164)	Moderate-to-Large Shunting Through a Patent Foramen Ovale (N = 39)	<i>p</i>
Superior vena cava collapsibility index, mean $\pm$ SD, %	18 $\pm$ 21	12 $\pm$ 18	.11
Atrial septal buckling toward left atrium, n (%)	17 (10)	8 (21)	.10
Maximum atrial septal excursion, mean $\pm$ SD, mm	12 $\pm$ 4	15 $\pm$ 6	.03
Ratio of early over late peak velocities at the mitral valve, mean $\pm$ SD	1.2 $\pm$ 0.9	1.0 $\pm$ 0.5	.22
Left ventricular fractional area contraction, mean $\pm$ SD, %	48 $\pm$ 16	53 $\pm$ 18	.30
Cardiac index, L/min/m <sup>2</sup> , mean $\pm$ SD	2.8 $\pm$ 1.1	2.6 $\pm$ 0.5	.73
Right ventricular/left ventricular end-diastolic area ratio, mean $\pm$ SD	0.8 $\pm$ 0.3	1.0 $\pm$ 0.3	<.01
Systolic pulmonary artery pressure, mean $\pm$ SD, mm Hg <sup>a</sup>	35 $\pm$ 18	43 $\pm$ 17	.04
Cor pulmonale, n (%)	29 (18)	15 (39)	<.01

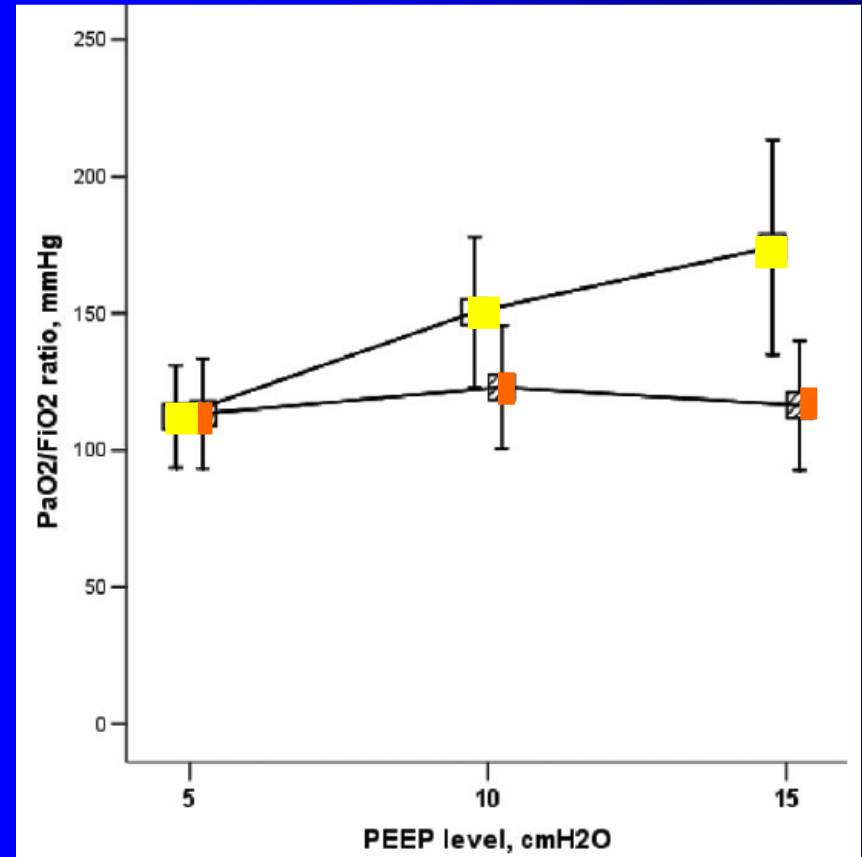
# Résultats

Titration PEP chez 36 patients  
(21 FOP+ et 15 FOP-)

FOP+: 50% Non  
répondeurs PEP

FOP-: 20%

$p=0,04$





# Résultats

- FOP- :  $\uparrow$  PEP de 9 à 14  $\Rightarrow$  +9%
- FOP+ :  $\downarrow$  PEP de 11 à 3  $\Rightarrow$  -13%
- NO: abolit shunt 2/14
- DV: pas de différence
- Plus de DV, NO dans groupe FOP+
- J28: plus de journée de VM FOP+

# Conclusion

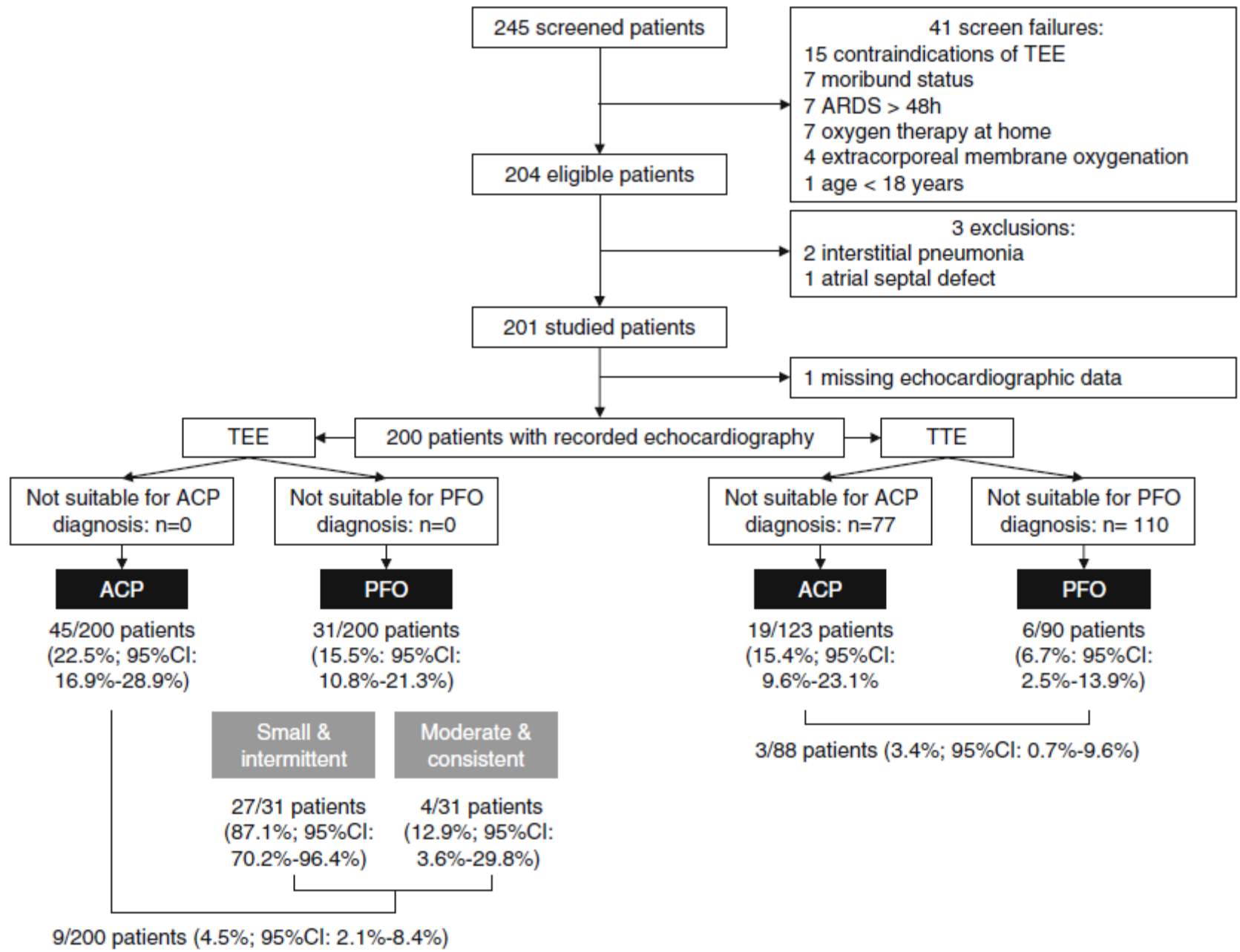
- Fréquence FOP et SDRA: 20%
- FOP:
  - « diminution efficacité PEP »
  - plus de thérapeutiques adjuvantes
  - Allonge durée de VM

lar shunts (37). Ignoring the presence of PFO shunting may have many consequences regarding the diagnosis of ARDS, the appraisal of its severity, and the assessment of the response to treatment.

Gwenaëlle Lhéritier  
Annick Legras  
Agnès Caille  
Thierry Lherm  
Armelle Mathonnet  
Jean-Pierre Frat  
Anne Courte  
Laurent Martin-Lefèvre  
Jean-Paul Gouëlle  
Jean-Bernard Amiel  
Denis Garot  
Philippe Vignon

## **Prevalence and prognostic value of acute cor pulmonale and patent foramen ovale in ventilated patients with early acute respiratory distress syndrome: a multicenter study**

- Etude multicentrique (9)
- Objectifs:
  - Incidence CPA et FOP quand SDRA
  - Facteurs favorisants



# Résultats

- Sur 201 patients
- age: 56 +/- 15 ans
  - SAPSII: 46 +/-17
  - PaO<sub>2</sub>/FiO<sub>2</sub>: 115+/-39
  - VT: 6.3 +/- 1,1 ml/kg
  - PEEP: 10,6 +/- 3,1 cmH<sub>2</sub>O
  - Plateau pressure: 25 +/-4 cmH<sub>2</sub>O
  - PaCO<sub>2</sub>: 47 +/-11
- ETO : 45 CPA (22,5%) et 31 FOP (15,5%)
- Shunt : faible et intermittent 27 patients
- Shunt important 4 patients
- Facteurs associés au CPA:PaCO<sub>2</sub> > 60mmHg
- Facteurs associés au FOP: aucun (tendance pour l'âge)

CPA et FOP : pas de lien avec mortalité

# Conclusion

- Incidence FOP 15,5%
- Incidence CPA 22,5%
- Peu de FOP important
- ETT: pas suffisamment performant pour dépistage

# SIP (shunt D-G intrapulmonaire)

- Plus rare que FOP
- Shunts localises: fistules arterioveineuses (post traumatique, rendu-osler)
- Shunts diffus: dilatations artéριοles pulmonaires precapillaires (hepatopathie severe)

# Diagnostic différentiel

- Shunt G-D
- CIA  
communication  
interauriculaire
- « Contraste négatif »
- image de soustraction dans l'OD opacifiée

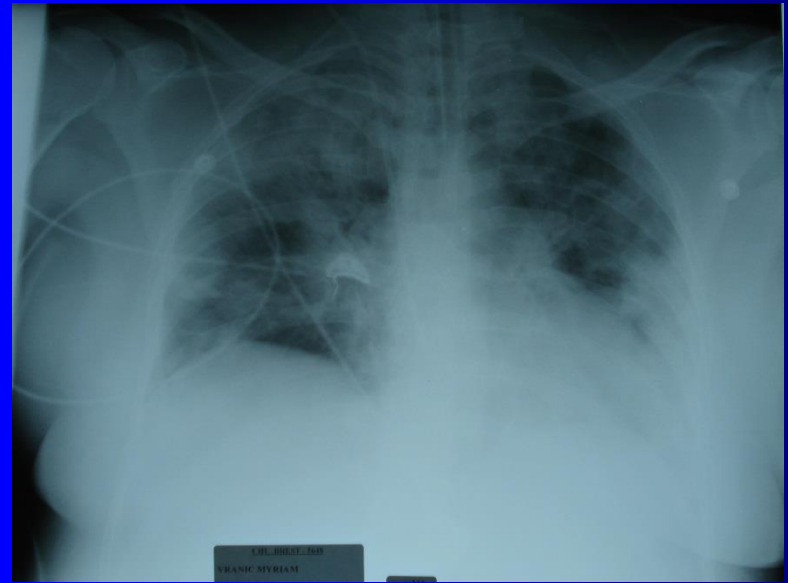




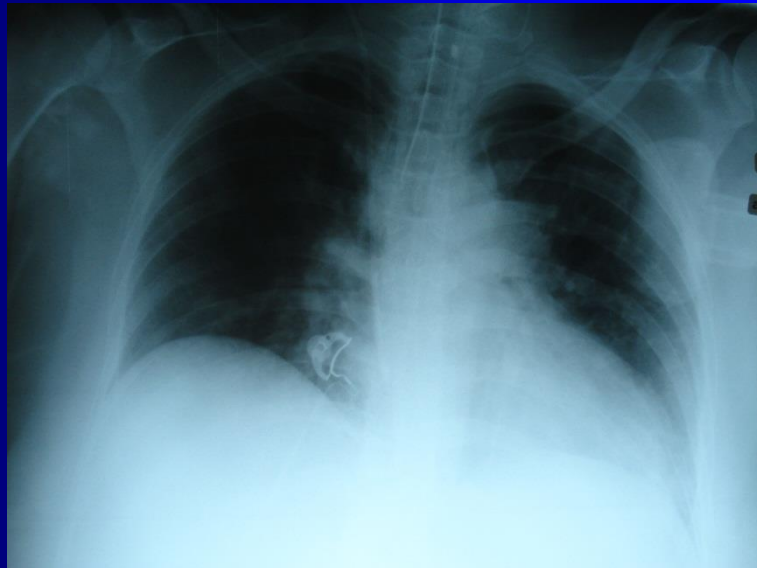
# Cas clinique 1

- Femme de 39 ans: détresse respiratoire aigue
- HDM
  - 20/10: pancréatite aigue Balthazar E
    - Sortie contre avis médical
  - 23/10: au domicile G3, SpO2 70%
    - Transfert en réa médicale: choc + SDRA

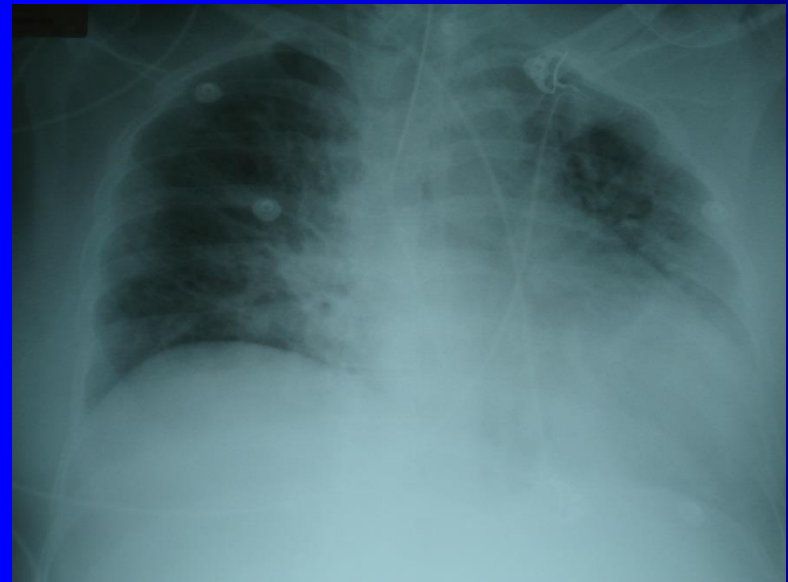
J3



J1



J5



CI 39Hz  
13cm

2D  
54%  
C 54  
P Arrêt  
HPén



C3



28/10/2010 10:42:41 ITm0.6 IM 1.0

S7-2omni/ETO

C3



JPEG

110 bpm

PHILIPS  
T PAT: 37.9C  
ETO: 38.9C



JPEG

108 bpm

PHILIPS  
T PAT: 37.9C  
ETO: 39.9C

CI 39Hz  
14cm

2D  
67%  
C 54  
P Arrêt  
HPén



C3



CI 31Hz  
6.0cm

2D / TM  
51% 51%  
C 54  
P Arrêt  
HPén



C3



-0  
-1  
-2  
-3  
-4  
-5

PHILIPS

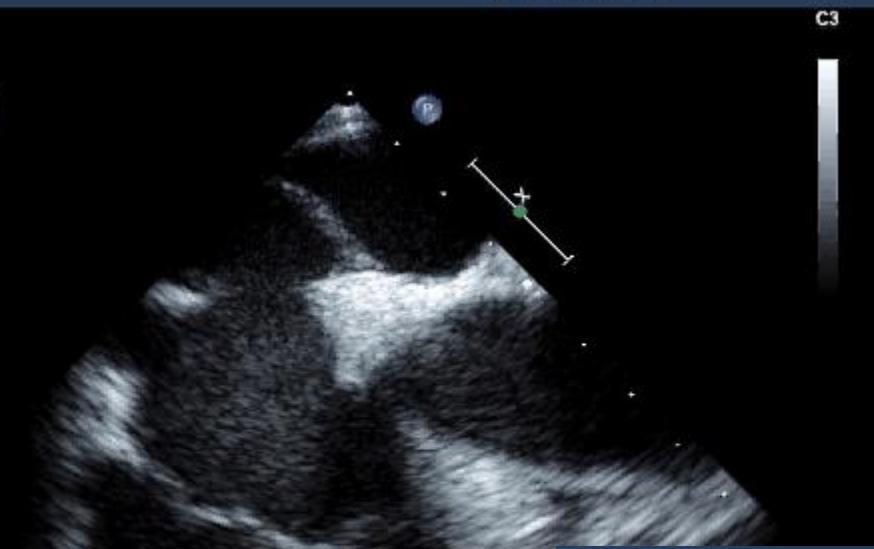
28/10/2010 10:45:40 ITm0.6 IM 0.9

S7-2omni/ETO

CI 39Hz  
9.0cm

C3

2D  
50%  
C 54  
P Arrêt  
HPén



PHILIPS

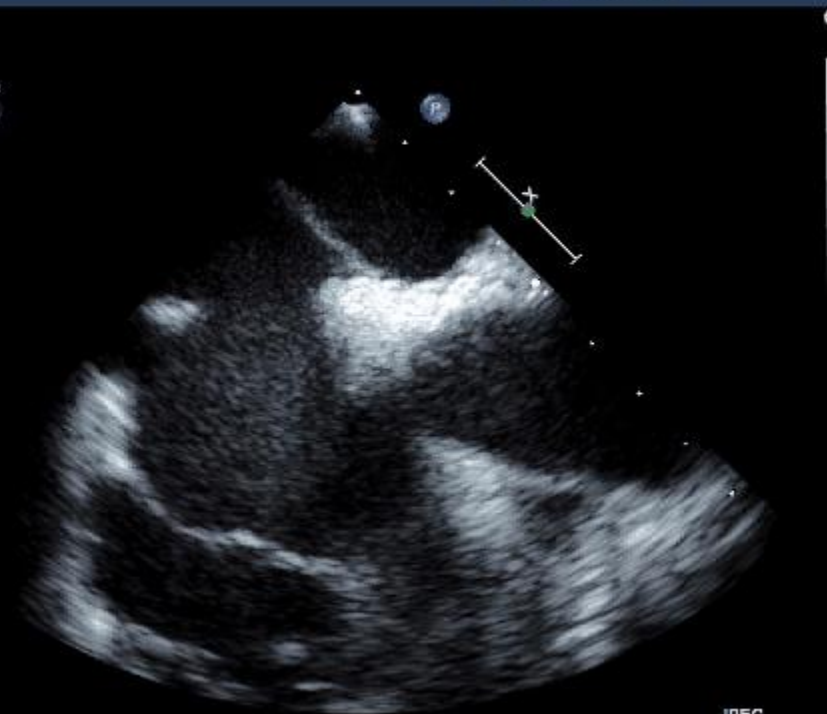
28/10/2010 10:46:32 ITm0.6 IM 0.9

S7-2omni/ETO

CI 39Hz  
9.0cm



2D  
50%  
C 54  
P Arrêt  
HPén



T PAT: 37.9C  
PHILIPS :TO: 39.7C

JPEG

# Cas clinique 2

- Femme de 34 ans
- Choc septique
- Atcd:
  - endocardite tricuspидienne
  - toxicomane
- J6: hypoxémie réfractaire NO
- ETT

PHILIPS

13/10/2011 22:20:55  
S5-1/CAR

PHILIPS

17/10/2011 14:39:57  
S5-1/CARDIO

ITm2.2 IM 1.

