La circulation pulmonaire au cours du SDRA

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Agenda

- Pathophysiologie
- Diagnostic
- Prognostic
- Traitement

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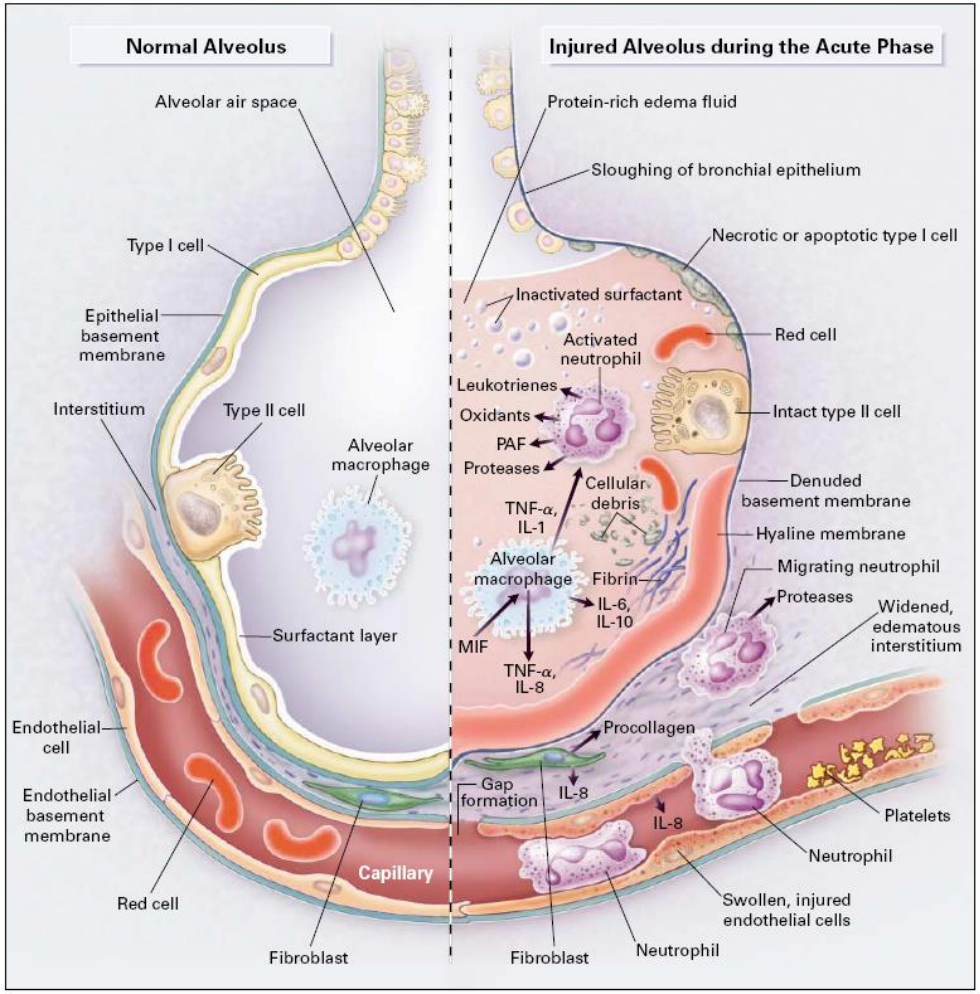
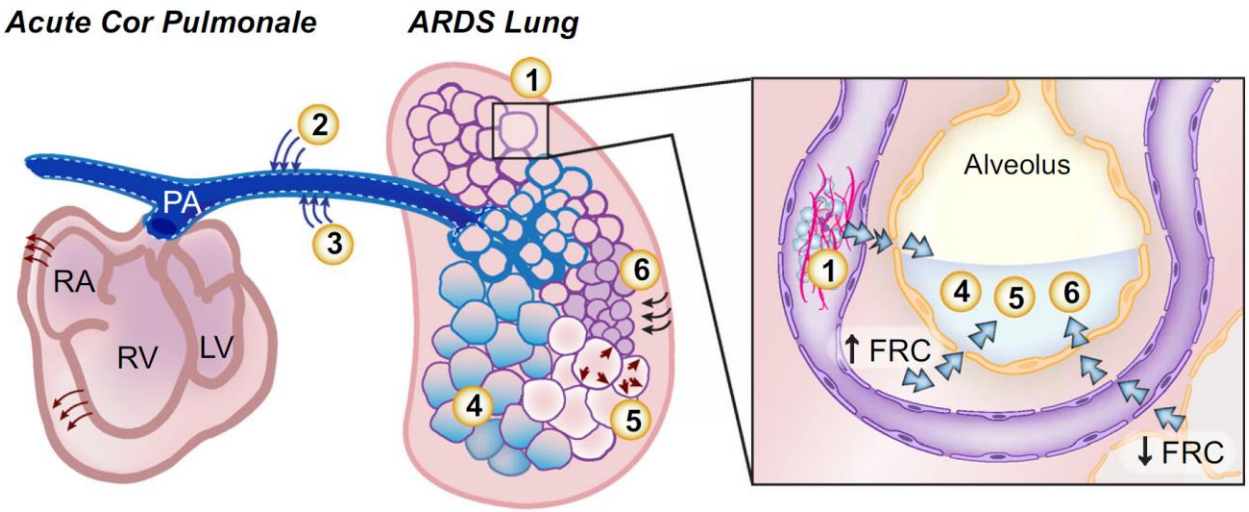
Le SDRA est une maladie des alvéoles ET des capillaires



Ware, NEJM 2000

Facteurs favorisant la dysfonction vasculaire pulmonaire au cours du SDRA



VASO-OCCLUSION

1. Lésions endothéliales, thrombose, remodelage

VASOCONSTRICTION

2. Hypoxémie, hypercapnie

3. Mediateurs endogènes (Tx, LT, ET…)

COMPRESSION VASCULAIRE

4. Oedème

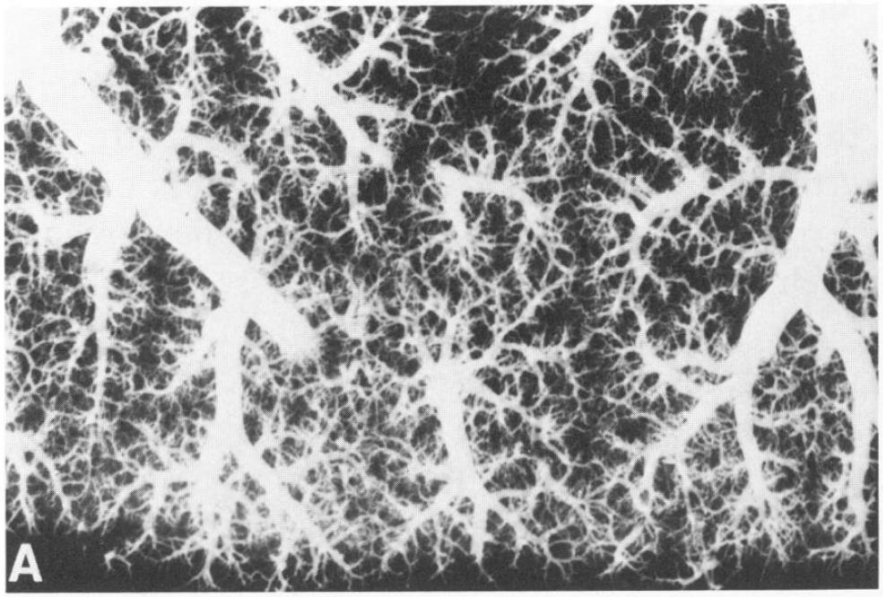
5. Surdistension

6.Collapsus pulmonaire

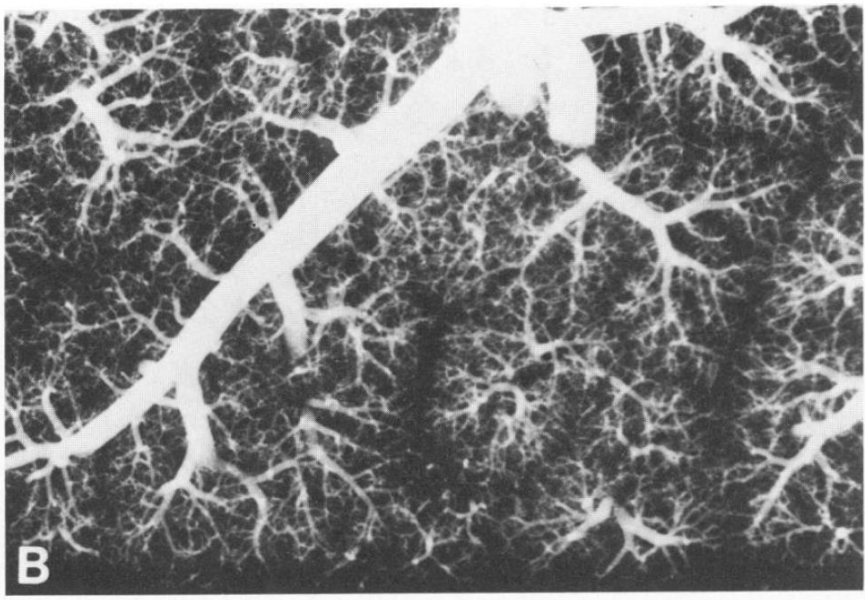
Adapted from Guerin, ICM 2016

Vaso-occlusion

Normal adult

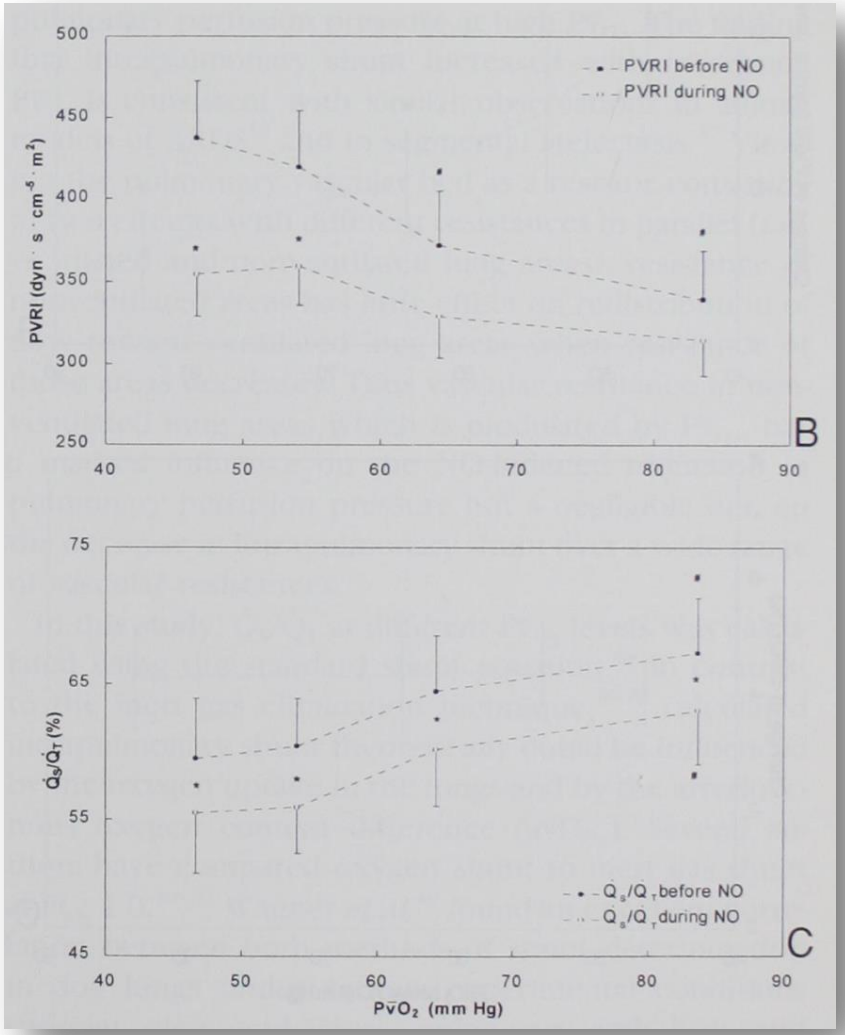


Early ARDS



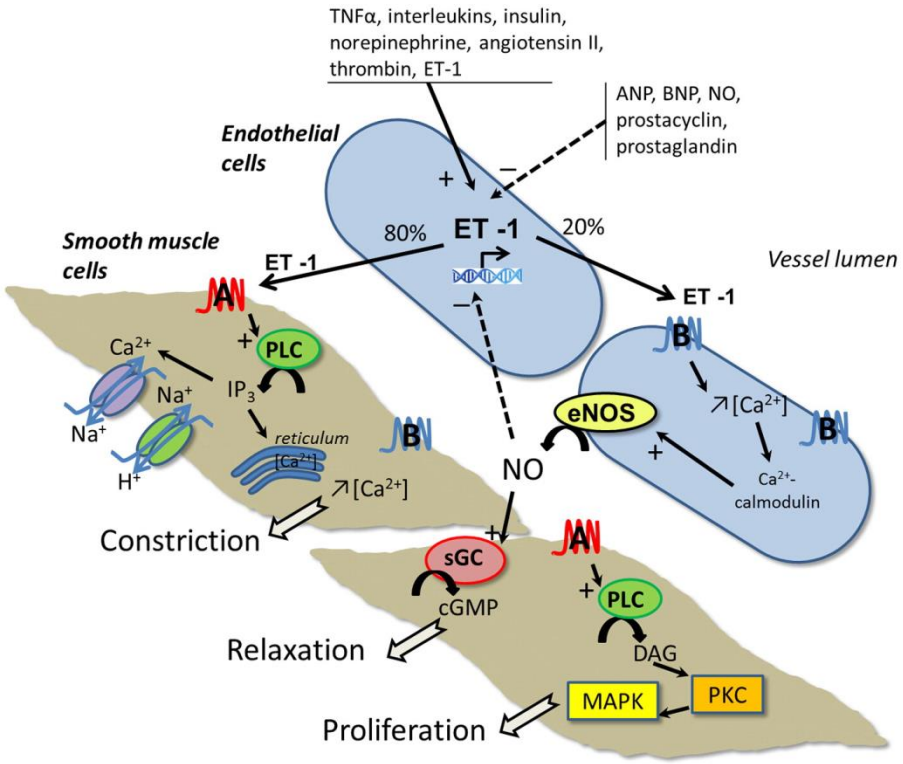
Tomashefski, Am J Pathol 1983

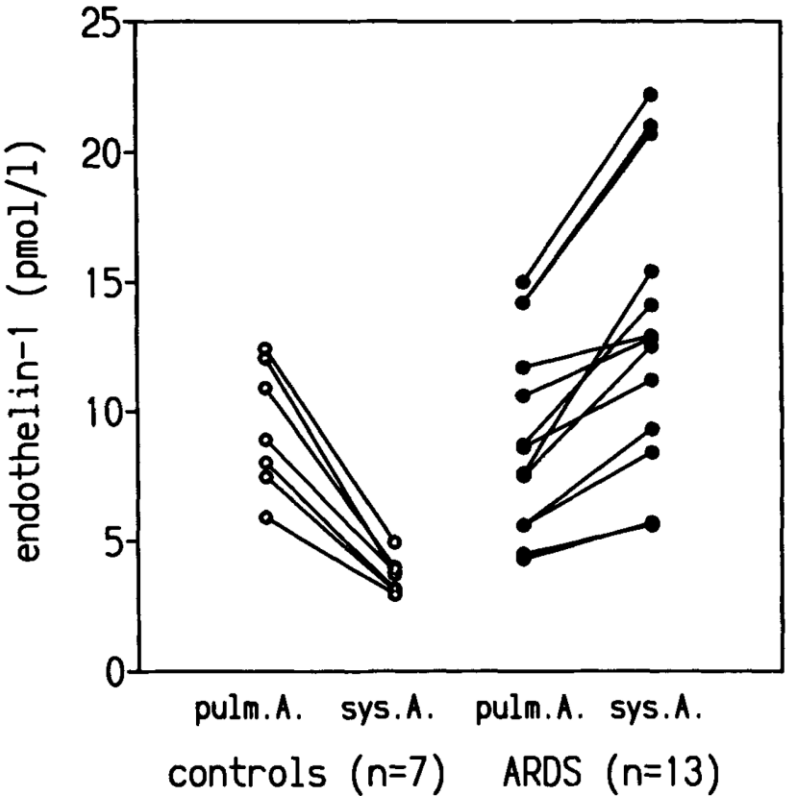
Vasoconstriction pulmonaire hypoxique



Benzing, Anesthesiology 1997

Endothéline

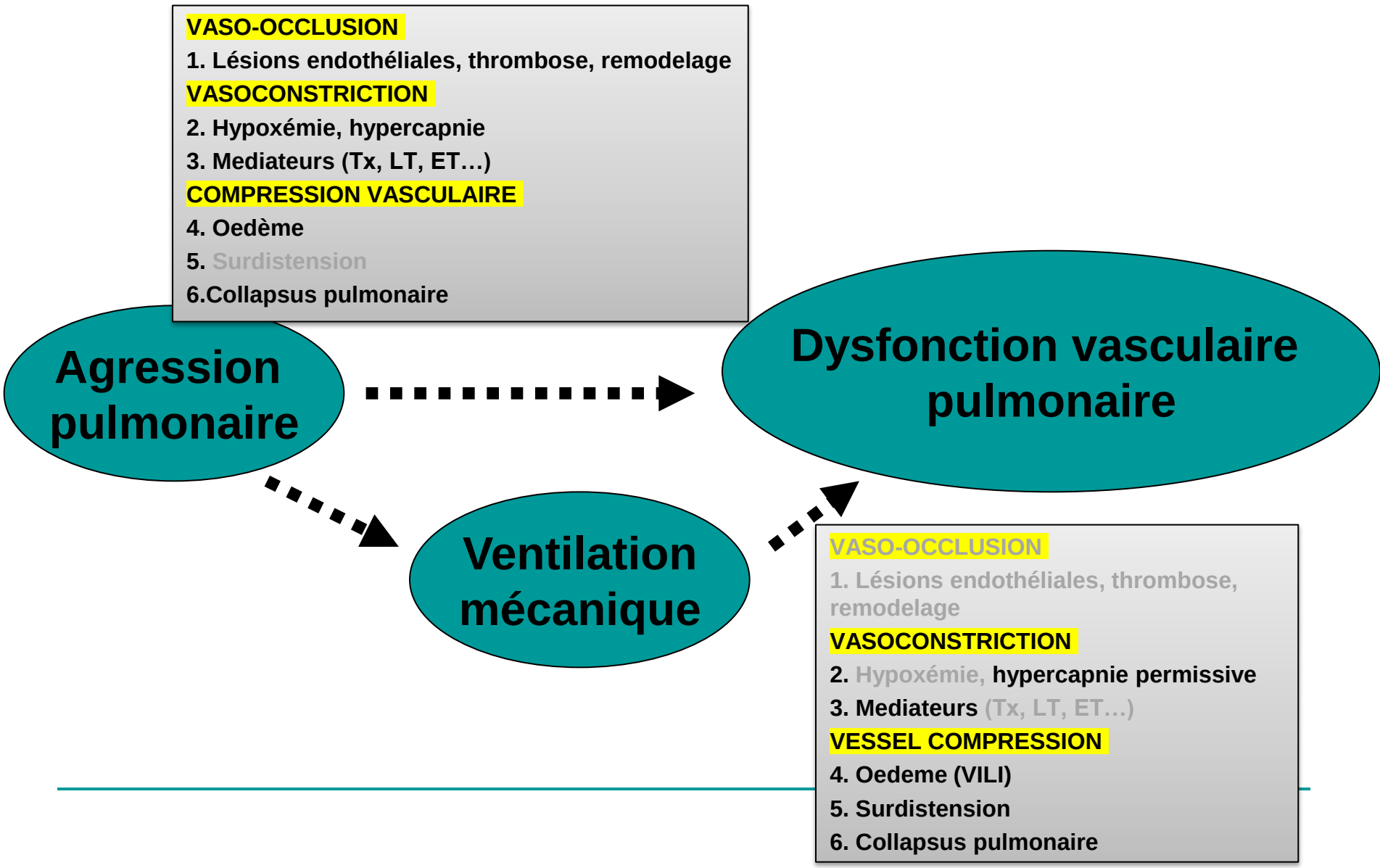




Nicolas Vignon-Zellwegera, Life Sci 2012