39Hz  
m

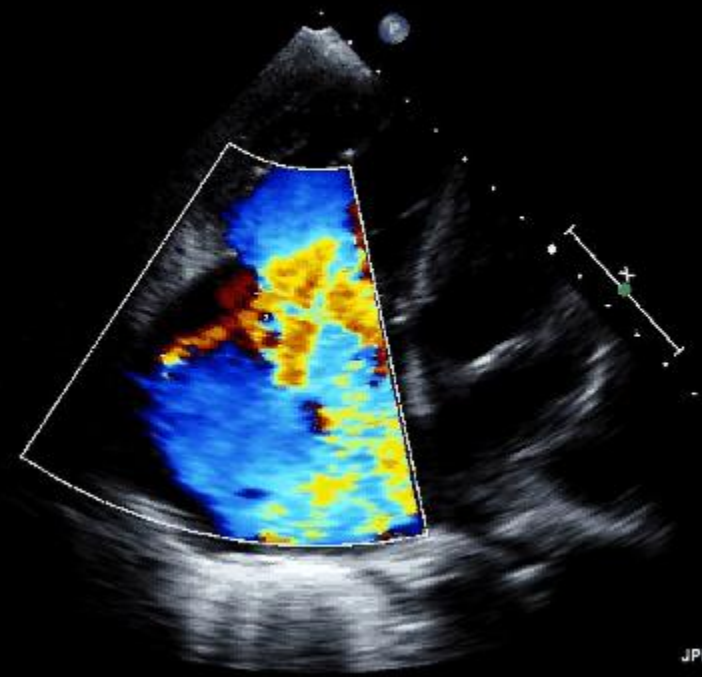
4  
D  
as  
en

R  
3.4

CI 14Hz  
16cm

2D  
59%  
C 50  
P Bas  
HGén  
Coul  
66%  
2.5MHz  
FP Haut  
Moy

P  
1.7  
R  
3.4



JPEG

LIPS

PHILIPS

PHILIPS

17/10/2011 14:24:11

PHILIPS

21/10/2011 14:02:15

ITm2.2 IM 1.

S5-1/CAR

S5-1/CARDIO

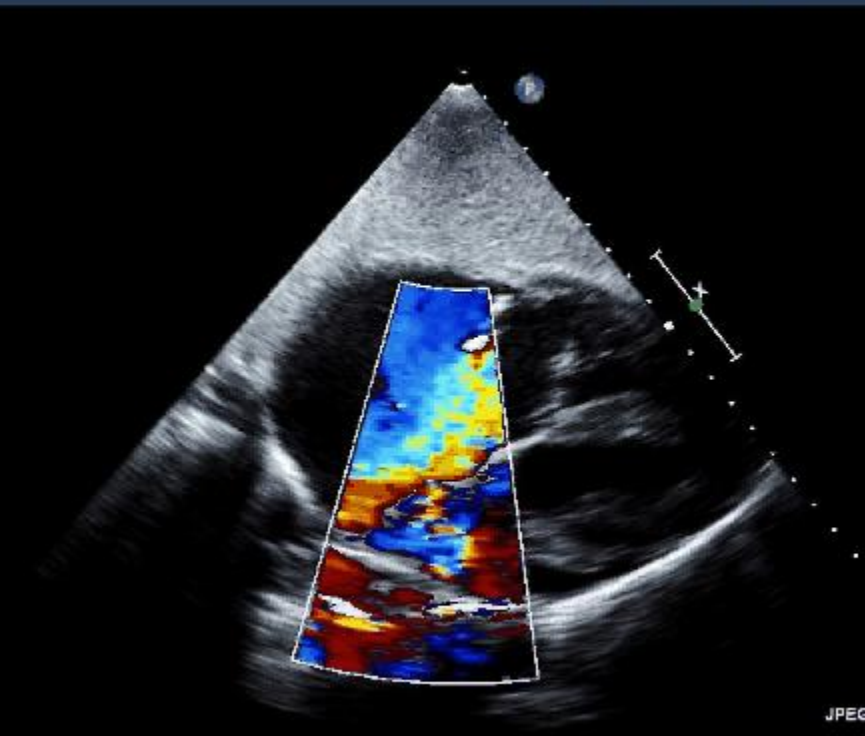
39Hz  
m

4  
] as  
en



CI 20Hz  
20cm

2D  
66%  
C 50  
P Bas  
HGén  
Coul  
66%  
2.5MHz  
FP Haut  
Moy



JPEG

LIPS

PHILIPS

www



# 3. Discuter l'intérêt de l'échocardiographie dans le sevrage du ventilateur



# Sevrage difficile ?

- Quelle(s) est / sont la (les) cause (s) ?
- Que faire?

Lemaire Anesthesiology 1988  
15 BPCO  
Échec: ↑ PAPo

Chatila Chest 1996  
93 patients / 49 coronariens  
Échec: 5 modif ECG

## échec sevrage VM

Mekontso-Dessap ICM 2006  
Echec: ↑ BNP

Jubran AJRCCM 1998  
Succès SBT: Svc02 → / Echec SBT Svc02 ↓

Zakynthinos ICM 2005  
↑ Consommation / ↑ extraction O<sub>2</sub>

# Sevrage VM : que se passe t-il?

Diminution pression  
intrathoracique

- ❑ augmente retour veineux et volume sanguin central
- ❑ diminution du gradient de pression VG / artères extrathoraciques
- ❑ VG doit augmenter pression pour éjecter même volume = augmentation post charge VG

Augmentation travail  
respiratoire

- ❑ augmentation travail cardiaque et demande O<sub>2</sub> cardiaque

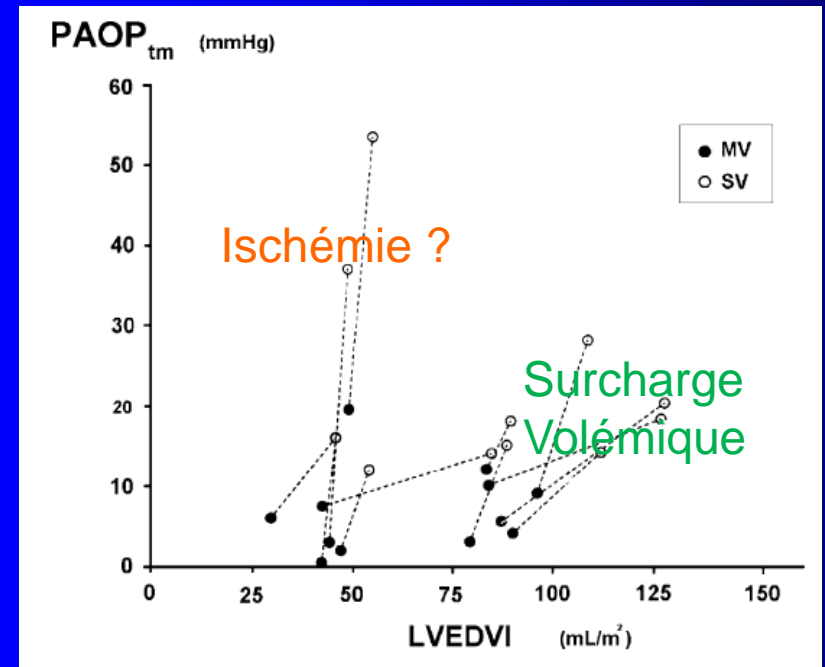
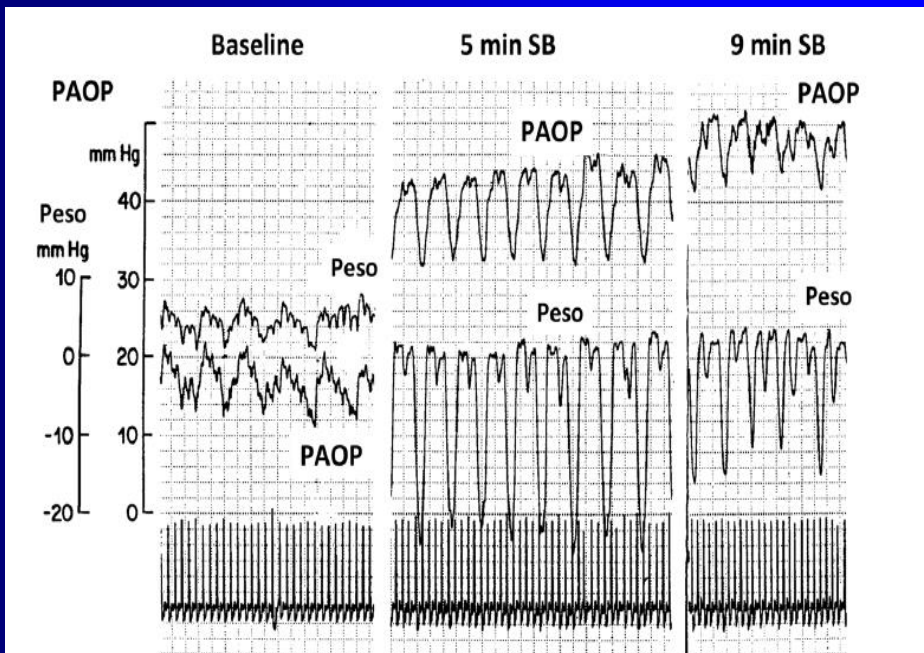
Décharge  
cathécolergique

- ❑ Augmentation tonus adrenergique:  
augmente retour veineux,  
post charge VG,  
W cardiaque,  
demande O<sub>2</sub> cardiaque

# Acute Left Ventricular Dysfunction during Unsuccessful Weaning from Mechanical Ventilation

Francois Lemaire, M.D.,\* Jean-Louis Teboul, M.D.,† Luc Cinotti, M.D.,‡ Guillen Giotto, M.D.,§  
Fekri Abrouk, M.D.,§ Gabriel Steg, M.D.,§ Isabelle Macquin-Mavier, M.D.,¶ Warren M. Zapol, M.D.\*\*

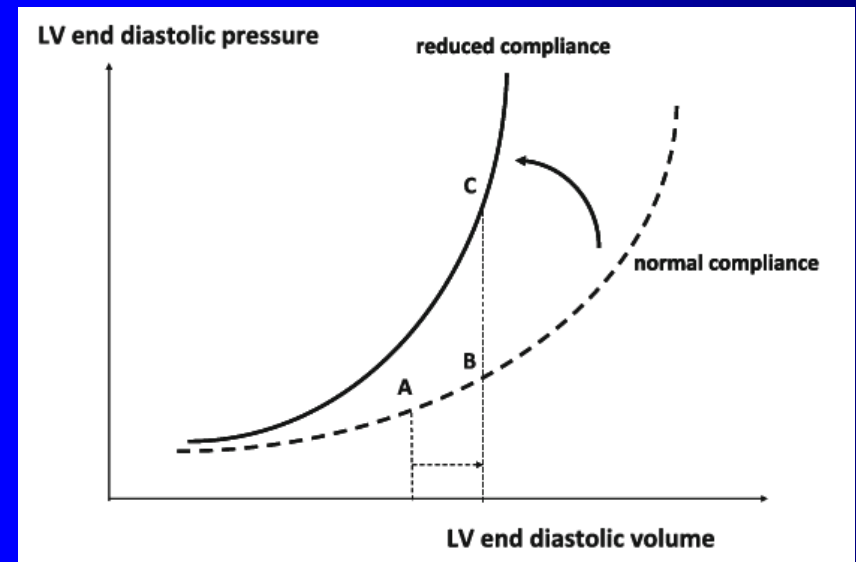
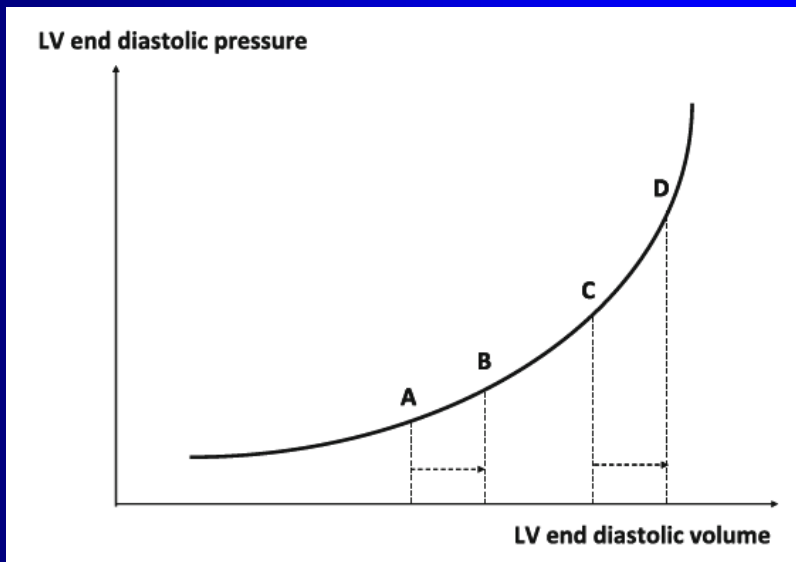
- 15 patients BPCO
  - +/- dysfunction VG
- 
- CAP
  - + angiographie
  - + mesure invasive pressions VG



## *Acute Left Ventricular Dysfunction during Unsuccessful Weaning from Mechanical Ventilation*

Francois Lemaire, M.D.,\* Jean-Louis Teboul, M.D.,† Luc Cinotti, M.D.,‡ Guillen Giotto, M.D.,§  
Fekri Abrouk, M.D.,§ Gabriel Steg, M.D.,§ Isabelle Macquin-Mavier, M.D.,¶ Warren M. Zapol, M.D.\*\*

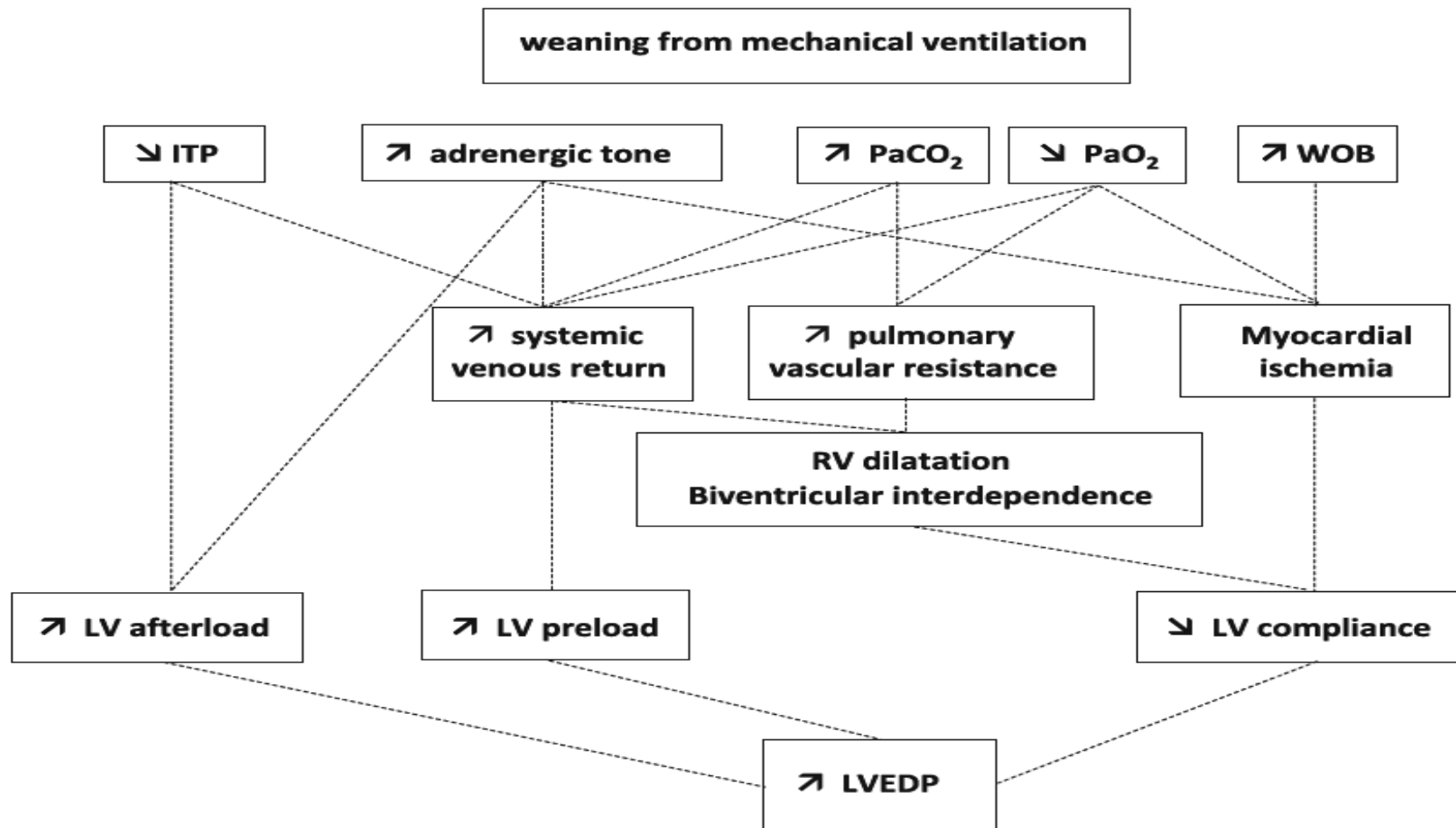
- 15 patients BPCO
  - +/- dysfunction VG
- ➔
- CAP
  - + angiographie
  - + mesure invasive pressions VG



# Weaning-induced cardiac dysfunction: where are we today?

Intensive Care Med (2014) 40:1069–1079  
DOI 10.1007/s00134-014-3334-4

MY PAPER 20 YEARS LATER



# Weaning from mechanical ventilation

J.-M. Biais<sup>1</sup>, J. Brochard<sup>2</sup>, A. Combes<sup>1</sup>, M. Hemidy<sup>3</sup>, P. Marot<sup>4</sup>, C. Melot<sup>5</sup>, P. Pasquetti<sup>6</sup>, H. Sibon<sup>7</sup>

Statement  
Organized  
(ATS),  
Medical  
approval

**TABLE 4**

Common pathophysiologies and their incidence, which may impact on the ability to wean a patient from mechanical ventilation

Pathophysiology	Consider
<b>Respiratory load</b>	<ul style="list-style-type: none"> <li>Increased work of breathing: inappropriate ventilator settings</li> <li>Reduced compliance: pneumonia (ventilator-acquired); cardiogenic or noncardiogenic pulmonary edema; acute respiratory distress syndrome; pulmonary fibrosis; pulmonary hemorrhage; diffuse pulmonary infiltrates</li> <li>Airway bronchoconstriction</li> <li>Increased resistive load</li> <li>During SBT: endotracheal tube</li> <li>Post-extubation: glottic oedema; increased airway secretions; sputum retention</li> </ul>
<b>Cardiac load</b>	<ul style="list-style-type: none"> <li>Cardiac dysfunction prior to critical illness</li> <li>Increased cardiac workload leading to myocardial dysfunction: dynamic hyperinflation; demand; unresolved sepsis</li> </ul>
<b>Neuromuscular</b>	<ul style="list-style-type: none"> <li>Depressed central drive: metabolic alkalosis; mechanical ventilation; sedative/hypnotic drugs</li> <li>Central ventilatory command: failure of the neuromuscular respiratory system</li> <li>Peripheral dysfunction: primary causes of neuromuscular weakness; CINMA</li> </ul>
<b>Neuropsychological</b>	<ul style="list-style-type: none"> <li>Delirium</li> </ul>
<b>Metabolic</b>	<ul style="list-style-type: none"> <li>Anxiety, depression</li> <li>Metabolic disturbances</li> <li>Role of corticosteroids</li> <li>Hyperglycaemia</li> </ul>
<b>Nutrition</b>	<ul style="list-style-type: none"> <li>Overweight</li> <li>Malnutrition</li> </ul>
<b>Anaemia</b>	<ul style="list-style-type: none"> <li>Ventilator-induced diaphragm dysfunction</li> </ul>

Estimation

Incidence

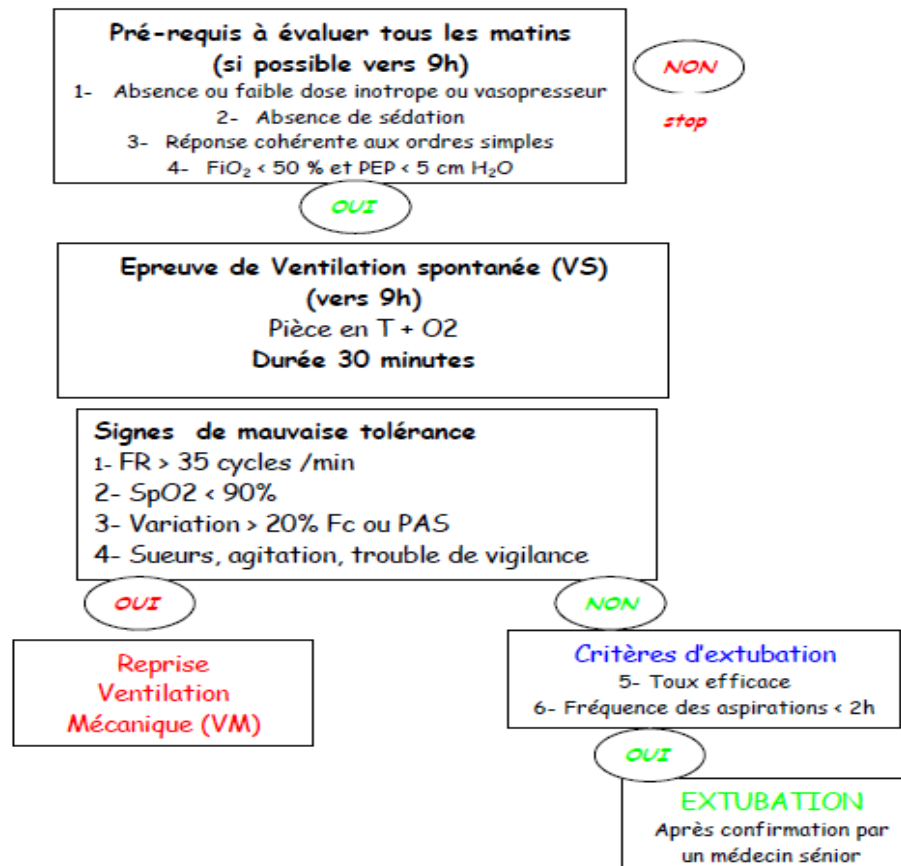
Echec

SEVRAGE VM

31%



## ORGANIGRAMME DECISIONNEL DE SEVRAGE DE LA VENTILATION MECANIQUE



**REMARQUE 1 :** Si malade alimenté par sonde nasogastrique : arrêter alimentation et mettre la sonde en aspiration à -20 cm H<sub>2</sub>O dès le début de l'épreuve de VS

**REMARQUE 2 :** Merci de noter dans le dossier informatique à chaque fois qu'une épreuve de VS a été faite ainsi que la durée de l'épreuve et les causes d'échec

Et l'échographie  
dans tout ça?

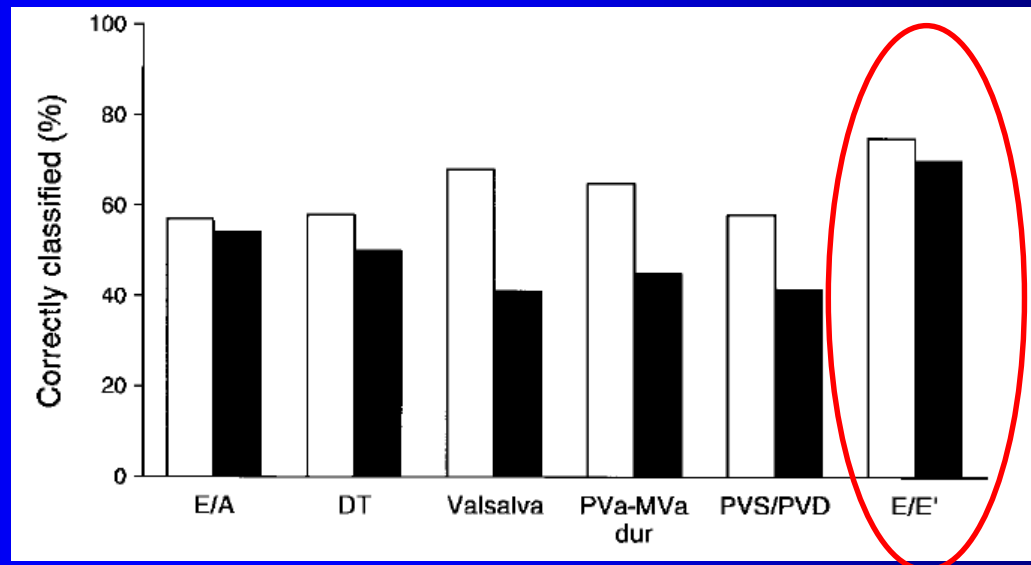
# Clinical Utility of Doppler Echocardiography and Tissue Doppler Imaging in the Estimation of Left Ventricular Filling Pressures

## A Comparative Simultaneous Doppler-Catheterization Study

S.R. Ommen, MD; R.A. Nishimura, MD; C.P. Appleton, MD; F.A. Miller, MD; J.K. Oh, MD; M.M. Redfield, MD; A.J. Tajik, MD

*(Circulation. 2000;102:1788-1794.)*

- 100 patients
- Comparaison :
  - Mesures écho
  - Mesures Invasives Pressions VG (seuil 12 mmHg)

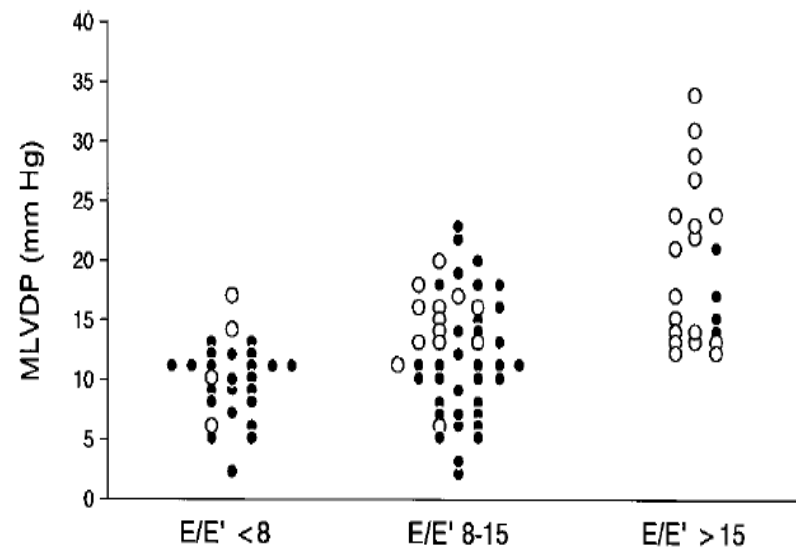
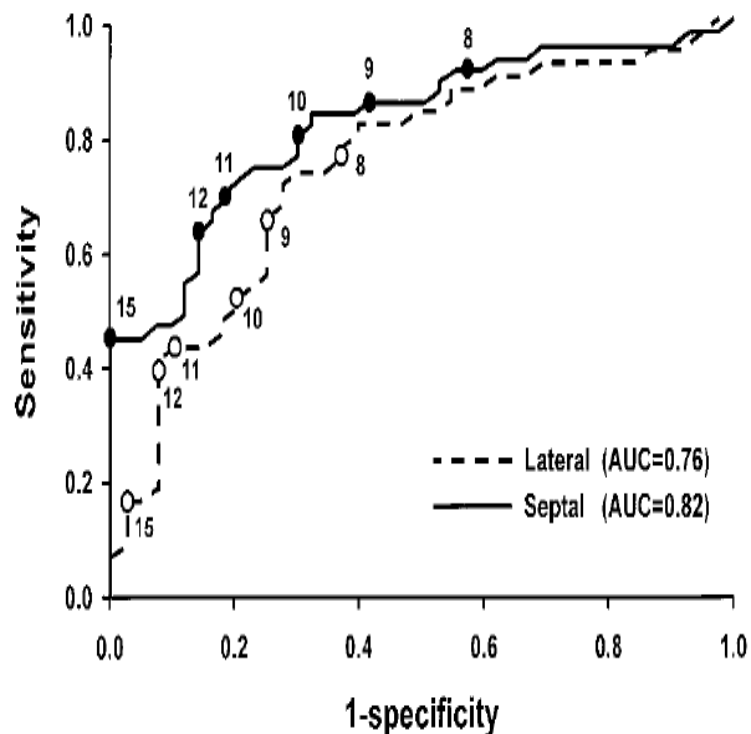


# Clinical Utility of Doppler Echocardiography and Tissue Doppler Imaging in the Estimation of Left Ventricular Filling Pressures

## A Comparative Simultaneous Doppler-Catheterization Study

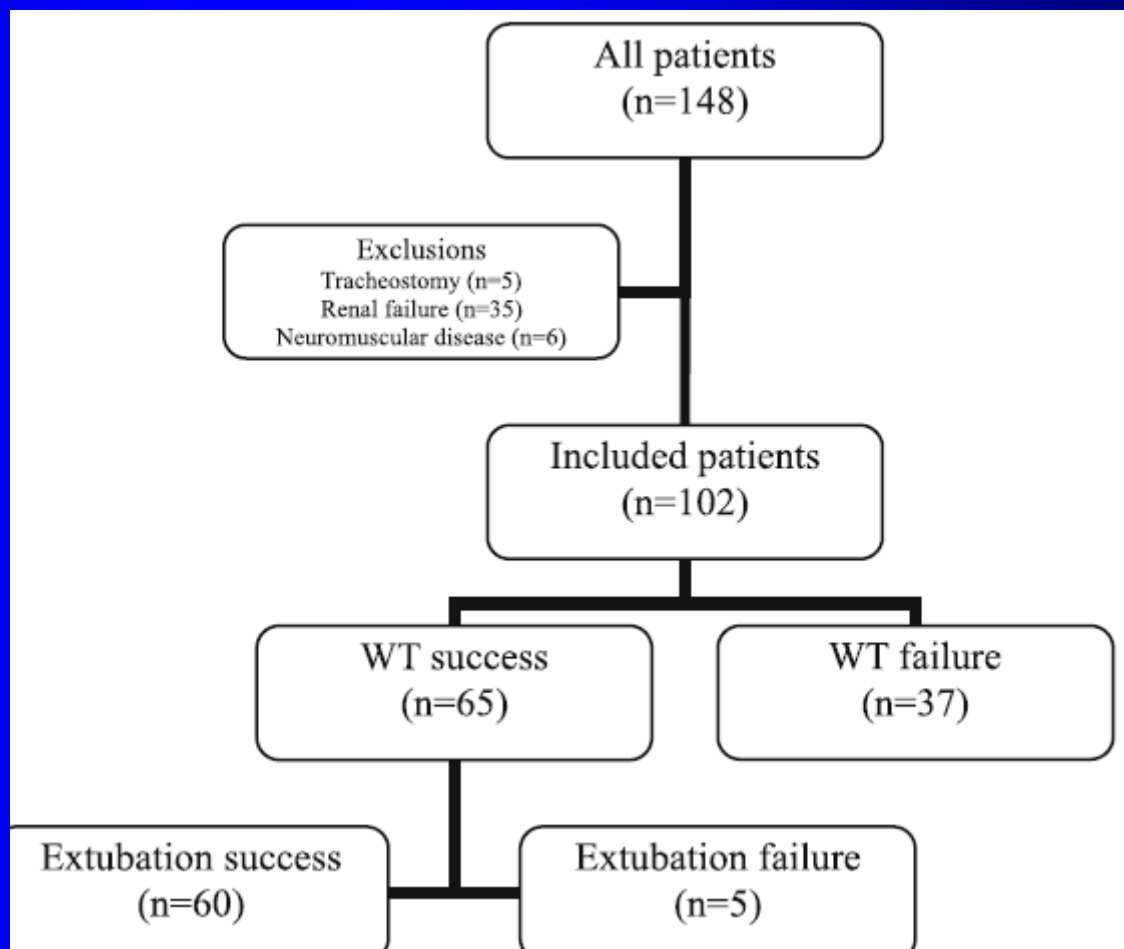
S.R. Ommen, MD; R.A. Nishimura, MD; C.P. Appleton, MD; F.A. Miller, MD; J.K. Oh, MD; M.M. Redfield, MD; A.J. Tajik, MD

(*Circulation*. 2000;102:1788-1794.)



**Figure 6.** M-LVDP versus groups defined by values of septal E/E'. ○ Indicates patients with EF <50%; ●, patients with EF >50%.

- **Objectif:**  
BNP peut il permettre de prédire échec de sevrage?
- 1 dosage avant et 1 dosage à 1h



Armand Mekontso-Dessap  
Nicolas de Prost  
Emmanuelle Girou  
François Braconnier  
François Lemaire  
Christian Brun-Buisson  
Laurent Brochard

# B-type natriuretic peptide and weaning from mechanical ventilation

Intensive Care Med (2006) 32:1529–1536  
DOI 10.1007/s00134-006-0339-7

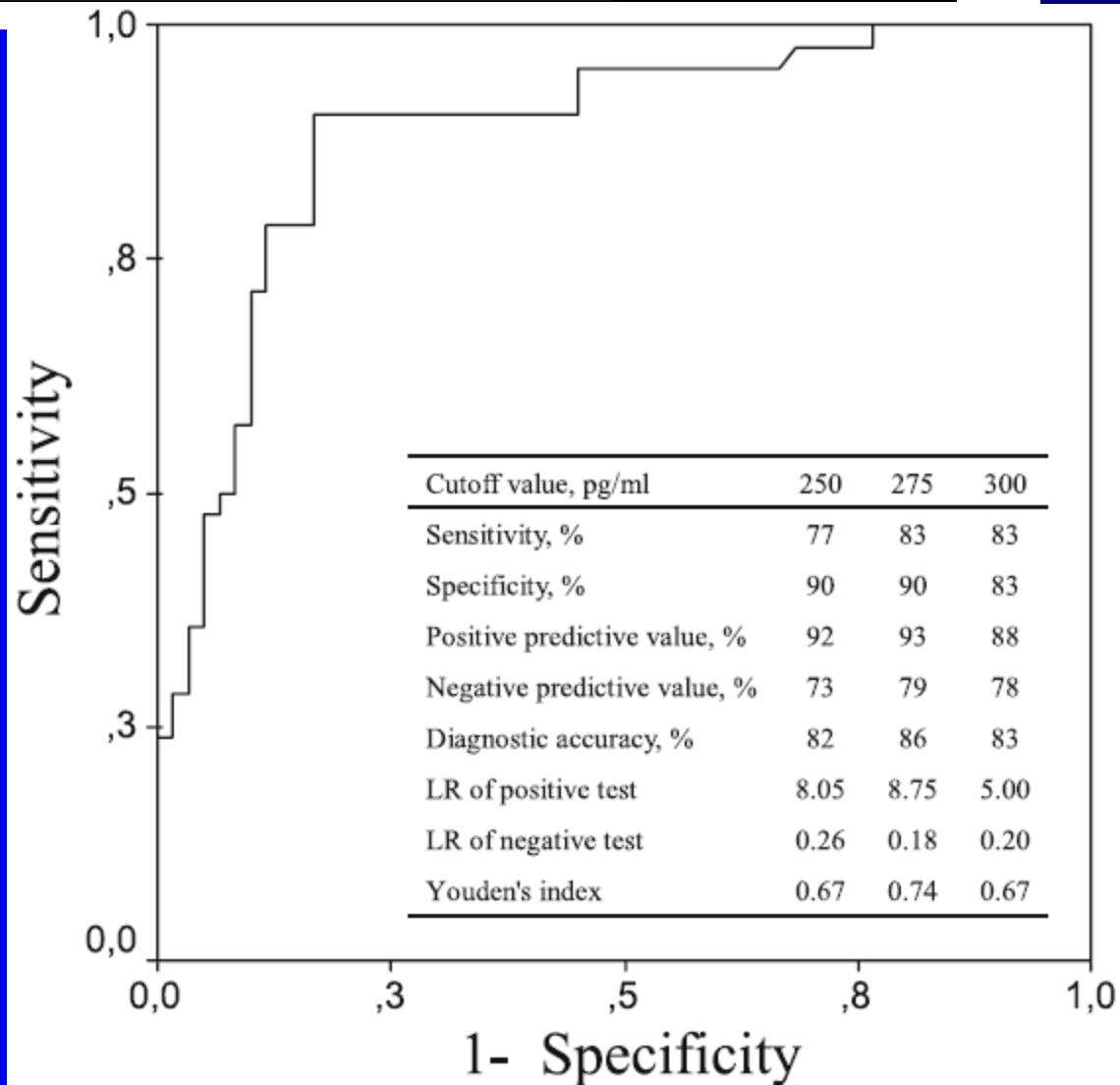
ORIGINAL

- Résultats:

analyse uni variée:  
Fr, PFP ( $Fr \times AI$ ),  
BNP ( $p < 0,05$ )