Druml, ARRD 1993

Rôle de la ventilation



Modifications des pressions intrathoraciques: Effet sur la fonction VD

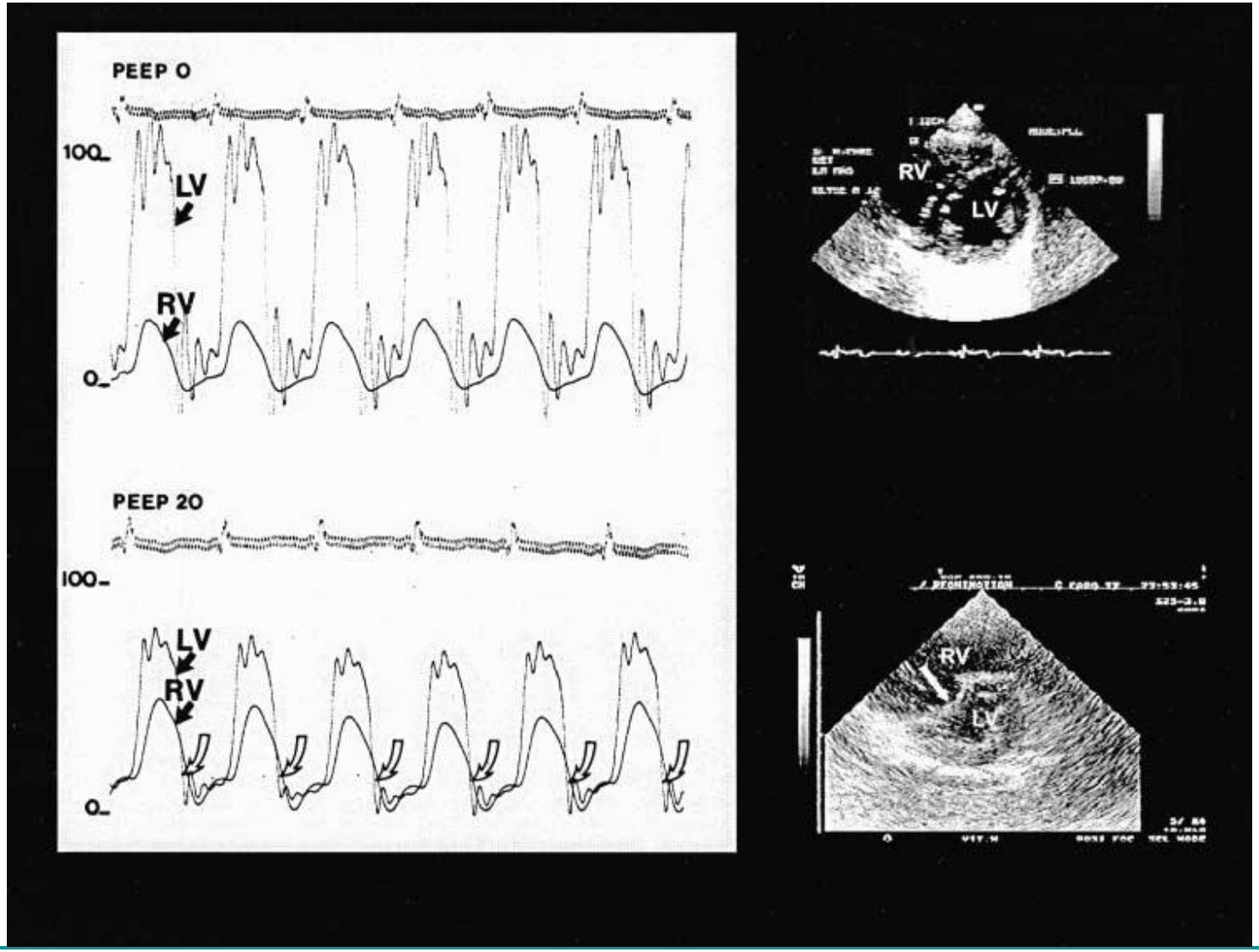
- ↑ pression pleurale
  - ↓ gradient de pression de retour veineux ?
  - ↓ conductance du retour veineux (zone collabable)

  → ↓ **précharge VD** (effet précharge)

- ↑ pression transpulmonaire
  - ↓ conductance capillaires pulmonaires

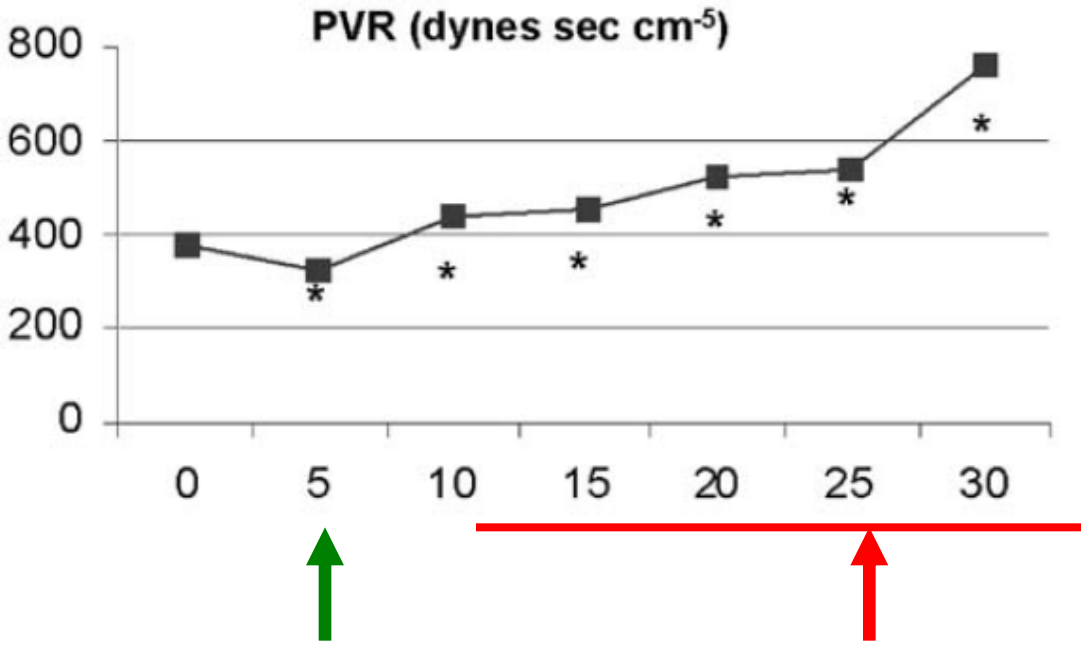
  → ↑ **postcharge VD** (effet postcharge)

Postcharge VD et couplage interventriculaire



Vieillard-Baron, AJRCCM 2002

Effet double de la PEP sur la postcharge VD



Jellinek JAP 2000

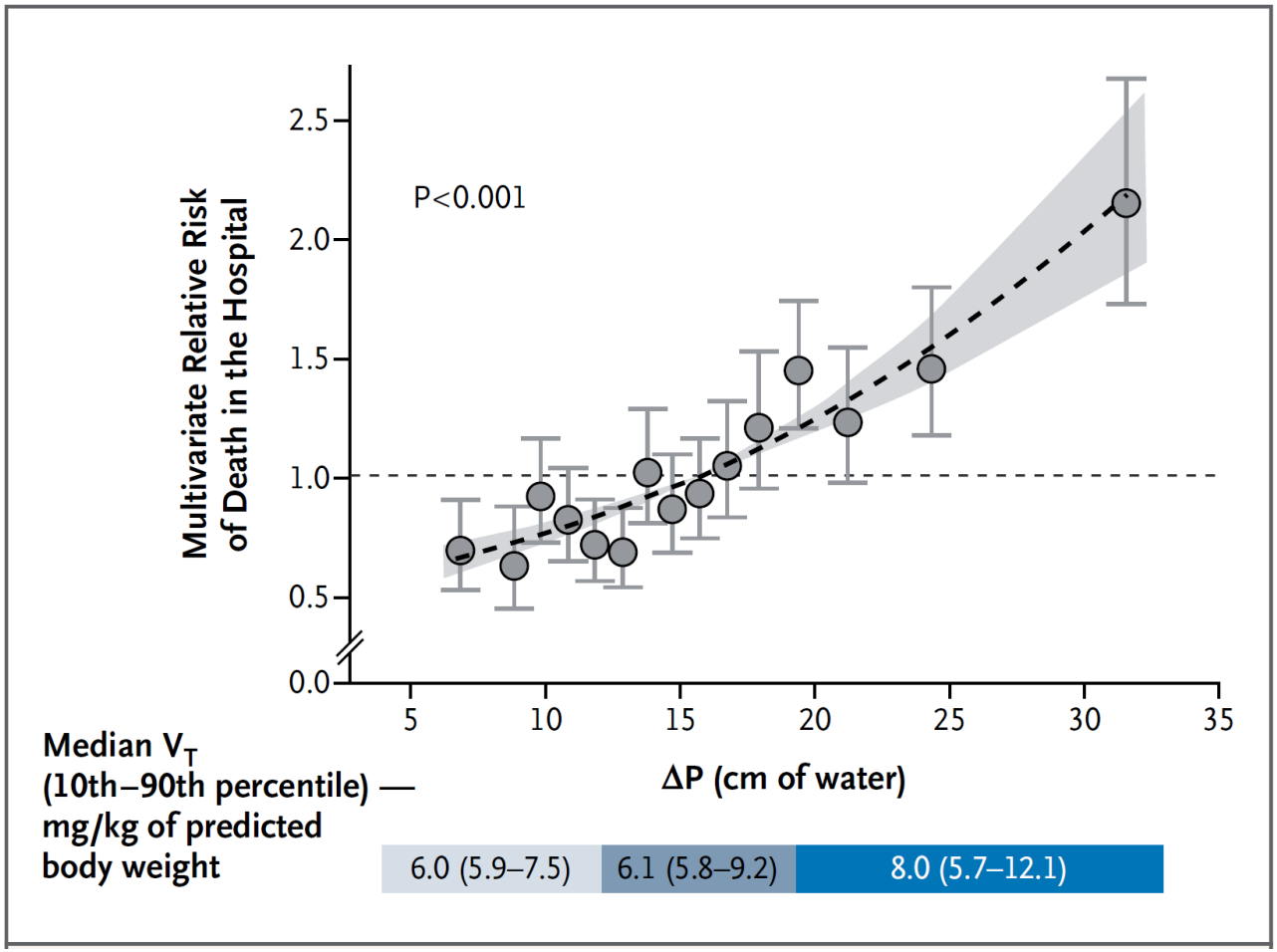
Impact des réglages ventilatoires

Table 2 Factors associated with acute cor pulmonale in patients with acute respiratory distress syndrome