Analyse multi  
variée: BNP  
(0,001)

BNP avant VS  
cut-off : 250

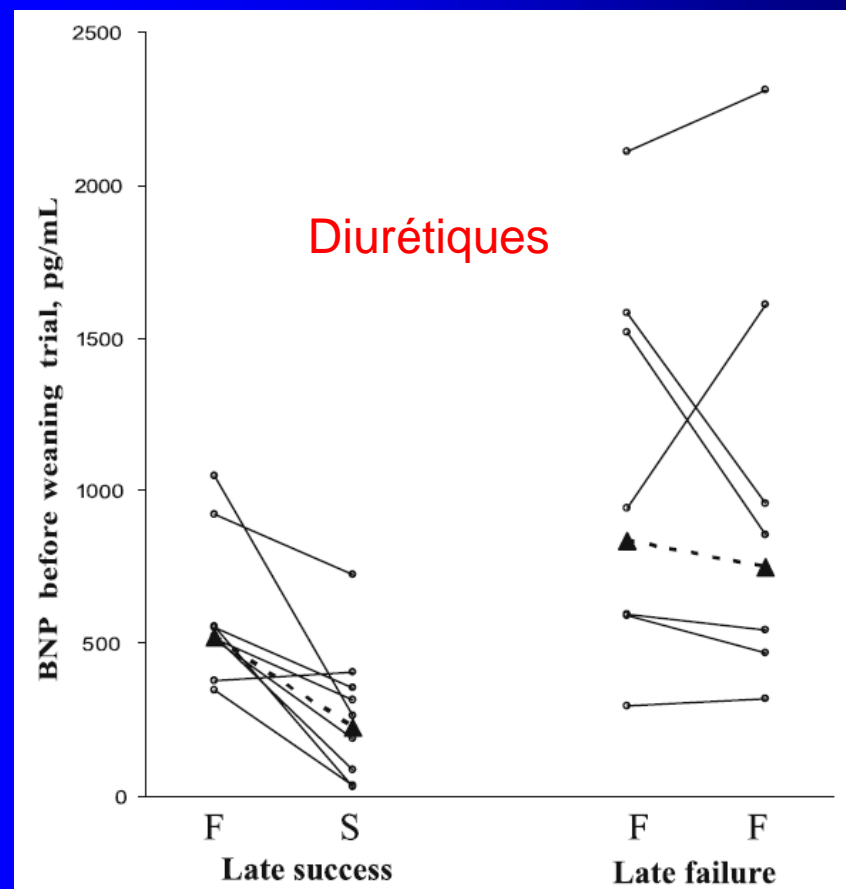
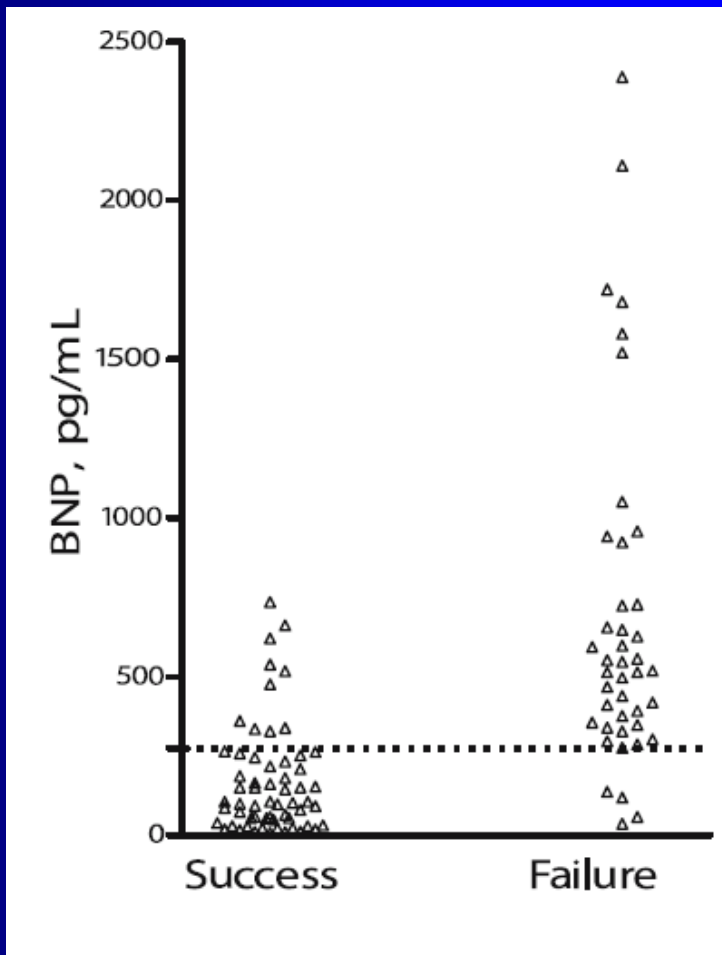


Armand Mekontso-Dessap  
Nicolas de Prost  
Emmanuelle Girou  
François Braconnier  
François Lemaire  
Christian Brun-Buisson  
Laurent Brochard

# B-type natriuretic peptide and weaning from mechanical ventilation

Intensive Care Med (2006) 32:1529–1536  
DOI 10.1007/s00134-006-0339-7

ORIGINAL



Armand Mekontso-Dessap  
Nicolas de Prost  
Emmanuelle Girou  
François Braconnier  
François Lemaire  
Christian Brun-Buisson  
Laurent Brochard

## **B-type natriuretic peptide and weaning from mechanical ventilation**

Intensive Care Med (2006) 32:1529–1536  
DOI 10.1007/s00134-006-0339-7

ORIGINAL

- Résultats:
- 66 patients évalués en ETT
- 21 patients FE < 45%
- Succès / échec : même prévalence de dysfonction VG



# Echocardiographic diagnosis of pulmonary artery occlusion pressure elevation during weaning from mechanical ventilation\*

Bouchra Lamia, MD, MPH, PhD; Julien Maizel, MD; Ana Ochagavia, MD; Denis Chemla, MD, PhD; David Osman, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

**Crit Care Med 2009; 37:1696–1701**

- *Objectif:* E/A et E/Ea pourrait aider a prédire augmentation pressions G lors du sevrage (et l'échec)
- *Patients:* 39 patients (2 échecs épreuve de VS)
- *Exclusion :* pathologies valvulaires
- *Méthode:* mesure swan et echo ETT
  - Avant début VS et à la fin VS 1h

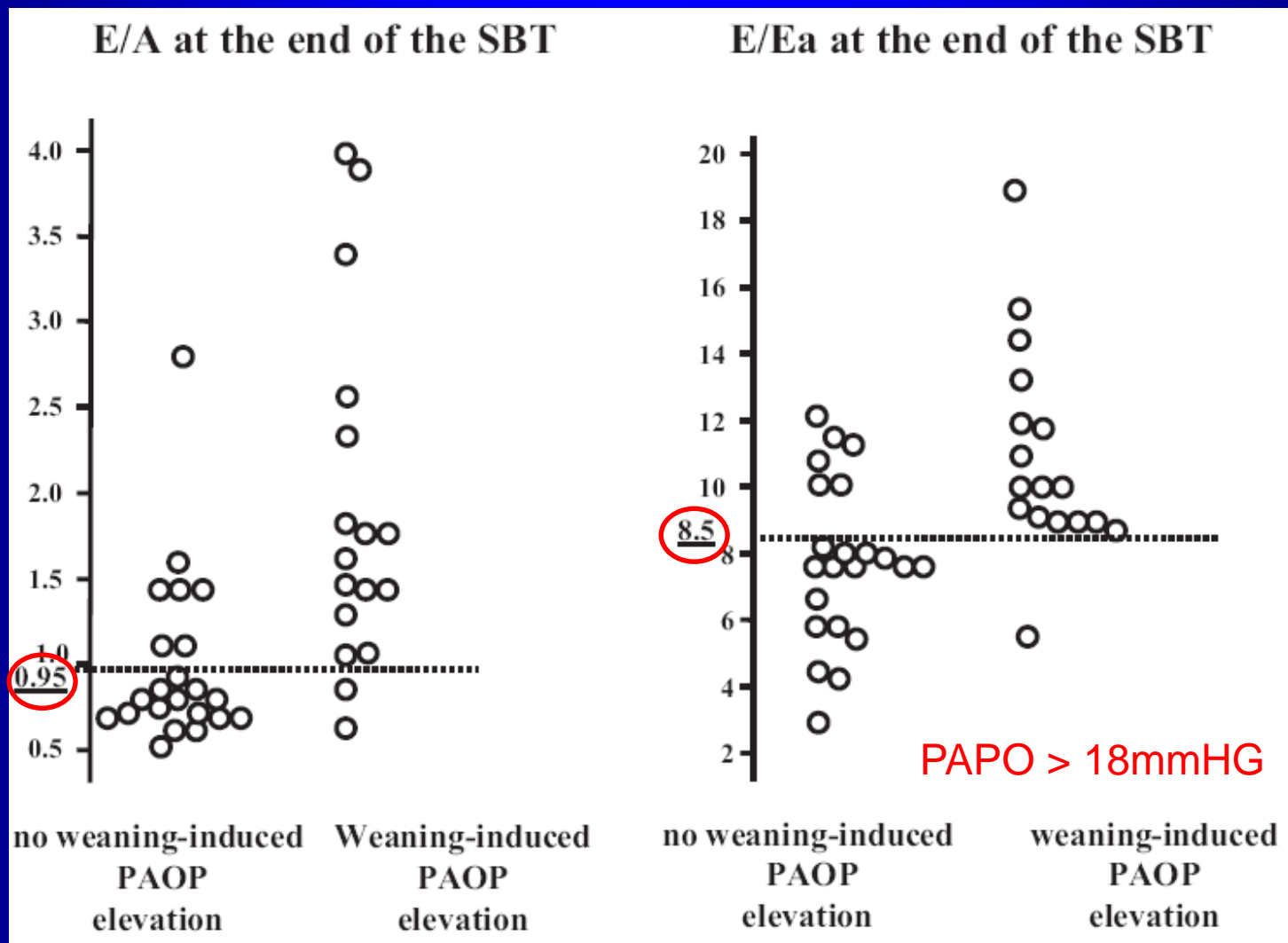
# Echocardiographic diagnosis of pulmonary artery occlusion pressure elevation during weaning from mechanical ventilation\*

## Résultats:

- 39 patients
  - 20 maladie cardiaque G / 7 FE < 50%
- 17 patients ↑ P<sub>APo</sub>

	↑ P <sub>APo</sub>	P <sub>APo</sub> →
CMH (%)	25	0
BPCO (%)	46	54

# Echocardiographic diagnosis of pulmonary artery occlusion pressure elevation during weaning from mechanical ventilation\*





## Echocardiographic diagnosis of pulmonary artery occlusion pressure elevation during weaning from mechanical ventilation\*

- Combinaison E/A et E/Ea,
  - bon indice pour prédire  $\uparrow$  PAPo
  - Se 82%, Sp 91%, VPP 88%, VPN 87%
- Traitement ?????????
- $\uparrow$  PAPo
  - 17 patients traités par diurétiques
  - 14 extubés J4
- PAPo $\rightarrow$ 
  - 14 patients échecs (BPCO sévère, pneumonie, neuromyopathie, encombrement)
  - 12 sur 14 extubés J4

# Echocardiography: a help in the weaning process

Vincent Caille<sup>1,2</sup>, Jean-Bernard Amiel<sup>3,4,5</sup>, Cyril Charron<sup>1,2</sup>, Guillaume Belliard<sup>1,2</sup>, Antoine Vieillard-Baron<sup>1,2</sup> and Philippe Vignon\*<sup>3,4,5</sup>

- 117 patients
- HTA 33% / BPCO 14% / cardiaque 30%
- ETT T0 : AI
- ETT T 30 min : VS Tube

**Table 3: Doppler echocardiographic findings according to baseline left ventricular ejection fraction (recorded under pressure support ventilation)**

**RESEARCH**

**Open Access**

**Echocardiography**

Vincent Caille  
 Philippe Vignat

	LVEF > 50% (n = 58)	LVEF 50-35% (n = 30)	LVEF < 35% (n = 29)
<b>ECHECS</b>	<b>17 %</b>	<b>13 %</b>	<b>31%</b>
<b>E/A</b>			
PS/PEEP	0.97 (0.81-1.09)	0.82 (0.74-1.0)	1.0 (0.78-1.47)
SBT	0.99 (0.85-1.20)	0.89* (0.76-1.32)	1.0* (0.86-1.89)
<b>DTE (ms)</b>			
PS/PEEP	174 (152-193)	187 (144-224)	119 <sup>¶</sup> (90-153)
SBT	163 (155-181)	140* (112-177)	96* (80-137)
<b>E/E'</b>			
PS/PEEP	5.2 (4.7-6.0)	6.0 (5.3-9.0)	7.9 <sup>¶</sup> (5.4-9.1)
SBT	5.8 (4.9-6.6)	6.9 (4.9-9.3)	7.8 (6.7-9.7)

process

Baron<sup>1,2</sup> and

RESEARCH

Open Access

# Echocardiography: a help in the weaning process

Vincent Caille<sup>1,2</sup>, Jean-Bernard Amiel<sup>3,4,5</sup>, Cyril Charron<sup>1,2</sup>, Guillaume Belliard<sup>1,2</sup>, Antoine Vieillard-Baron<sup>1,2</sup> and Philippe Vignon<sup>\*3,4,5</sup>

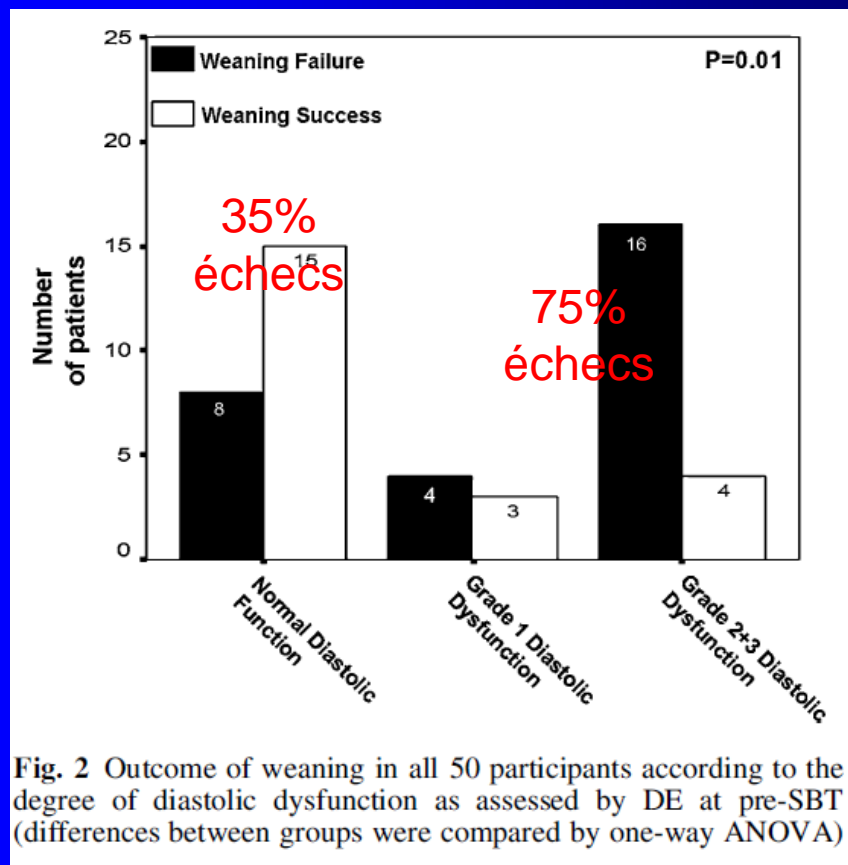
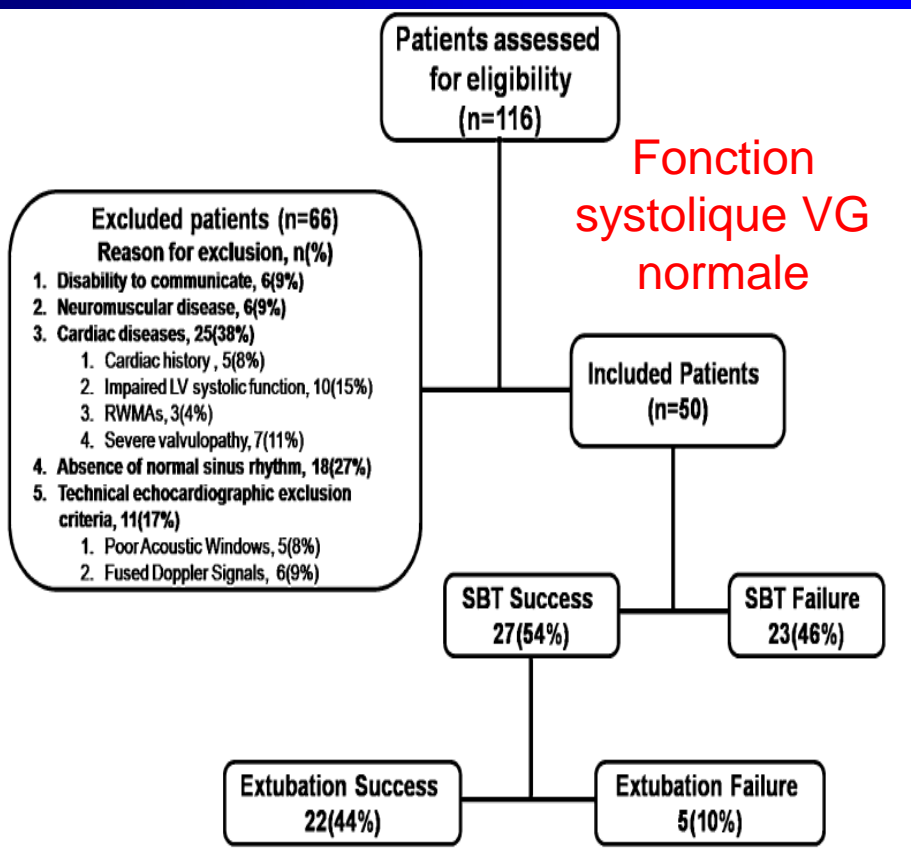
**Table 4: Patients' characteristics prior to SBT, according weaning success or failure**