Variable	Odds ratio (95 % CI) by logistic regression	
	Univariate	Multivariable[a]
Pneumonia as cause of ARDS	2.54 (1.79–3.62), $p < 0.01$	2.73 (1.84–4.05), $p < 0.01$
Respiratory settings on TEE day		
Tidal volume <7 mL/kg	1.70 (1.17–2.47), $p < 0.01$	I/NR
Respiratory rate ≥30 breaths/min	1.70 (1.11–2.60), $p = 0.02$	I/NR
Plateau pressure ≥27 cmH_2O	1.91 (1.33–2.73), $p < 0.01$	I/NR
Compliance <30 ml/cmH_2O	1.91 (1.33–2.73), $p < 0.01$	I/NR
Driving pressure ≥18 cmH_2O[b]	2.16 (1.51–3.10), $p < 0.01$	2.28 (1.53–3.38), $p < 0.01$
Arterial blood gases on TEE day		
PaO_2/FiO_2 ratio <150 mmHg	2.41 (1.49–3.92), $p < 0.01$	2.60 (1.50–4.52), $p < 0.01$
$PaCO_2$ ≥48 mmHg	2.95 (2.06–4.21), $p < 0.01$	2.39 (1.62–3.52), $p < 0.01$

Mekontso Dessap, ICM 2016

Delta P et pronostic du SDRA



Amato, NEJM 2015

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Comment détecter la dysfonction vasculaire pulmonaire ?

- Biologie
  - ↑marqueurs sanguins de dysfonction endothéliale ?

    eg: ↑ ratio angiopoietine-2/angiopoietine-1

    (►*reflet de l'atteinte systémique et pas uniquement pulmonaire*)

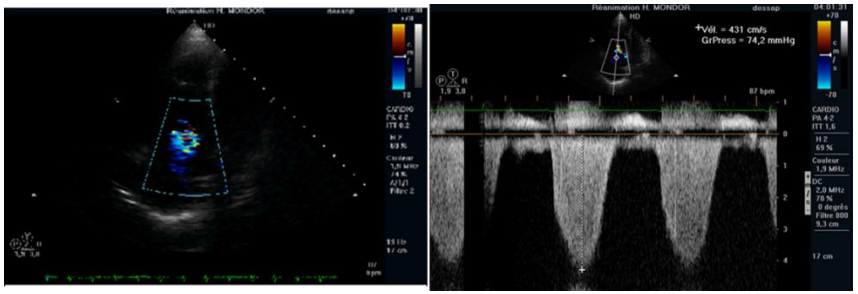
- Calcul de l'espace mort
  - ↑espace mort alvéolaire

- Cathéter artériel pulmonaire
  - ↑PAP et RVP
  - ↑gradient transpulmonaire (PAPm - PAPO)
  - PVC > PAPO

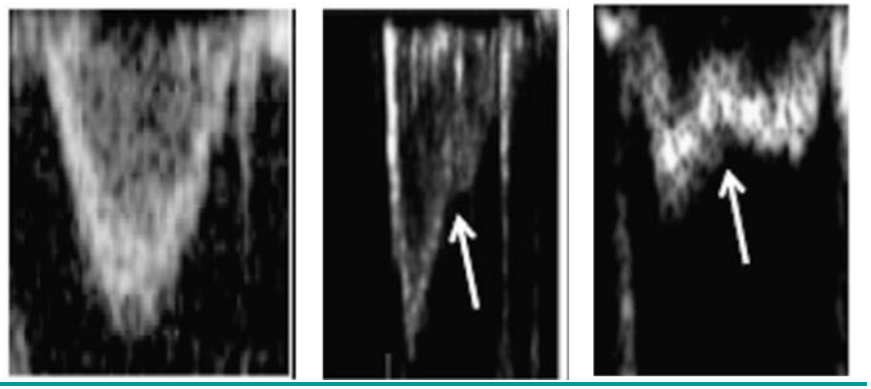
Echocardiographie pour détecter la dysfonction vasculaire pulmonaire

↑ postcharge VD

- ↑PAP



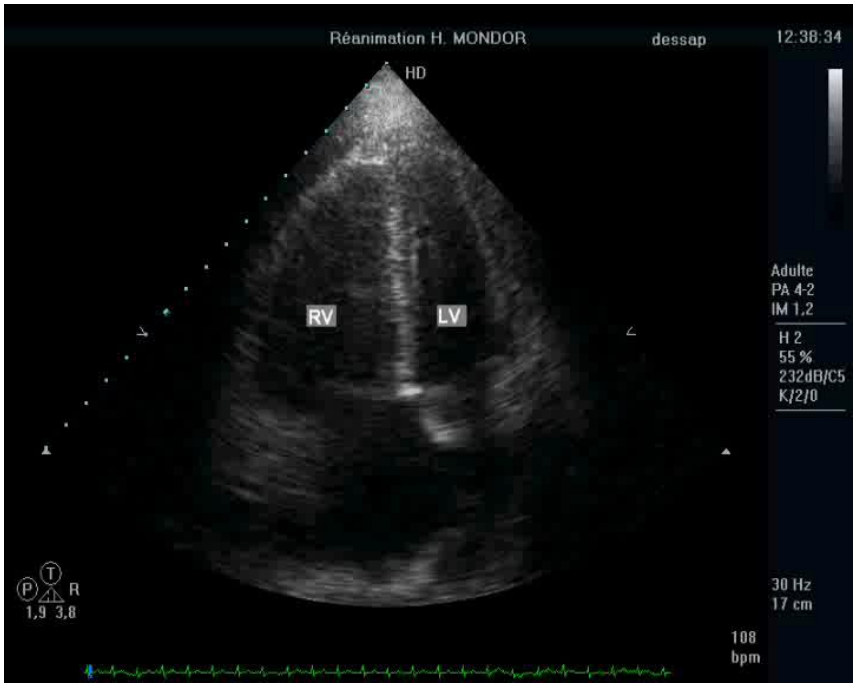
- Alteration du flux d'éjection pulmonaire