	Weaning success (n = 94)	Weaning failure (n = 23)	P value
SAP (mmHg)	139 (133-147)	132 (115-149)	0.28
HR (bpm)	92 (86-97)	110 (95-120)	<b>0.007</b>
SV (mL)	63 (57-70)	60 (39-66)	0.06
CO (L/min/m <sup>2</sup> )	5.8 (5.2-6.3)	5.4 (3.3-6.5)	0.19
LVEF (%)	51 (43-55)	36 (27-55)	<b>0.04</b>
E/A	0.94 (0.82-1.03)	0.88 (0.68-1.65)	0.7
DTE (ms)	170 (150-189)	138 (98-195)	0.07
E/E'	5.6 (5.2-6.3)	7.0 (5.0-9.2)	<b>0.038</b>
RVEDA/LVEDA	0.47 (0.44-0.51)	0.48 (0.43-0.52)	0.99



John Papanikolaou  
Demosthenes Makris  
Theodosios Saranteas  
Dimitrios Karakitsos  
Elias Zintzaras  
Andreas Karabinis  
Georgia Kostopanagiotou  
Epaminondas Zakynthinos

## New insights into weaning from mechanical ventilation: left ventricular diastolic dysfunction is a key player



# Diastolic dysfunction as a predictor of weaning failure: A systematic review and meta-analysis



C.A. de Meirelles Almeida, MD <sup>a,\*</sup>, W.L. Nedel, MD <sup>b</sup>, V.D. Morais, MD <sup>b</sup>, M.M. Boniatti, PhD <sup>c</sup>, O.C. de Almeida-Filho, MD <sup>d</sup>

Main characteristics of the studies included in the systematic review

Study	n (% male)	Study design	Inclusion criteria	Diastolic function measurements	Outcomes
Lamia et al [6]	39 (NR)	Prospective cohort	Two previous SBT failures with PAC inserted, measurements pre- and post-new SBT (until 1 h)	Measures taken before and after SBT: E and A waves, E/A ratio, lateral e' wave, E/e' ratio	EA >0.95 (88% sensitivity and 68% specificity) and E/e' >8.5 (94% sensitivity, and 73% specificity) predicted PCP elevation weaning induced. Combination of both: S 82% and E 91%
Caille et al [7]	117 (60)	Prospective cohort	Patients with >48 h MV with SBT criteria	Measures taken before and after SBT: E and A waves, E/A ratio, DTE, lateral e' wave, E/e' ratio	Patients with weaning failure presented higher E/e' (7.0 vs 5.6; P= .04), but not EA (0.88 vs 0.94; P= .7) or DTE (138 vs 170; P= .07) when compared with patients who did not fail SBT
Zapata et al [8]	100 (NR)	Prospective cohort	Patients in MV for >48 h ready to wean	Measures taken before and after SBT: E and A waves, E/A ratio, DTE	E/A ratio and DTE both at baseline and after SBT were not related to weaning failure
Papanikolaou et al [9]	50 (66)	Prospective cohort	Patients in MV for >72 h ready to wean	Measures taken before and after SBT: E and A waves, E/A ratio, DTE, lateral and septal e waves, E/e' ratio (average)	At baseline, weaning success group had lower E/e' average ratio (6.18 vs 10.98; P< .001) than the failure group, E/A ratio (1.26 vs 1.24; P= .89) and DTE (205 vs 194; P= .31) had no significant differences. E/e' lateral ratio >7.8 pre-SBT predicted weaning failure with a sensitivity of 79% and specificity of 100% (AUC, 0.86; 95% CI, 0.75–0.96; P< .01)
Schifelhain et al [10]	24 (58)	Randomized crossover trial	Patients in MV for >48 h ready to wean	Measures taken before and after SBT (crossover PSV/T-tube): E and A waves, E/A ratio, DTE, e' and a' waves, E/e' ratio	E wave (0.71 vs 0.82; P= .352), A wave (0.76 vs 0.67; P= .444), E/A ratio (1.02 vs 1.53; P= .221), DTE (239 vs 187; P= .101), e' 0.09 vs 0.13; P= .053), a' (0.14 vs 0.29; P= .329) and E/e' ratio (8.25 vs 7.24; P= .48) had no significant differences between weaning success and failure groups
Abdelbary et al [11]	30 (53)	Prospective cohort	Patients in MV ready to wean who had a pulmonary artery catheter inserted as part of the treatment	Measures taken before and after SBT: E and A waves, E/A ratio, DTE, septal e' wave, E/e' ratio (septal)	At the end of SBT, a value of E/e' >10.4 predicted PCP elevation with a sensitivity of 100% and a specificity of 78%. E and A waves, E/A ratio, and DTE did not have significant differences between groups or moments (baseline vs after SBT)
Gerbaud et al [12]	44 (61)	Prospective cohort	Patients in MV due to severe heart failure (decompensated CHF or acute myocardial infarction Killip III/IV)	Measures taken before and after SBT: E and A waves, E/A ratio, lateral and septal e' waves, E/e' ratio (average)	At baseline, E/A (1.12 vs 1.06; P= .69) and E/e' ratio (9.5 vs 10.7; P= .63) had no differences between weaning success or failure groups. Weaning failure group, comparing baseline with SBT, increased E/A (1.06 vs 1.38; P< .05) and E/e' ratios (10.7 vs 16.8; P< .05)
Moschietto et al [13]	68 (57)	Prospective cohort	Patients in MV for >48 h ready to wean	Measures taken before and after beginning of SBT: E wave, DTE, lateral e' wave, E/e' ratio (lateral)	At baseline, patients who succeeded had lower E/e' ratio (8.9 vs 13.4; P= .001), higher e' (8 vs 7; P= .01) and DTE (215 vs 170; P= .03). E/e' ratio during SBT >14.5 predicts weaning failure with an AUC of 0.86 (P< .001)
Konomi et al [14]	55 (62)	Prospective cohort	Patients in MV for >72 h ready to wean	Measures taken before SBT. Diastolic dysfunction quantified from 0 to 3 using E and A wave, E/A ratio, E/e' ratio and DTE	LV diastolic dysfunction was significantly correlated with weaning failure (P< .001). Grade 0: 7.7%, grade 1: 33%, grade 2: 60%, grade 3: 100%
Thille et al [15]	225 (59)	Prospective cohort	Patients in MV for >24 h ready to wean	Diastolic dysfunction defined when lateral e' <10 cm/s. Cardiac function was systematically assessed.	Diastolic dysfunction was not associated with weaning failure (55% vs 55%; P= .84)

CHF indicates chronic heart failure; MV, mechanical ventilation; NR, not reported; PAC, pulmonary arterial catheter; PCP, pulmonary capillary pressure.

# Diastolic dysfunction as a predictor of weaning failure: A systematic review and meta-analysis



C.A. de Meirelles Almeida, MD <sup>a,\*</sup>, W.L. Nedel, MD <sup>b</sup>, V.D. Morais, MD <sup>b</sup>, M.M. Boniatti, PhD <sup>c</sup>, O.C. de Almeida-Filho, MD <sup>d</sup>

## Ratio E/e'

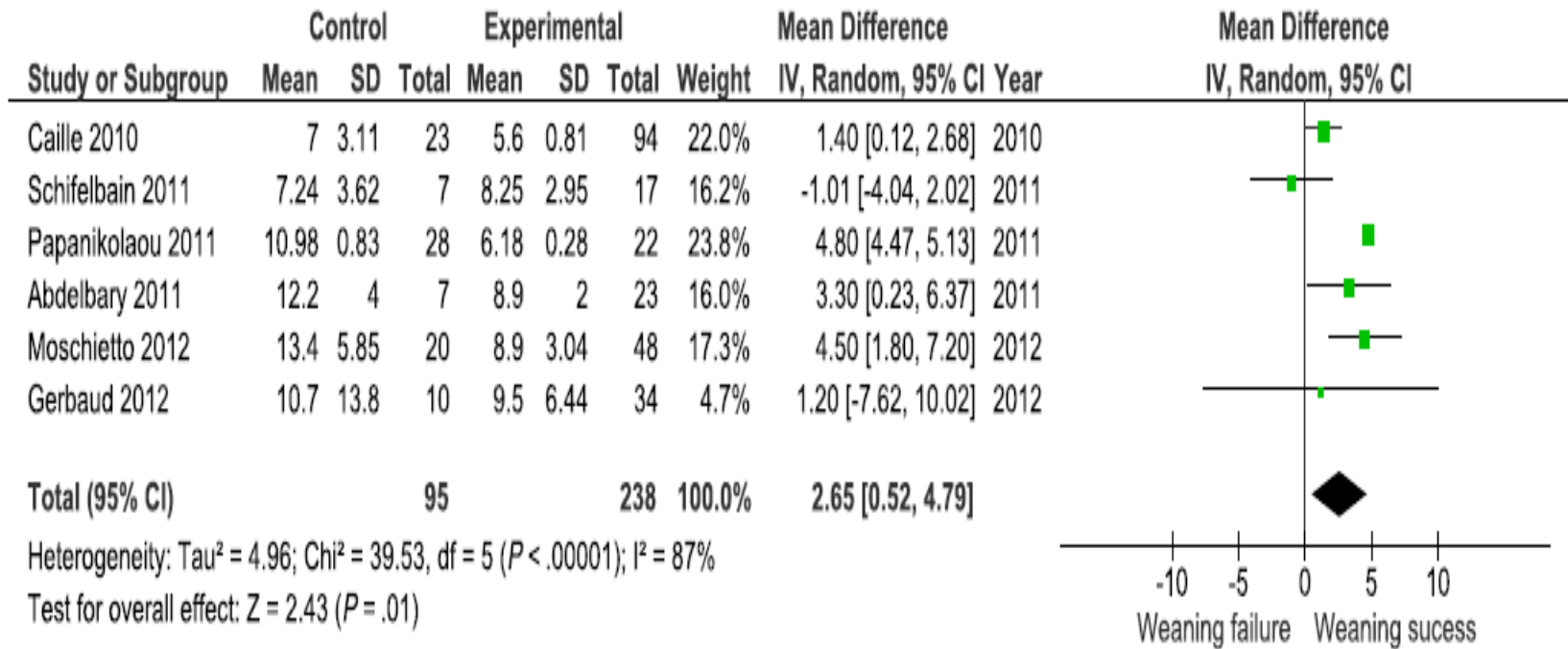


Fig. 2. E/e' ratio mean difference between weaning failure and weaning success groups.

# Diastolic dysfunction as a predictor of weaning failure: A systematic review and meta-analysis



C.A. de Meirelles Almeida, MD <sup>a,\*</sup>, W.L. Nedel, MD <sup>b</sup>, V.D. Morais, MD <sup>b</sup>, M.M. Boniatti, PhD <sup>c</sup>, O.C. de Almeida-Filho, MD <sup>d</sup>

## Ratio E/A

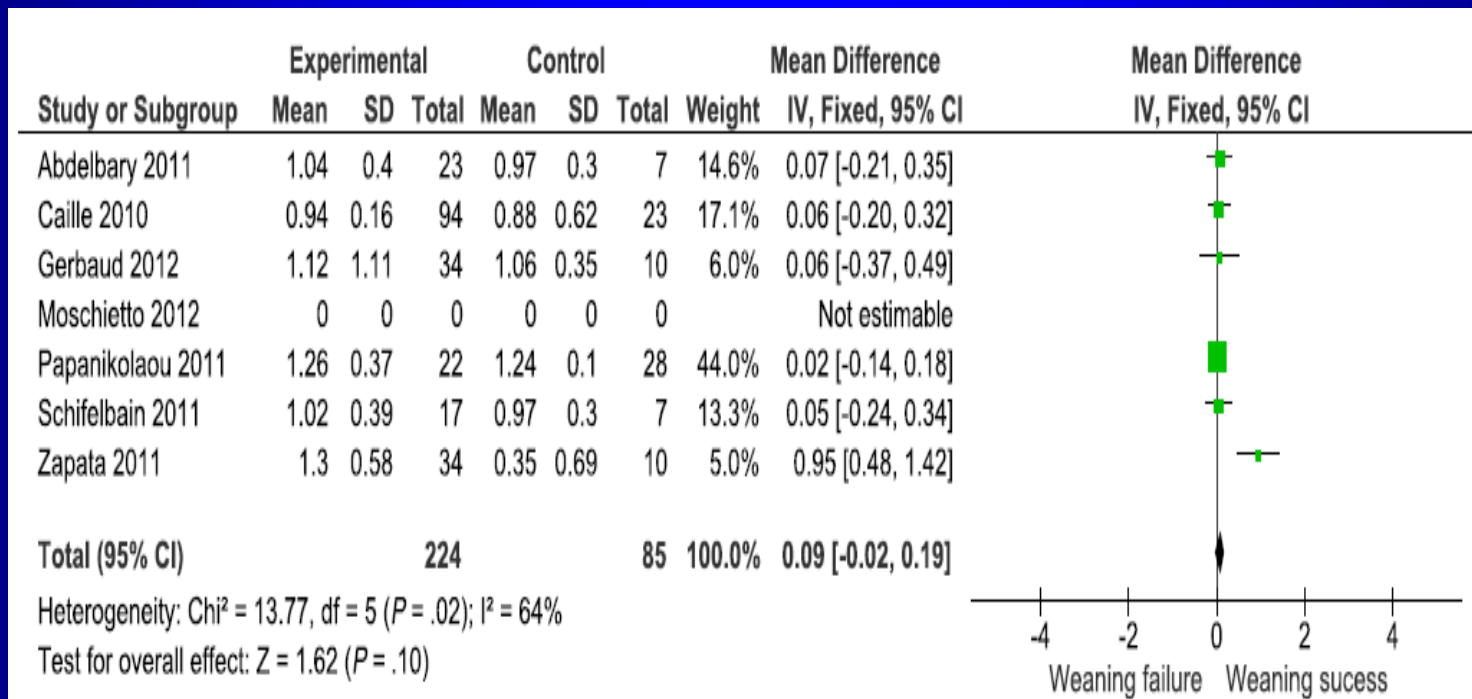


Fig. 3. E/A ratio mean difference between weaning failure and weaning success groups.

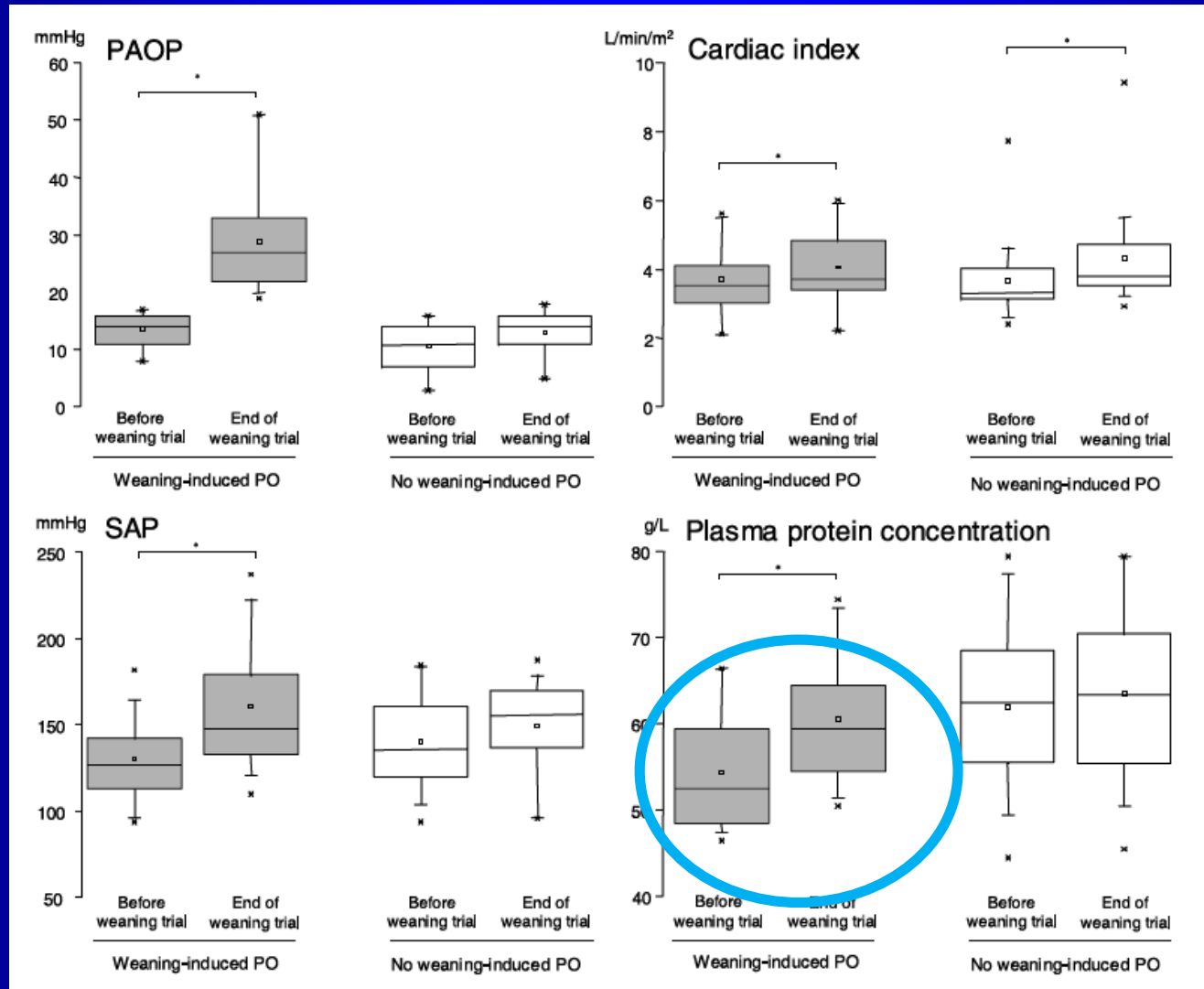
Autre chose que l'ECHO pour prédire l'issu sevrage ventilatoire ?



Nadia Anguel  
Xavier Monnet  
David Osman  
Vincent Castelain  
Christian Richard  
Jean-Louis Teboul

# Increase in plasma protein concentration for diagnosing weaning-induced pulmonary oedema

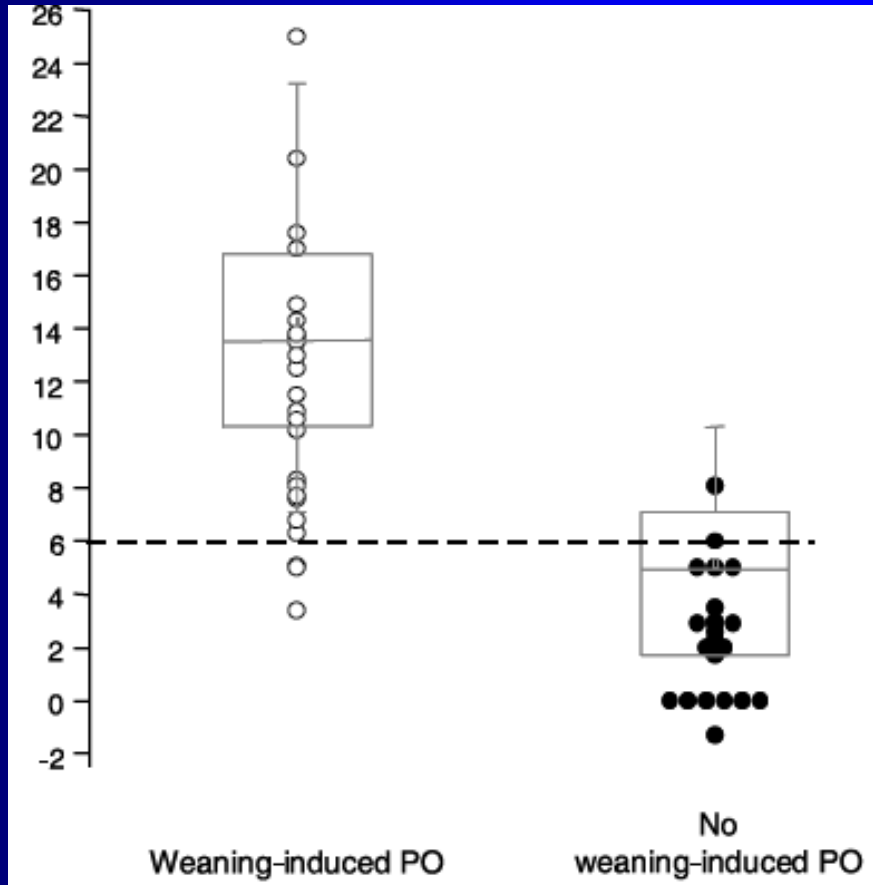
Intensive Care Med (2008) 34:1231–1238



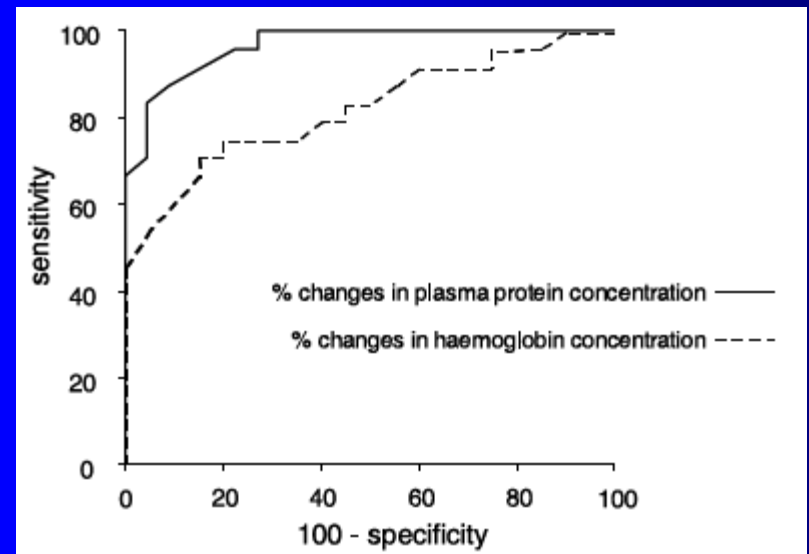
Nadia Anguel  
Xavier Monnet  
David Osman  
Vincent Castelain  
Christian Richard  
Jean-Louis Teboul

# Increase in plasma protein concentration for diagnosing weaning-induced pulmonary oedema

Intensive Care Med (2008) 34:1231–1238



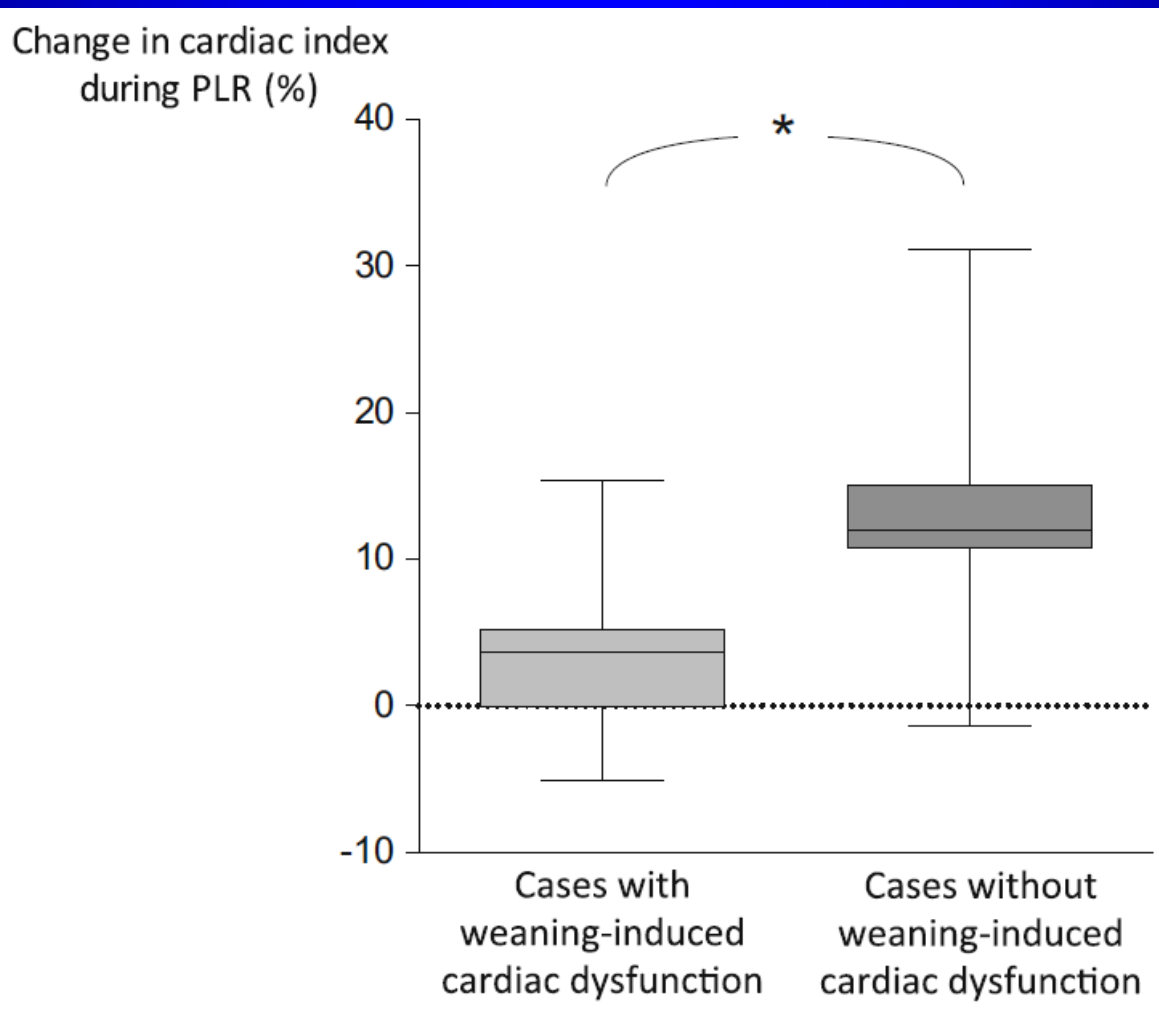
Protidémie ou  
Hématocrite  
Seuil à 6%



Martin Dres  
Jean-Louis Teboul  
Nadia Anguel  
Laurent Guerin  
Christian Richard  
Xavier Monnet

## Passive leg raising performed before a spontaneous breathing trial predicts weaning-induced cardiac dysfunction

Intensive Care Med (2015) 41:487–494

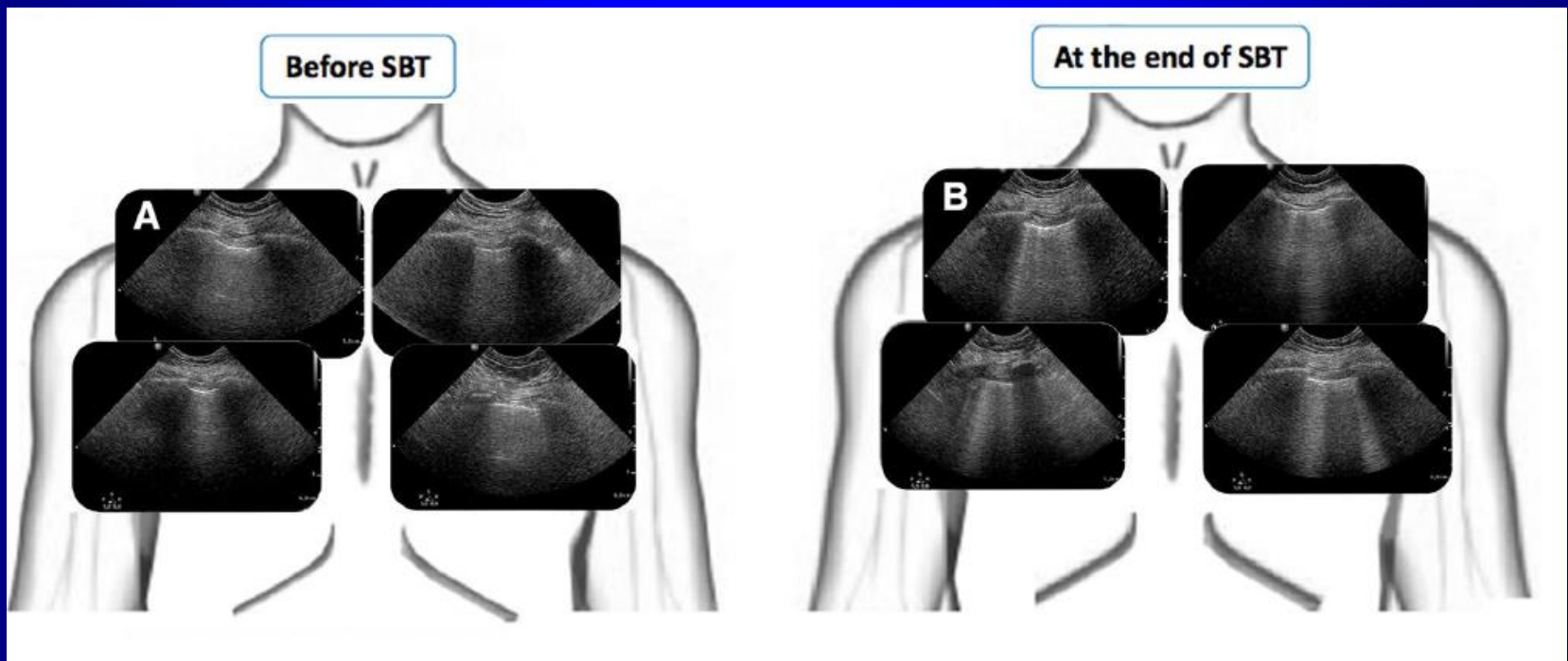




# Lung ultrasound allows the diagnosis of weaning-induced pulmonary oedema

Alexis Ferré<sup>1,2</sup>, Max Guillot<sup>1,2</sup>, Daniel Lichtenstein<sup>3</sup>, Gilbert Mezière<sup>4</sup>, Christian Richard<sup>1,2</sup>, Jean-Louis Teboul<sup>1,2</sup> and Xavier Monnet<sup>1,2\*</sup>

*Intensive Care Med (2019) 45:601–608*

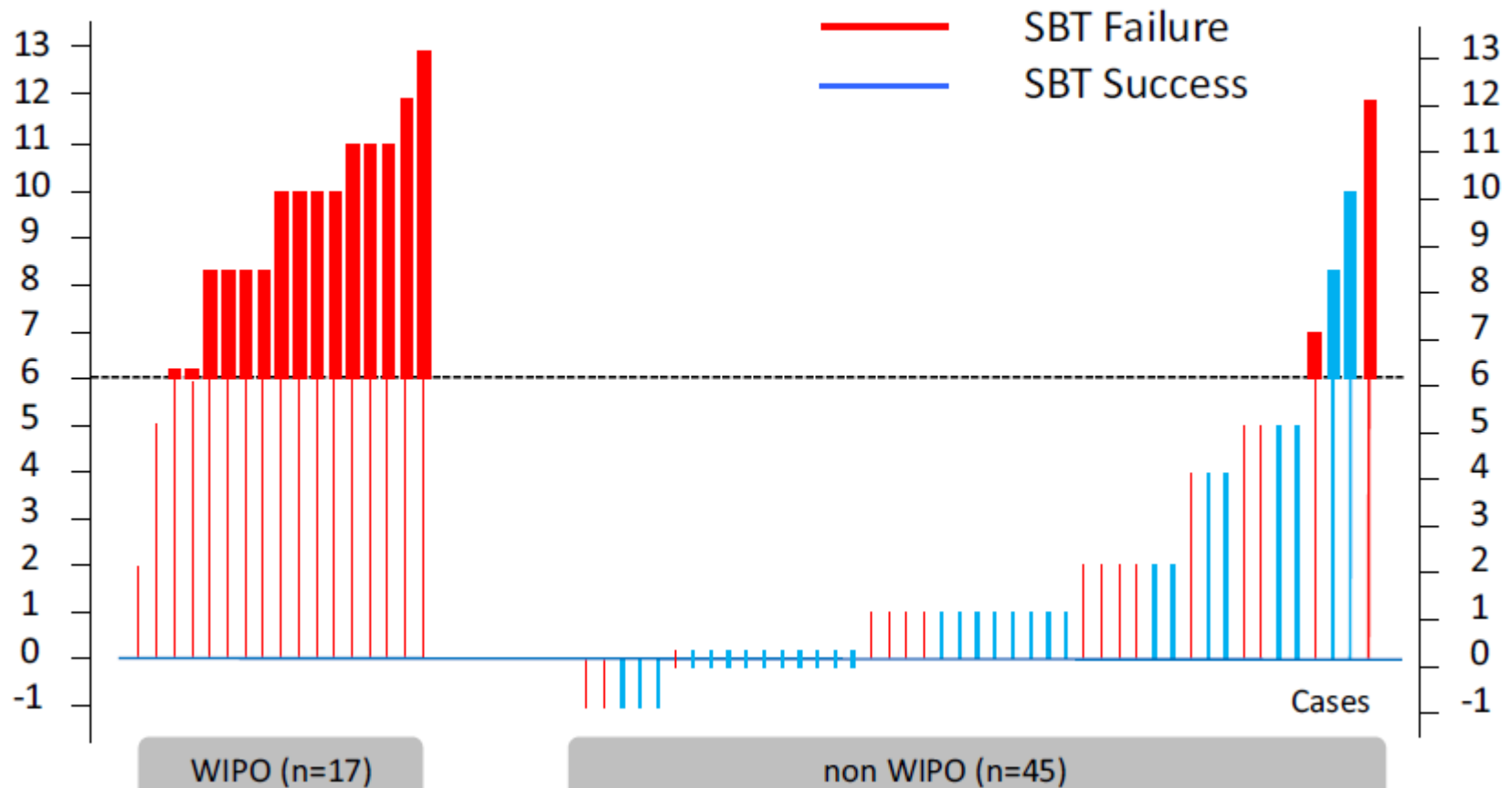


# Lung ultrasound allows the diagnosis of weaning-induced pulmonary oedema

Alexis Ferré<sup>1,2</sup>, Max Guillot<sup>1,2</sup>, Daniel Lichtenstein<sup>3</sup>, Gilbert Mezière<sup>4</sup>, Christian Richard<sup>1,2</sup>, Jean-Louis Teboul<sup>1,2</sup> and Xavier Monnet<sup>1,2\*</sup>

*Intensive Care Med (2019) 45:601–608*

Increase in the number of B-lines



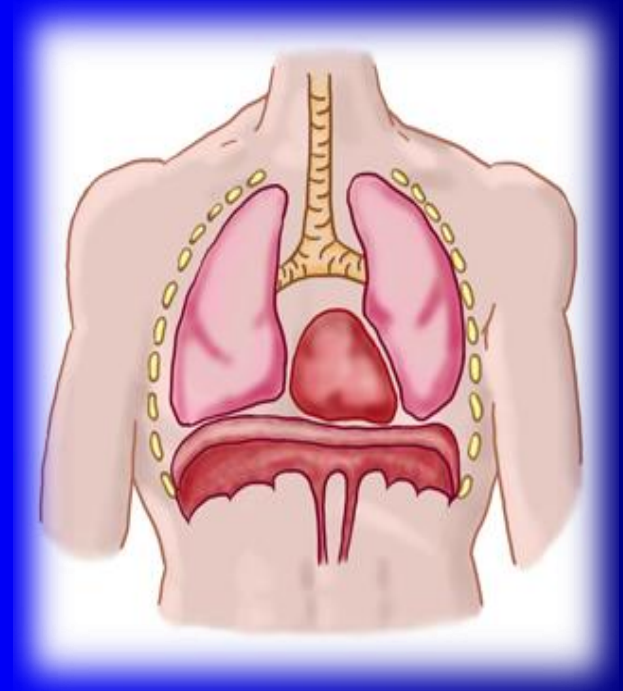
REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>

- Evaluation fonctions
  - Cardiaque
  - Diaphragmatique
  - Pulmonaire
  - Epanchement pleural



REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>

## Evaluation Coeur

	Value	Potential utility
Measurement before SBT		
LV ejection fraction	<40 %	Increased likelihood of failure of SBT
LV ejection fraction	Normal	Increased likelihood of success of SBT
Mitral diastolic inflow	If EF reduced: $E/A > 2$	Increased likelihood of failure of SBT
Mitral diastolic inflow	If EF normal: $E/e' > 12$	Increased likelihood of failure of SBT
CO before/after PSL	No increase in CO	Increased likelihood of failure of SBT
Measurement after SBT		
Mitral diastolic inflow	Increased $E/A$ , $E/e'$	Identification of SBT-induced cardiogenic pulmonary oedem

REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>

## Evaluation Diaphragme

Measurement	Value	Potential utility
Diaphragmatic excursion during SBT	<11 mm	Increased likelihood of failure of SBT
Best diaphragmatic excursion on right or left	>25 mm	Increased likelihood of success of SBT
Thickening fraction of diaphragm during SBT	>30–36 %	Increased likelihood of success of SBT
Right- and left-sided diaphragmatic excursion	Bilateral absence of diaphragmatic excursion	Increased likelihood of failure of SBT

REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>

## Evaluation plèvre

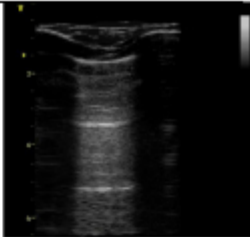
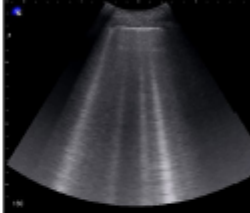

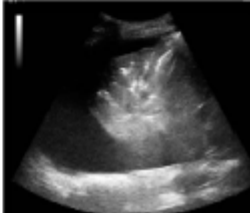
Ultrasonography result	Proposed intervention	Probable result
Small PLEFF	Removal of PLEFF	No effect on likelihood of success of SBT
Moderate PLEFF without co-existing dysphysiology	Removal of PLEFF	No effect on likelihood of success of SBT
Moderate PLEFF with co-existing dysphysiology	Removal of PLEFF	Increased likelihood of success of SBT
Large PLEFF	Removal of PLEFF	Increased likelihood of success of SBT

REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>

Points	Degrees of lung aeration	Patterns	
0 point	Normal aeration	Horizontal <b>A-lines</b> (or no more than two B-lines)	
1 point	Moderate loss of aeration	<b>Multiple B-lines</b> , either regularly spaced (7 mm apart), or irregularly spaced and even coalescent but only visible in a limited area of the intercostal space	
2 points	Severe loss of aeration	<b>Multiple coalescent B-lines</b> , in prevalent areas of the intercostal spaces and observed in one or several intercostal spaces	
3 points	Complete loss of aeration	<b>Lung consolidation</b> , with or without air bronchograms	

## Evaluation Poumon

LUS at end of SBT	Value	Potential utility
LUS score	<13	Increased likelihood of success of extubation
LUS score	13–17	Indeterminate likelihood
LUS score	>17	Increased likelihood of failure of extubation

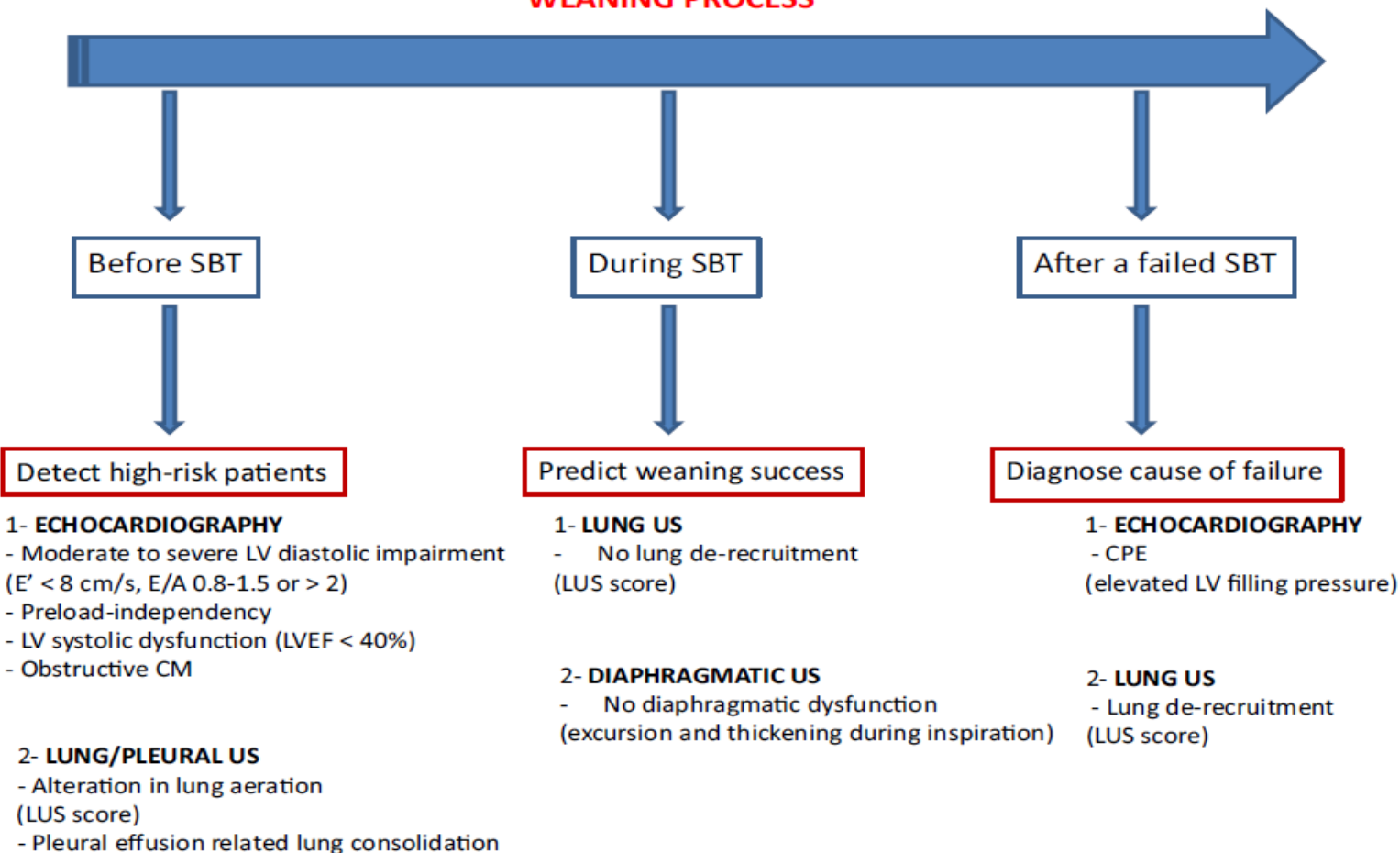
REVIEW



# Ultrasonography evaluation during the weaning process: the heart, the diaphragm, the pleura and the lung

P. Mayo<sup>1\*</sup>, G. Volpicelli<sup>2</sup>, N. Lerolle<sup>3</sup>, A. Schreiber<sup>4</sup>, P. Doelken<sup>5</sup> and A. Vieillard-Baron<sup>6,7,8</sup>


## WEANING PROCESS





# Myocardial ischemia during ventilator weaning: a prospective multicenter cohort study


Bedet et al. *Critical Care* (2019) 23:321

Alexandre Bedet<sup>1,2\*</sup> , Françoise Tomberli<sup>3</sup>, Gwenael Prat<sup>4</sup>, Pierre Bailly<sup>4</sup>, Achille Kouatchet<sup>5</sup>, Sater Mortaza<sup>5</sup>, Emmanuel Vivier<sup>6</sup>, Sylvene Rosselli<sup>6</sup>, Larissa Lipskaia<sup>1,2</sup>, Guillaume Carteaux<sup>1,2</sup>, Keyvan Razazi<sup>1,2</sup> and Armand Mekontso Dessap<sup>1,2</sup>

- **Type d'étude:** multicentrique prospective
  - 4 centres
  - 218 patients / 20% atcd coronarien
- **Objectif:**
  - authentifier lien entre ischémie / OAP et sevrage (incidence) WICI / WIPO
- VM > 24h/ 1 échec VS tube
- **Mesures** T0 puis T H2 ou au rebranchement VM

# Myocardial ischemia during ventilator weaning: a prospective multicenter cohort study


Bedet *et al. Critical Care* (2019) 23:321

Alexandre Bedet<sup>1,2\*</sup> , Françoise Tomberli<sup>3</sup>, Gwenael Prat<sup>4</sup>, Pierre Bailly<sup>4</sup>, Achille Kouatchet<sup>5</sup>, Sater Mortaza<sup>5</sup>, Emmanuel Vivier<sup>6</sup>, Sylvene Rosselli<sup>6</sup>, Larissa Lipskaia<sup>1,2</sup>, Guillaume Carteaux<sup>1,2</sup>, Keyvan Razazi<sup>1,2</sup> and Armand Mekontso Dessap<sup>1,2</sup>

- Bilan hydrique
- Mesures biologiques:
  - Ht/ Protide/ albumine / Troponine / myoglobine / BNP
- Monitoring ST 12 dérivations pendant VS Tube
- Mesures ETT:
  - FEVG / ITVAo/ doppler mitral / DTI mitral / Cinétique segmentaire / Fuite mitrale

# Myocardial ischemia during ventilator weaning: a prospective multicenter cohort study

Bedet *et al. Critical Care* (2019) 23:321


Alexandre Bedet<sup>1,2\*</sup> , Françoise Tomberli<sup>3</sup>, Gwenael Prat<sup>4</sup>, Pierre Bailly<sup>4</sup>, Achille Kouatchet<sup>5</sup>, Sater Mortaza<sup>5</sup>, Emmanuel Vivier<sup>6</sup>, Sylvene Rosselli<sup>6</sup>, Larissa Lipskaia<sup>1,2</sup>, Guillaume Carteaux<sup>1,2</sup>, Keyvan Razazi<sup>1,2</sup> and Armand Mekontso Dessap<sup>1,2</sup>

## WIPO : Weaning Induced Pulmonary Edema

- pas de définition consensuelle
- Durant épreuve de sevrage
- Signes Echo augmentation pressions G :  $E/A > 0,95$  et  $E/E' > 8,5$
- Augmentation BNP  $> 48$  ou NT-proBNP  $> 21$
- Augmentation Prot  $> 6\%$ 
  - « Conservative » définition : 2 critères
  - « Liberal définition » : 1 critère

# Myocardial ischemia during ventilator weaning: a prospective multicenter cohort study

Bedet *et al. Critical Care* (2019) 23:321

Alexandre Bedet<sup>1,2\*</sup> , Françoise Tomberli<sup>3</sup>, Gwenael Prat<sup>4</sup>, Pierre Bailly<sup>4</sup>, Achille Kouatchet<sup>5</sup>, Sater Mortaza<sup>5</sup>, Emmanuel Vivier<sup>6</sup>, Sylvène Rosselli<sup>6</sup>, Larissa Lipskaia<sup>1,2</sup>, Guillaume Carteaux<sup>1,2</sup>, Keyvan Razazi<sup>1,2</sup> and Armand Mekontso Dessap<sup>1,2</sup>

## WICI: Weaning Induced Cardiac Ischemia

### Définition ESC 2012

- ST + 2 dérivations contiguës > 0,10mV toutes dérivations sauf V2-V3

V2-V3: 0,20 à 0,25mV

Homme 40 ans ou > 40 ans

Femme 0,15 mV

OU

- ST- > 0,05mV 2 dérivations continues

### Définition AHA 2013

- ST + ou ST- >0,1mV
- 2 dérivations

218 patients / 20% atcd coronarien/ 132 échecs (63,5% )

WIPO+

124/208 (59,6%)

Ou

44/208 (21,2%)

WICI +

36/177 (20,3%)

ou

12/177 (6,8%)

Troponine NS

2 patients traités pour Sd coronarien

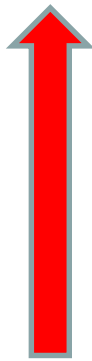
7 atcd coronarien: 2 Coro + sans traitement / 5 Coro –

# Myocardial ischemia during ventilator weaning: a prospective multicenter cohort study

Bedet *et al. Critical Care*

(2019) 23:321

Biological and echocardiographic data	Before	At the end	<i>p</i>
		Success ( <i>n</i> = 76)	
Troponin T, ng/l	297 (926)	303 (969)	0.641
NT-proBNP, ng/l	4166 (7316)	3975 (6632)	0.159
Protein, g/l	59.1 (10.9)	60.4 (10.1)	0.040
E mitral wave, cm/s	87.4 (24.4)	89.9 (26.7)	0.248
E/A ratio	0.99 (0.39)	1.00 (0.52)	0.736
E/e' ratio	10.6 (5.7)	10.7 (5.4)	0.778
LVEF, %	52 (15)	53 (14)	0.323
CO, l/min	5.9 (1.8)	6.2 (2.0)	0.225
		Failure ( <i>n</i> = 132)	
Troponin T, ng/l	410 (1866)	418 (1921)	0.326
NT-proBNP, ng/l	5726 (14509)	5983 (15476)	0.015
Protein, g/l	59.8 (9.1)	62.0 (9.0)	< 0.001
E mitral wave, cm/s	88.6 (33.7)	101.9 (36.0)	< 0.001
E/A ratio	1.04 (0.54)	1.18 (0.61)	0.003
E/e' ratio	11.1 (6.7)	11.8 (6.9)	0.040
LVEF, %	54 (14)	55 (15)	0.048
CO, l/min	5.7 (2.0)	6.1 (2.2)	0.012



## Weaning induced pulmonary edema (WiPO)

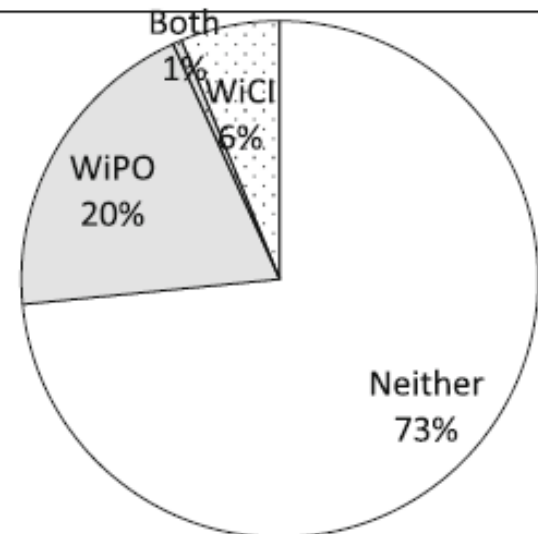
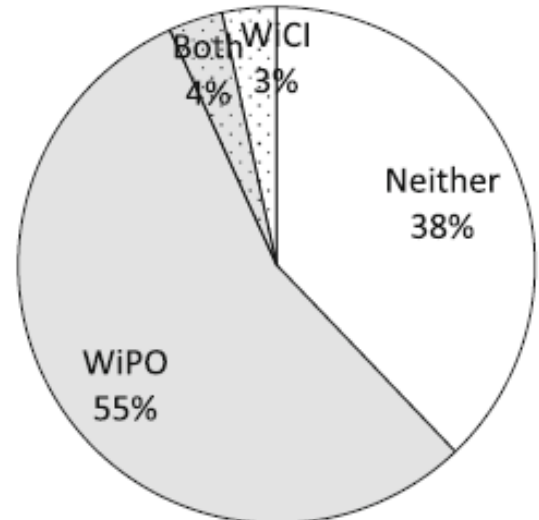
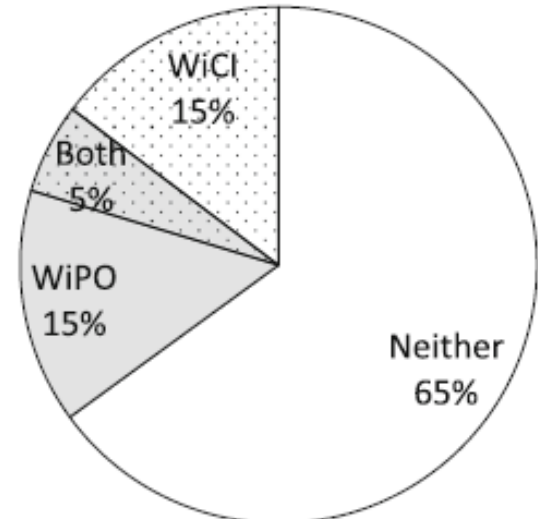
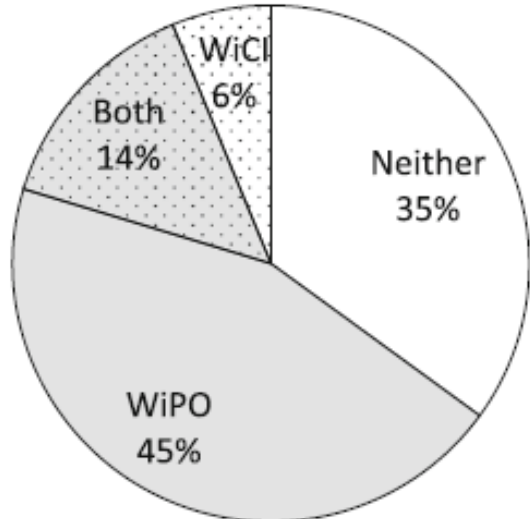
**Liberal definition**

**Conservative definition**

**Weaning induced cardiac ischemia (WiCI)**

**ESC definition 2012**

**AHA definition 2013**



# Thérapeutiques dans l'échec de sevrage??.....

- Peu d'études
- Dysfonction systolique:
  - diurétiques? inotrope?
- Dysfonction diastolique:
  - diurétiques ? dérivés nitrés?
- Ischémie:
  - dérivés nitrés?
- Autres Pistes :
  - Inodilatateurs : levosimendan, exominone
  - B Bloquant

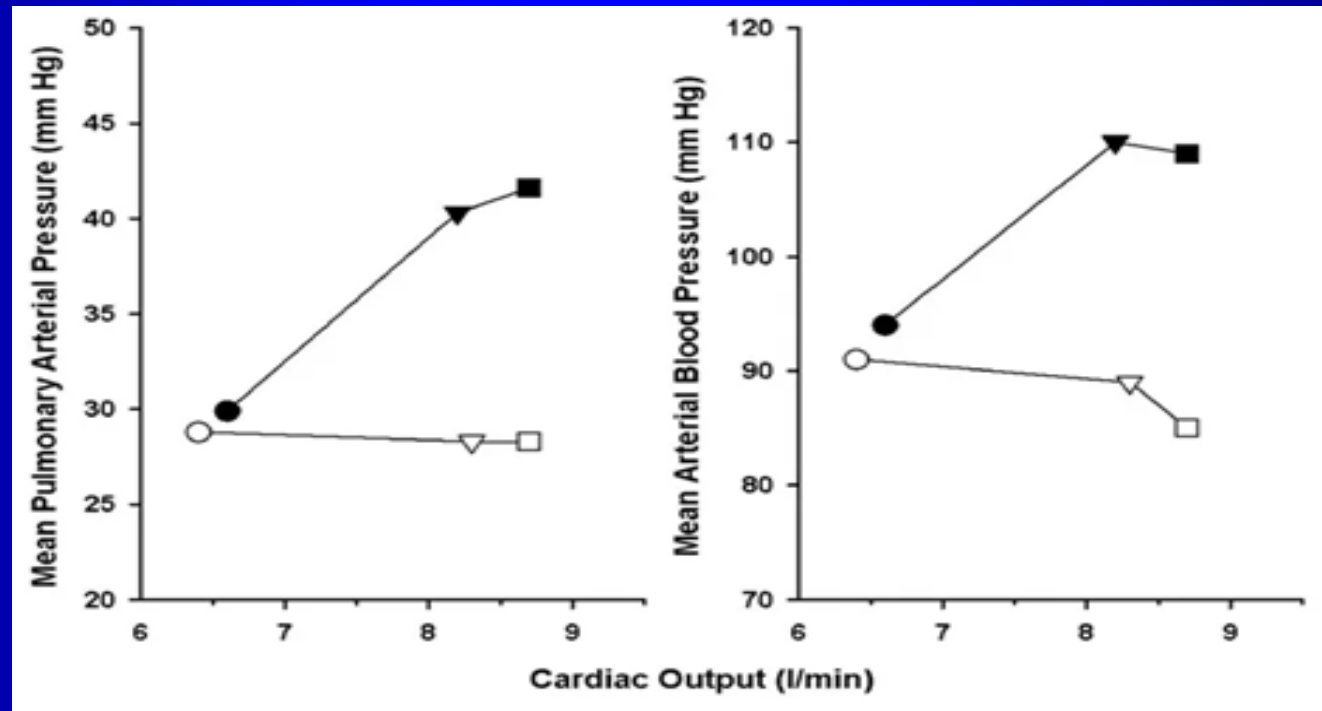


# Nitroglycerin can facilitate weaning of difficult-to-wean chronic obstructive pulmonary disease patients: a prospective interventional non-randomized study