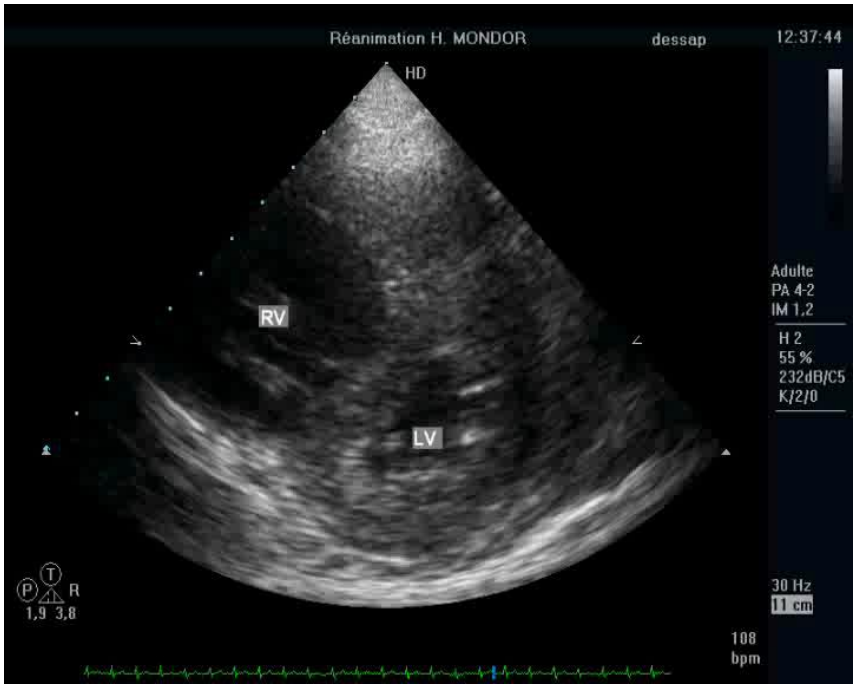
Arkles, AJRCCM 2011

Cœur pulmonaire

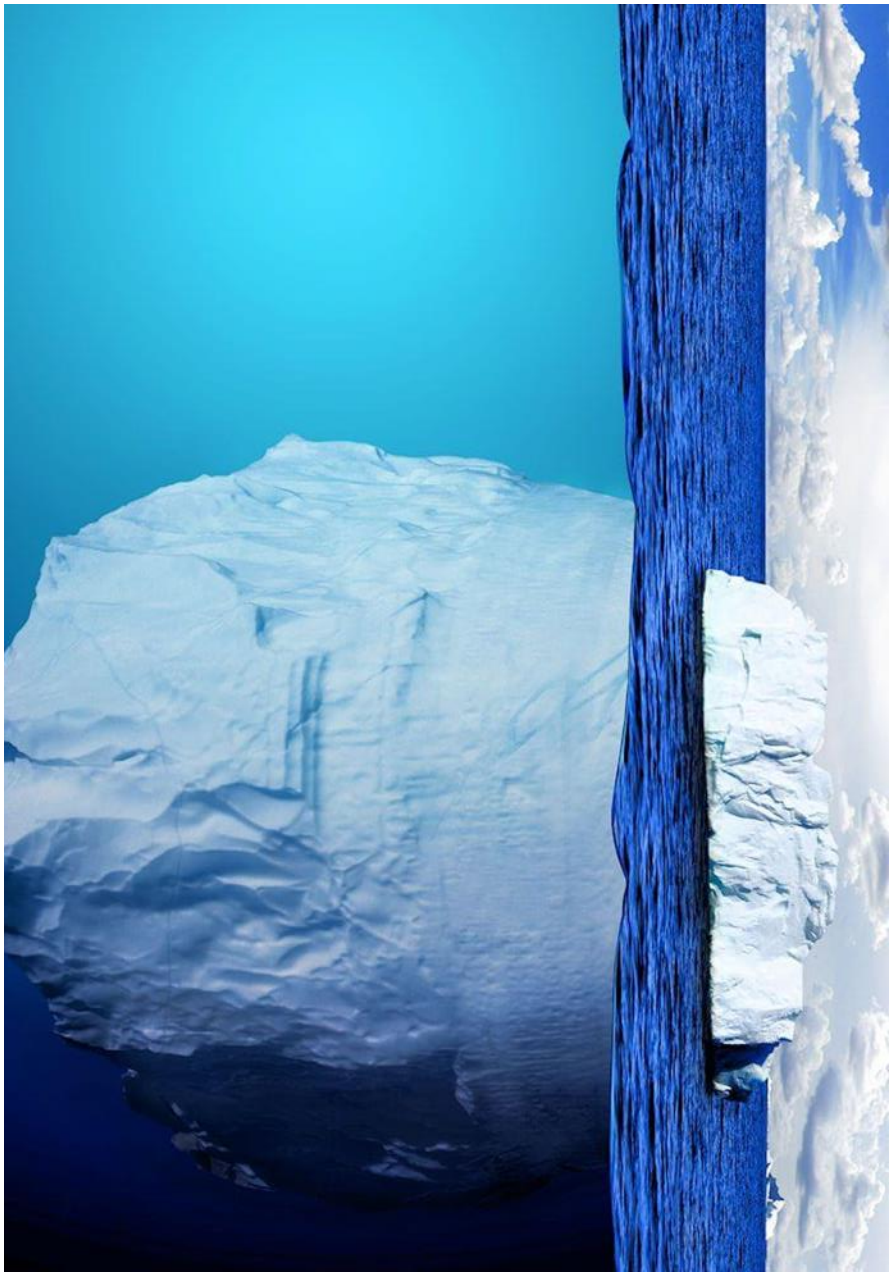
Dilatation VD



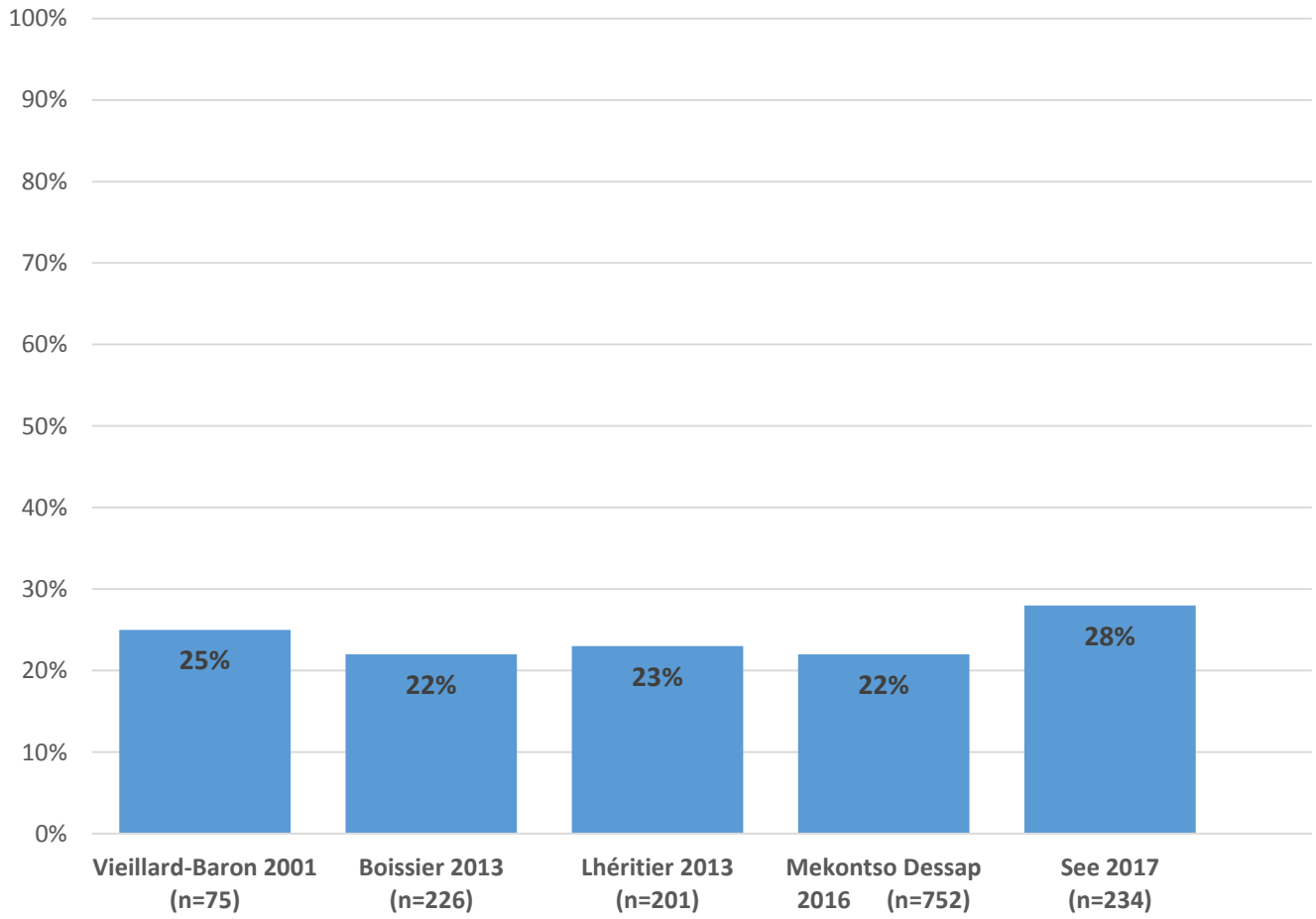
Dyskinésie septale



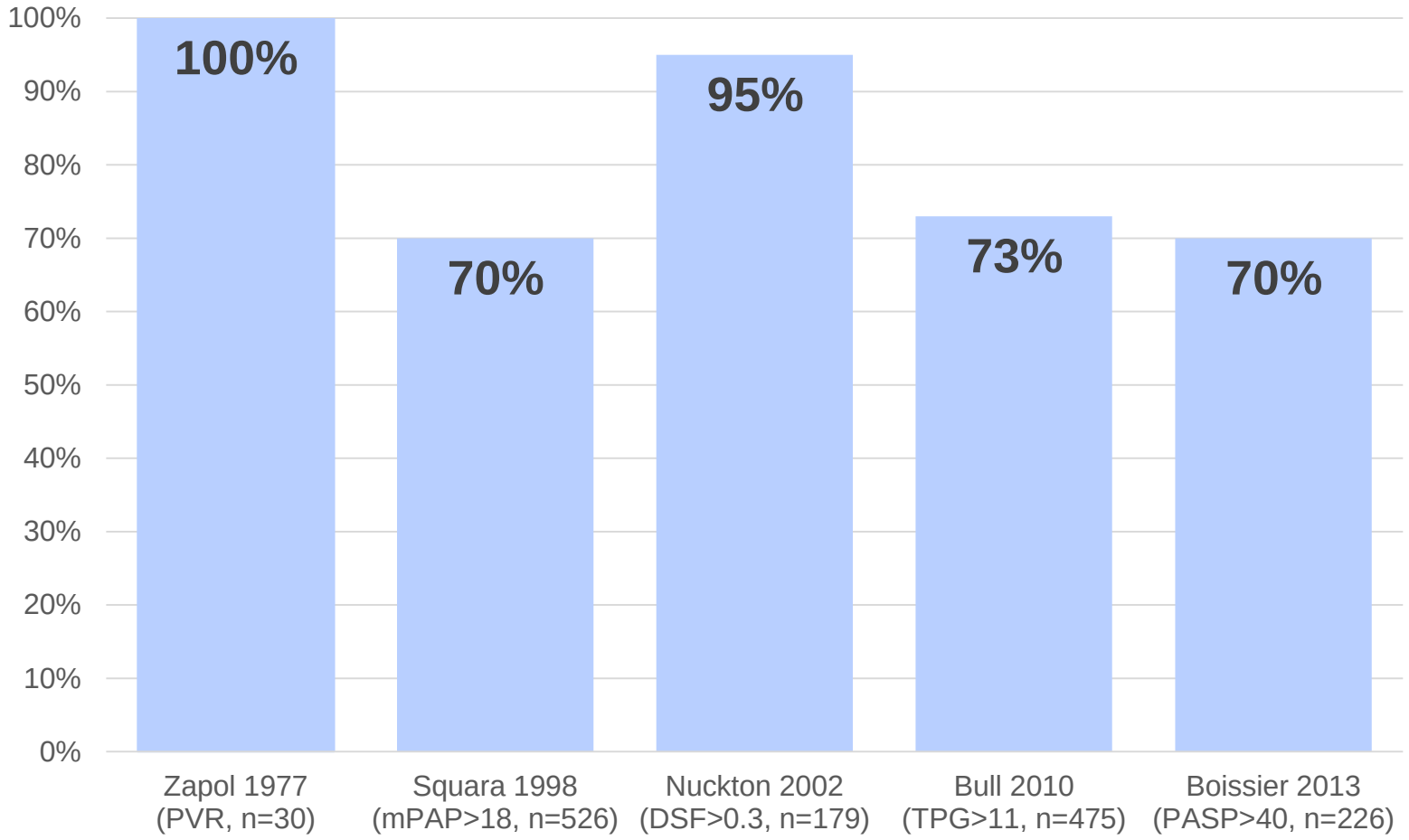
Dysfonction vasculaire pulmonaire	Coeur pulm. aigu



Prévalence du CPA au cours du SDRA



Prévalence de la dysfonction vasculaire pulmonaire au cours du SDRA



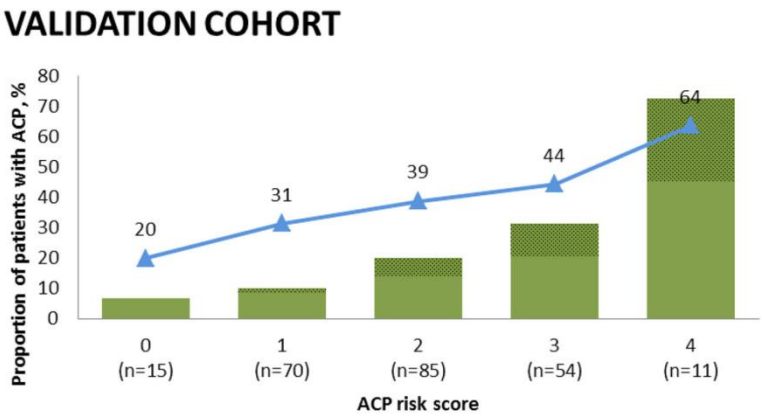
Facteurs de risque de cœur pulmonaire

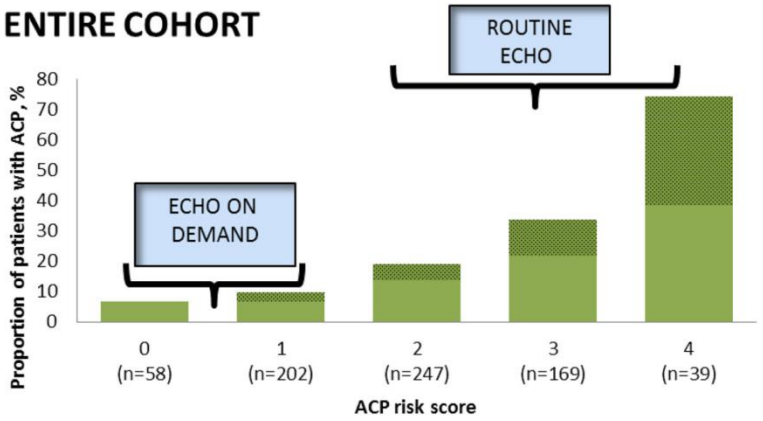
Table 3 The acute cor pulmonale risk score

Parameter	Score
Pneumonia as cause of ARDS	1
Driving pressure $\geq$18 cmH_2O[a]	1
PaO_2/FiO_2 ratio <150 mmHg	1
$PaCO_2$ $\geq$48 mmHg	1
Total score	0–4

Mekontso Dessap, ICM 2015

ACP risk score

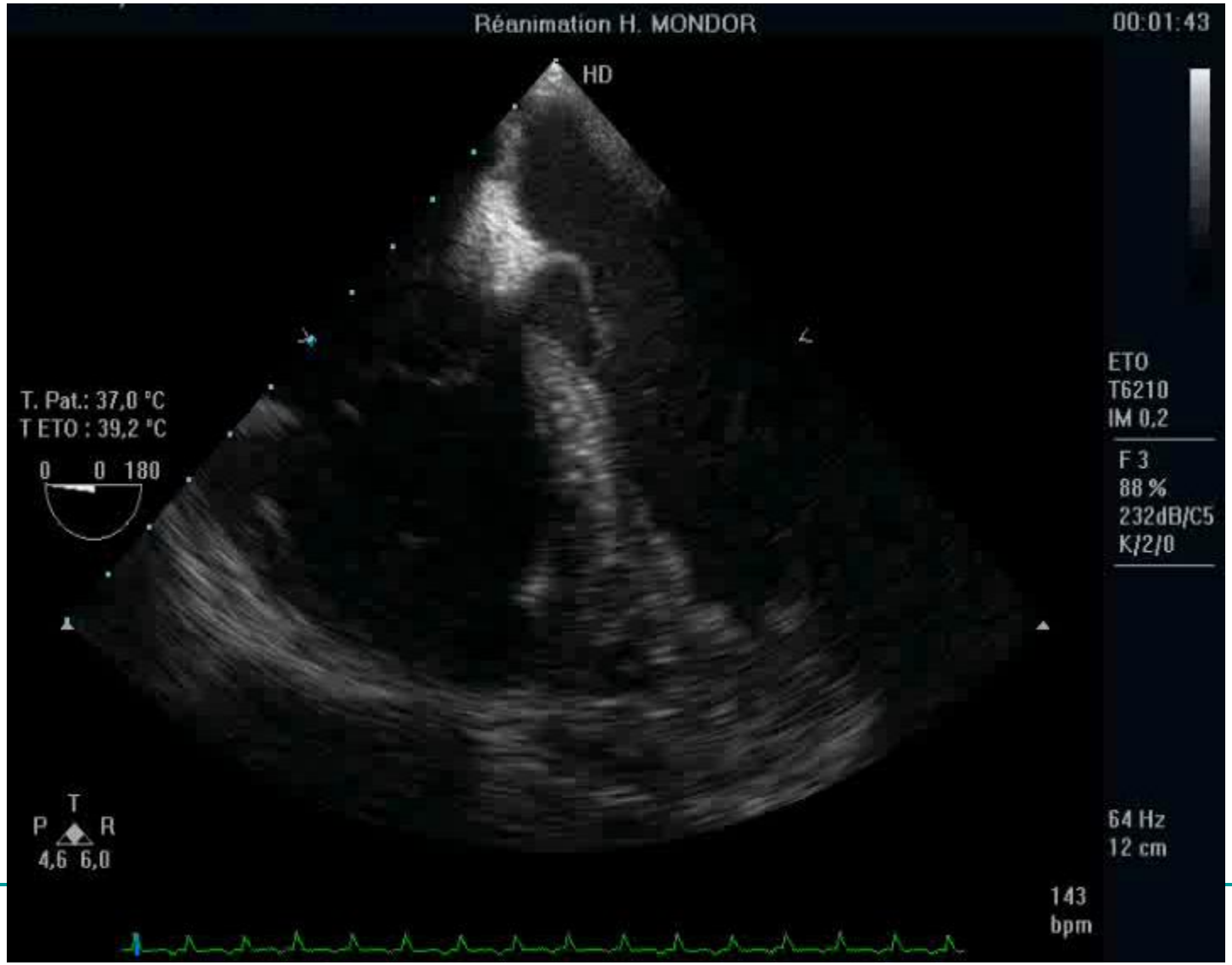




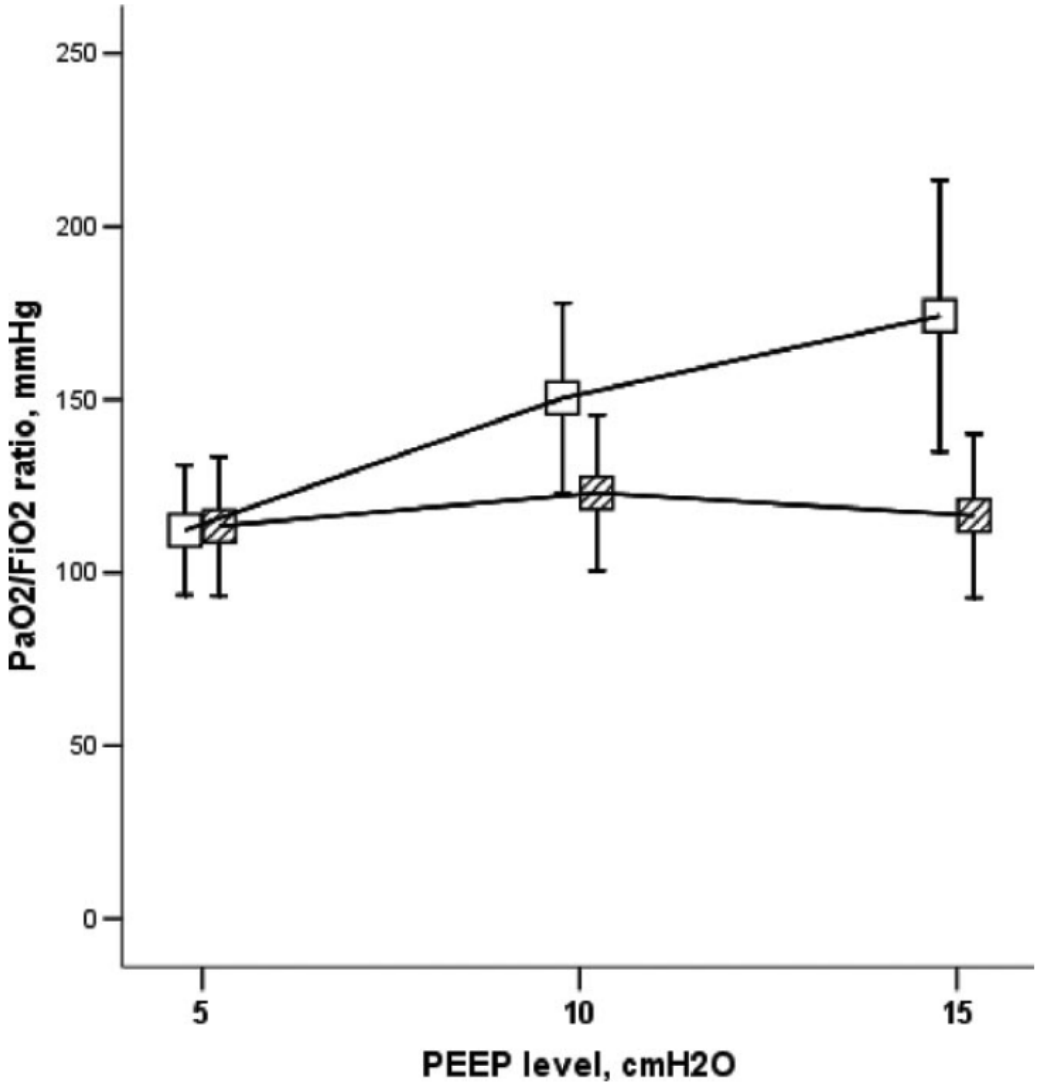
Mekontso Dessap, ICM 2015

Implications cliniques de la dysfonction vasculaire pulmonaire

- Hemodynamique (défaillance VD)
- Oxygénation (shunt cardiaque)


Réanimation H. MONDOR
00:01:43
HD
T. Pat.: 37,0 °C
T ETO : 39,2 °C
0 0 180
ETO
T6210
IM 0,2
F 3
88 %
232dB/C5
K/2/0
T
P R
4,6 6,0
64 Hz
12 cm
143
bpm