[Christina Routsis](#) [Ioannis Stanopoulos](#), [Epaminondas Zakynthinos](#), [Panagiotis Politis](#), [Vassilios Papas](#), [Demetrios Zervakis](#) & [Spyros Zakynthinos](#)

*Critical Care* 14, Article number: R204 (2010)

- 12 patients BPCO (coronarien)
- 3 échecs VS Tube ou trachéo
- Mesure avant puis sous nitrés

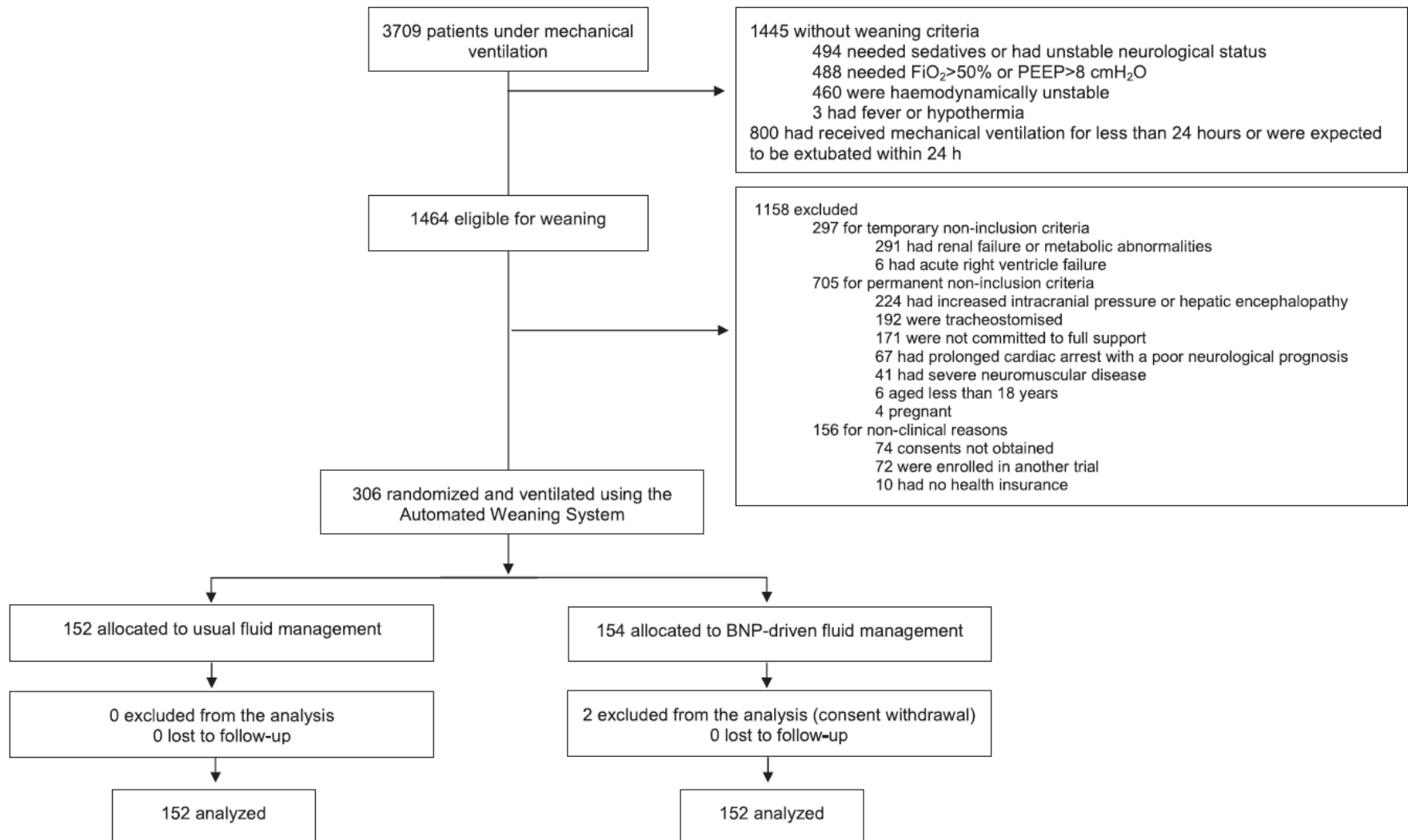


# Natriuretic Peptide-driven Fluid Management during Ventilator Weaning

Am J Respir Crit Care Med Vol 186, Iss. 12, pp 1256–1263, Dec 15, 2012

## A Randomized Controlled Trial

Armand Mekontso Dessap<sup>1,2,3</sup>, Ferran Roche-Campo<sup>1,4</sup>, Achille Kouatchet<sup>5</sup>, Vinko Tomcic<sup>6</sup>, Gaetan Beduneau<sup>7</sup>, Romain Sonnevile<sup>8</sup>, Belen Cabello<sup>4</sup>, Samir Jaber<sup>9</sup>, Elie Azoulay<sup>10</sup>, Diego Castanares-Zapatero<sup>11</sup>, Jerome Devaquet<sup>12</sup>, François Lellouche<sup>13</sup>, Sandrine Katsahian<sup>14</sup>, and Laurent Brochard<sup>1,2,3,15</sup>



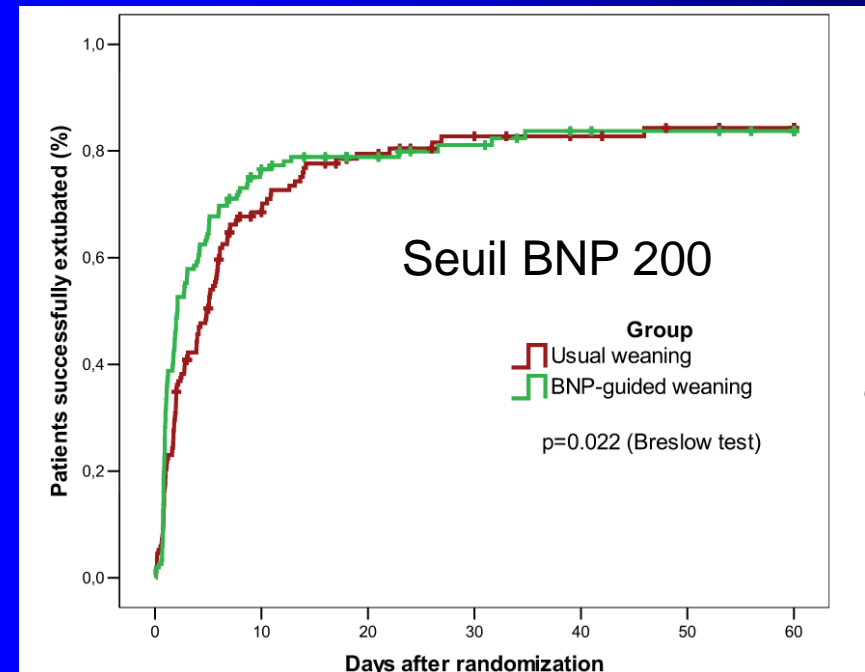
# Natriuretic Peptide–driven Fluid Management during Ventilator Weaning

A Randomized Controlled Trial

Armand Mekontso Dessap<sup>1,2,3</sup>, Ferran Roche-Campo<sup>1,4</sup>, Achille Kouatchet<sup>5</sup>, Vinko Tomicic<sup>6</sup>, Gaetan Beduneau<sup>7</sup>, Romain Sonnevile<sup>8</sup>, Belen Cabello<sup>4</sup>, Samir Jaber<sup>9</sup>, Elie Azoulay<sup>10</sup>, Diego Castanares-Zapatero<sup>11</sup>, Jerome Devaquet<sup>12</sup>, François Lellouche<sup>13</sup>, Sandrine Katsahian<sup>14</sup>, and Laurent Brochard<sup>1,2,3,15</sup>

Am J Respir Crit Care Med Vol 186, Iss. 12, pp 1256–1263, Dec 15, 2012

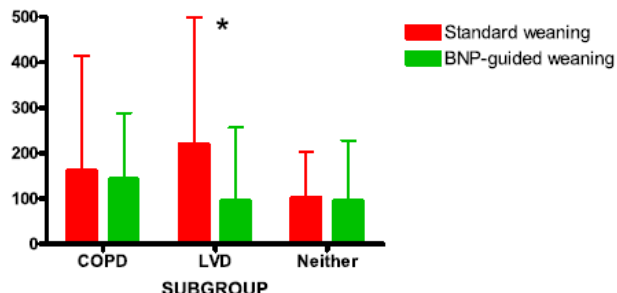
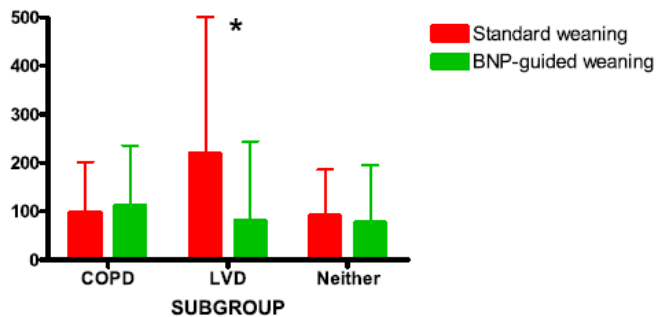
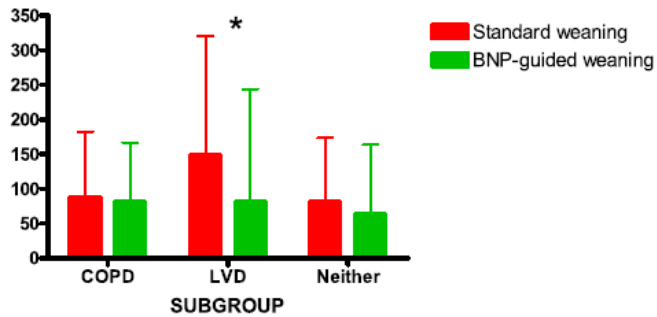
- groupe interventionnel : restriction des apports et diurétiques selon BNP
- → extubés + tôt / dysfonction VG
- → mortalité et DS idem
- → pas de complication ionique, rénal



# Natriuretic Peptide-driven Fluid Management during Ventilator Weaning

## A Randomized Controlled Trial

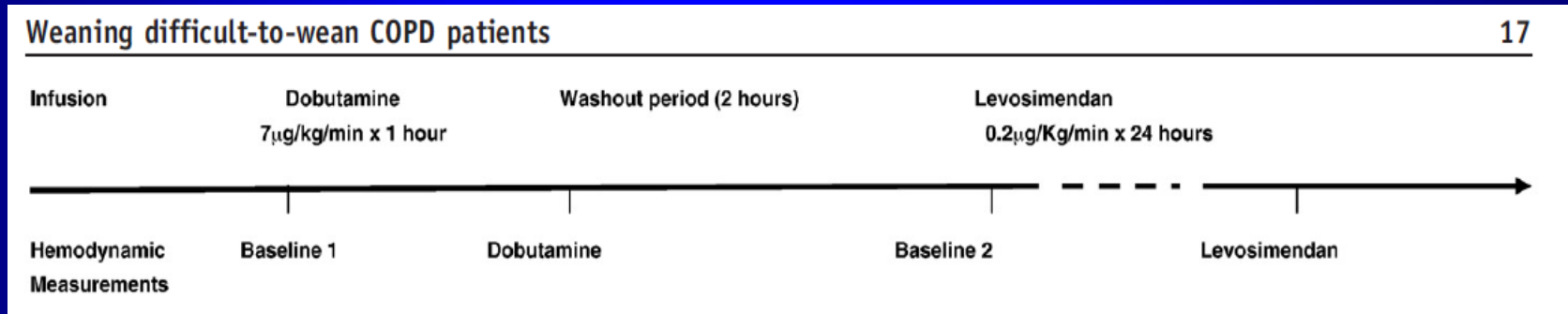
Armand Mekontso Dessap<sup>1,2,3</sup>, Ferran Roche-Campo<sup>1,4</sup>, Achille Kouatchet<sup>5</sup>, Vinko Tomicic<sup>6</sup>, Gaetan Beduneau<sup>7</sup>, Romain Sonnevile<sup>8</sup>, Belen Cabello<sup>4</sup>, Samir Jaber<sup>9</sup>, Elie Azoulay<sup>10</sup>, Diego Castanares-Zapatero<sup>11</sup>, Jerome Devaquet<sup>12</sup>, François Lellouche<sup>13</sup>, Sandrine Katsahian<sup>14</sup>, and Laurent Brochard<sup>1,2,3,15</sup>



# Weaning difficult-to-wean chronic obstructive pulmonary disease patients: A pilot study comparing initial hemodynamic effects of levosimendan and dobutamine

Lamia Ouanes-Besbes<sup>a</sup>, Islem Ouanes<sup>a</sup>, Fahmi Dachraoui<sup>a</sup>, Saoussen Dimassi<sup>a</sup>, Alexandre Mebazaa<sup>b</sup>, Fekri Abroug MD<sup>a,\*</sup>

Journal of Critical Care (2011) 26, 15–21



- SBT : augmentation PAPO
- Baisse plus importante PAPO sous levosimendan
- Tous extubés sans inotrope




# Etude en cours

Open access

Protocol

## BMJ Open Comparison of a preventive or curative strategy of fluid removal on the weaning of mechanical ventilation: a study protocol for a multicentre randomised open-label parallel-group trial

---

Martin Dres <sup>1</sup>, Candice Estellat,<sup>2</sup> Jean-Luc Baudel,<sup>3</sup> François Beloncle,<sup>4</sup> Julien Cousty,<sup>5</sup> Arnaud Galbois,<sup>6</sup> Laurent Guérin,<sup>7</sup> Vincent Labbe,<sup>8</sup> Guylaine Labro <sup>9</sup>, Jordane Lebut,<sup>10</sup> Jean-Paul Mira,<sup>11</sup> Gwenael Prat,<sup>12</sup> Jean-Pierre Quenot <sup>13</sup>, Armand Mekontso Dessap,<sup>14</sup> The Réseau Européen de Recherche en Ventilation Artificielle (REVA) research network

# Objectif et critère d'évaluation principal

## ■ Objectif principal

Evaluation de l'impact de la stratégie de déplétion utilisée sur la réduction de la durée du sevrage de la ventilation mécanique :

**Stratégie de déplétion  
préventive systématique**

vs

**Stratégie de  
déplétion curative**

## ■ Critère d'évaluation principal

Durée du sevrage de la ventilation mécanique = délai entre la randomisation et l'extubation réussie (patient vivant, non trachéotomisé et sans réintubation dans les 7 jours suivant l'extubation) jusqu'à J28

# Modalités de la déplétion hydro-sodée

## APPORTS LIQUIDIENS LIMITES :

Volume total perfusion de base et nutrition  $\leq 1500$  mL/24 heures

Pas de sel ou de solutés salés en dehors nutrition et médicaments ; apports salés réduits au strict nécessaire

## SURVEILLANCE BIOLOGIQUE :

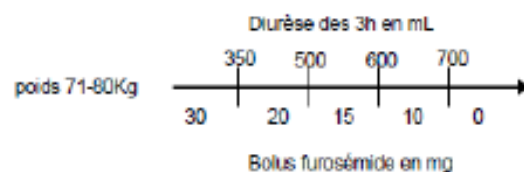
Réalisation quotidienne d'un ionogramme (sodium, potassium, urée et créatinine), voire plus, à la discrétion du clinicien

## STADE KDIGO

- Stade 1 : augmentation de la créatininémie comprise entre 228 et moins de 304 micromol/l ou  $\geq 0.3$  mg/dl (26.5 micromol/m) ou oligurie (diurèse  $< 39$  ml/h) pendant 6-12h malgré dose maximale de diurétiques
- Stade 2 : augmentation de la créatininémie comprise entre 304 et moins de 456 micromol/l ou oligurie (diurèse  $< 39$  ml/h) pendant  $\geq 12$ h malgré dose maximale de diurétiques
- Stade 3 : augmentation de la créatininémie à plus de 456 micromol/l ou  $\geq 4$  mg/dl (353.6 micromol/l) ou nécessité d'épuration extrarénale ou oligurie sévère (diurèse  $< 23$  ml/h) pendant  $\geq 24$  heures ou anurie pendant  $\geq 12$  heures, malgré dose maximale de diurétiques

## FUROSEMIDE :

Bolus initial de 20 mg IVD, puis nouveau bolus IVD toutes les 3 heures selon le poids du patient et la diurèse des 3 heures précédentes



## SUPPLEMENTATION EN MAGNESIUM ET POTASSIUM SYSTEMATIQUE SOUS FUROSEMIDE

- Mg (sulfate ou chlorure) :  $\geq 1,5$  g/jour
- KCl :  $\geq 4$  g/jour si kaliémie  $< 4.0$  mEq/L ;
- KCL :  $\geq 3$  g/jour si kaliémie comprise entre 4.0 et 4.4 mEq/L



# CONCLUSION

- Le sevrage VM c'est complexe
- A tout cela : vous rajouter VNI /OHD en post extubation .....
- Progrès dans la compréhension des mécanismes
- Le cœur oui mais pas que !
- Algorithme dans le diagnostic
- Manque d'études sur les thérapeutiques
- Futur: Algorithme dans PEC?

**MERCI!**