FOP et PEP



Mekontso Dessap, CCM 2010

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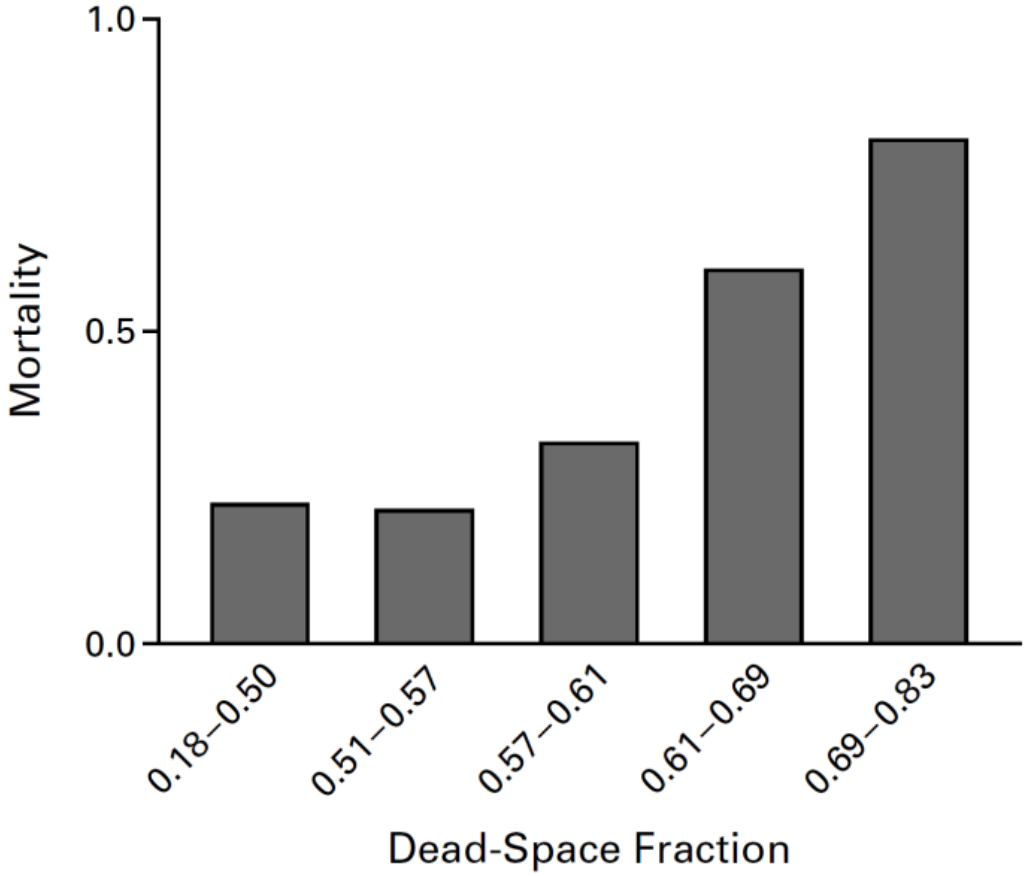
Pronostic de l'espace mort alvéolaire



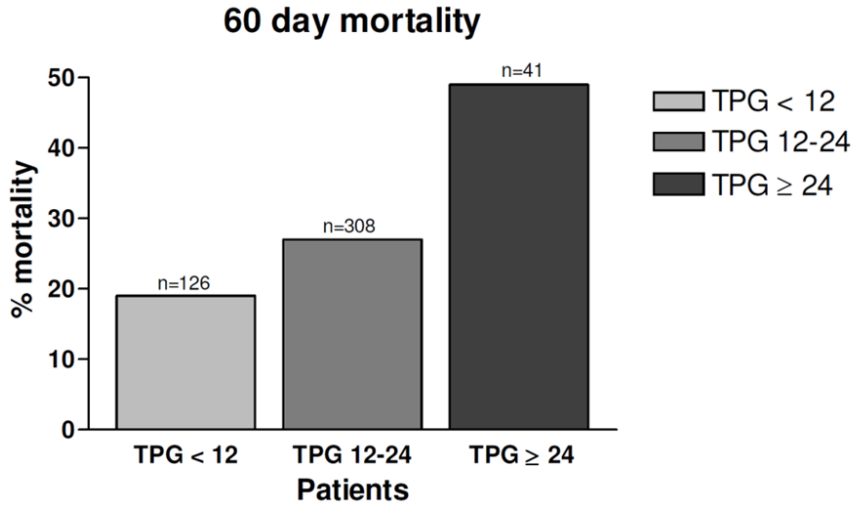
Nuckton, NEJM 2002

Pronostic des indices CAP

	Survivants (n=47)	Décédés (n=98)	p
PAPm, mmHg	27	28	0.49
RVPi	350	367	0.60
PVC>PAPO	**19%**	**33%**	**<0.05**
Dysfonction VD	9%	10%	0.98

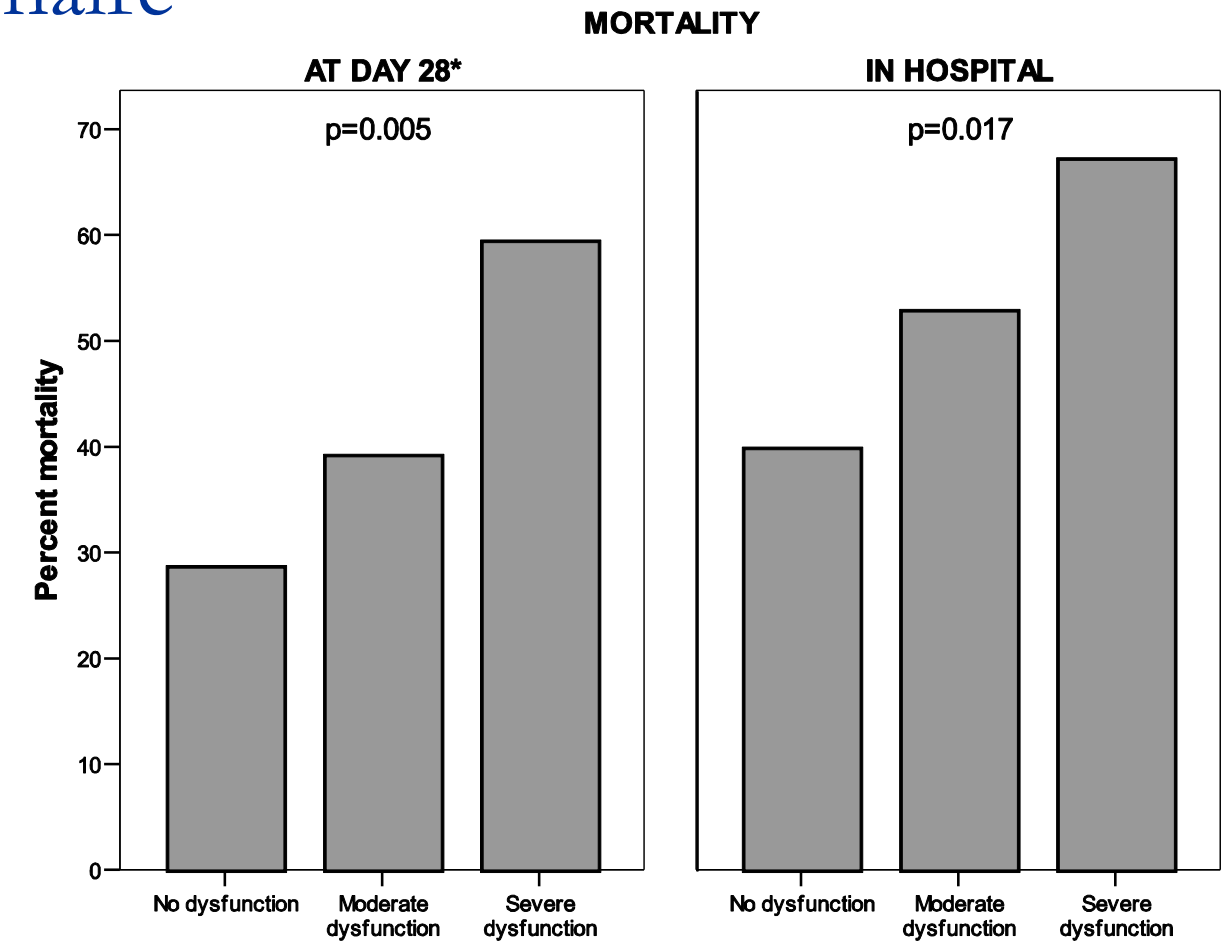
Osman, ICM 2009

	Survivants (n=348)	Décédés (n=127)	P
GTP	**14.3**	**15.7**	**0.009**
RVPi	**299.9**	**326.4**	**0.03**



Bull, AJRCCM 2010

Pronostic de la dysfonction vasculaire pulmonaire



Boissier, ICM 2013

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Vasodilatateurs intraveineux

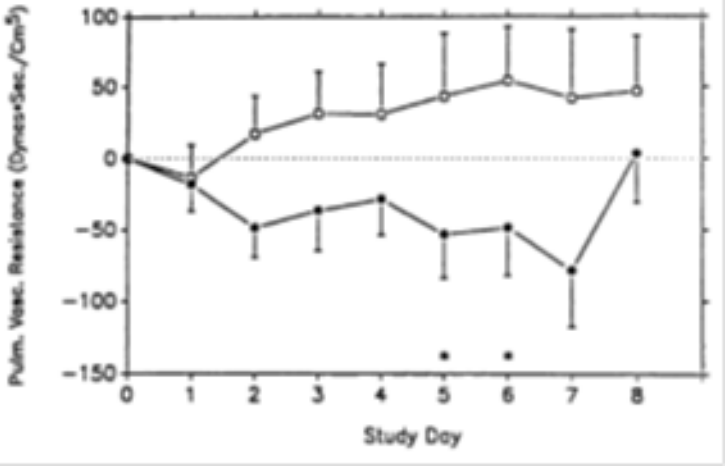
EXEMPLES

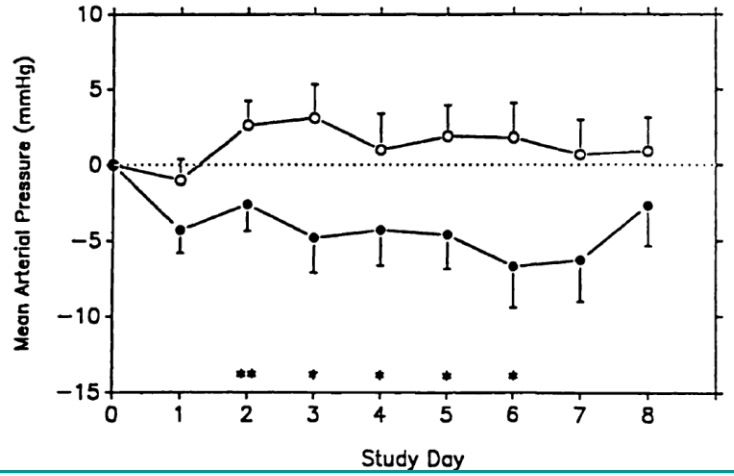
- PGE1
- PGI2 (prostacycline)
- Nitroprusside
- Isoproterenol
- Diltiazem

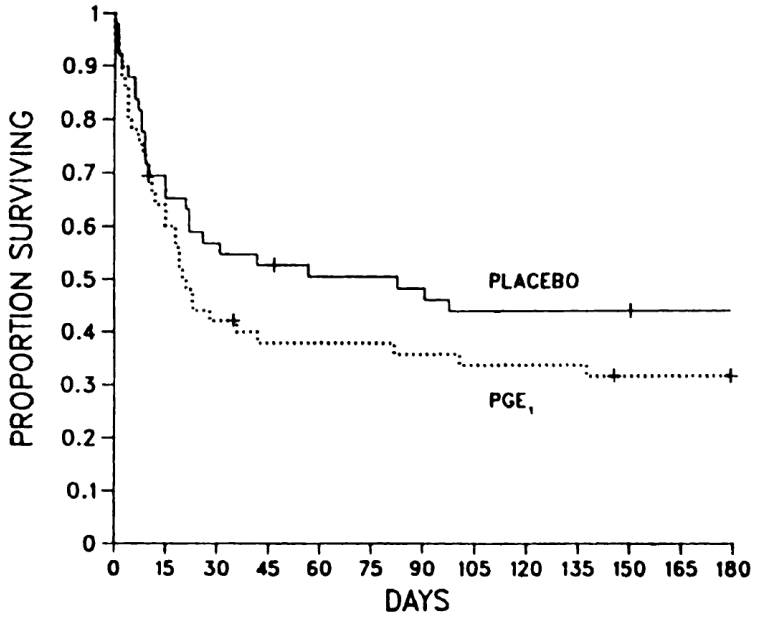
LIMITES

- Absence de sélectivité pour la circulation pulmonaire
  - Hypotension systémique
- Absence de sélectivité pour la vaisseaux pulmonaires ventilés
  - ↑ shunt et ↓ PaO_2
- **Pas de bénéfice dans les essais randomisés**

Prostaglandin E1 intraveineuse

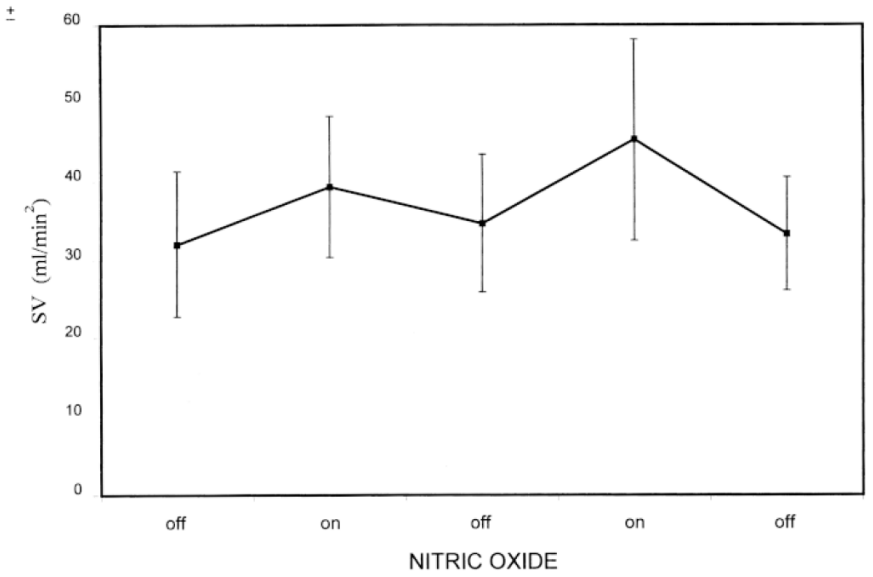


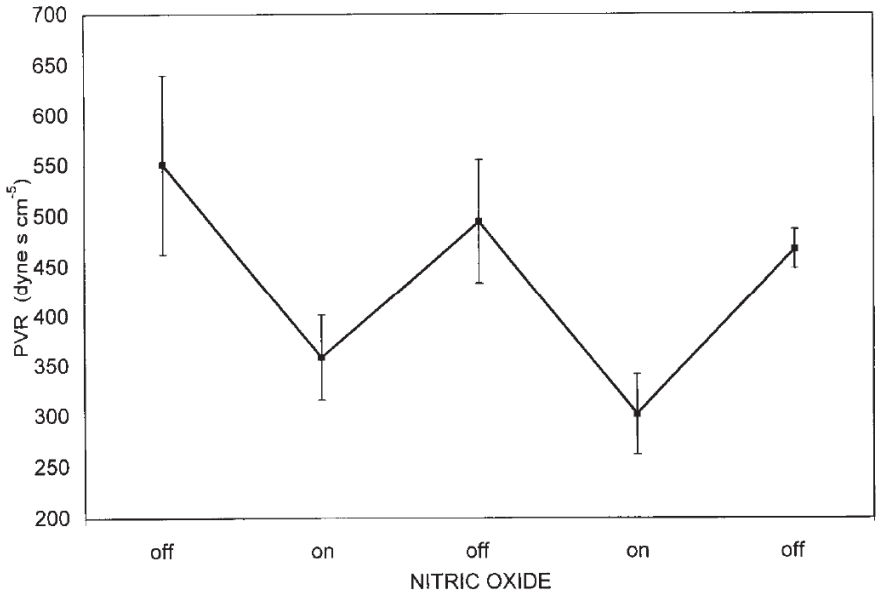




Bone, Chest 1989

NO inhalé

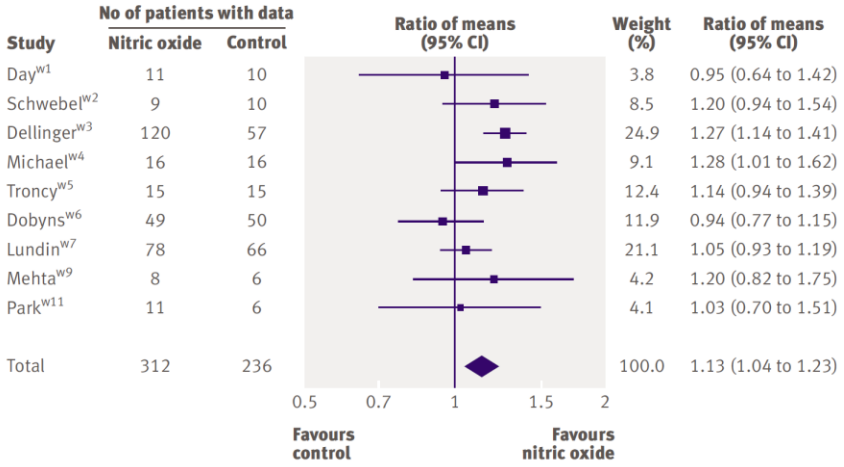




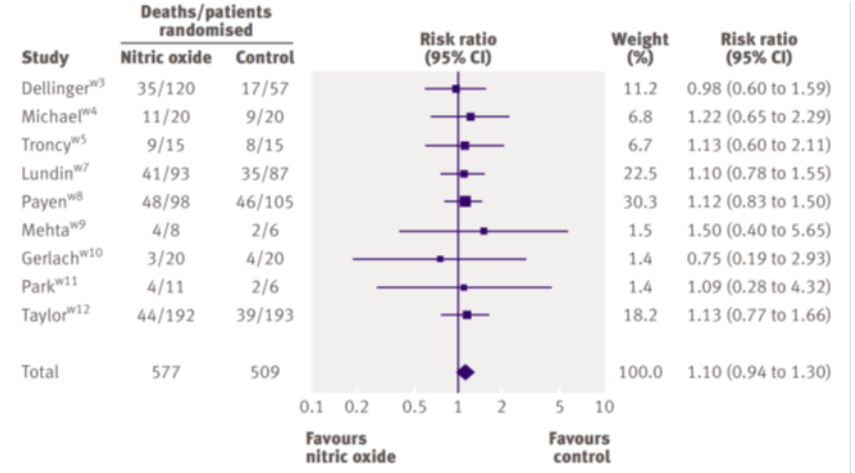
Défaillance VD humaine
Bohrade, AJRCCM 1999

NO ihnalé

P/F



SURVIE



Adhikari, BMJ 2007

Ventilation protectrice du VD

- Eviter l'excès d'hypoxie/hypercapnie
- Eviter l'excès de stress/strain pulmonaire
  - Limiter Delta P
  - Eviter les manœuvres de recrutement
- DV++

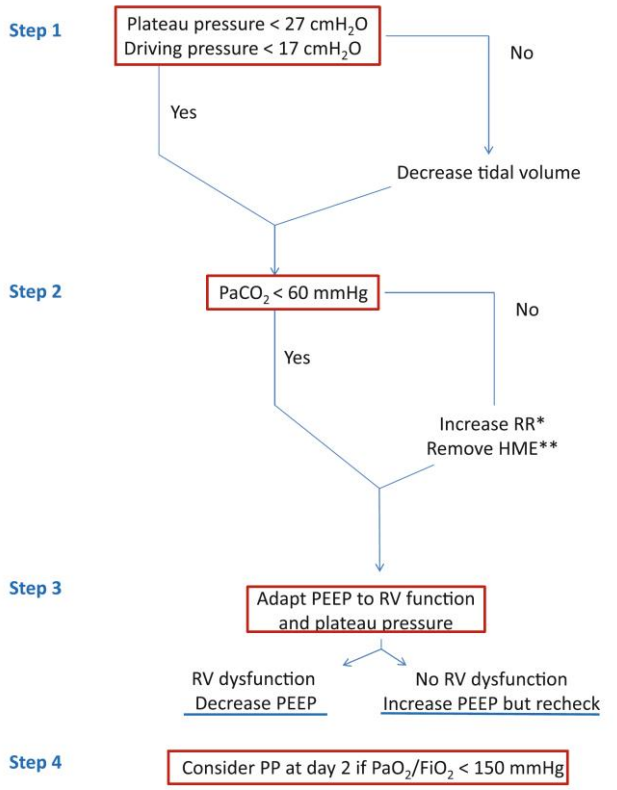
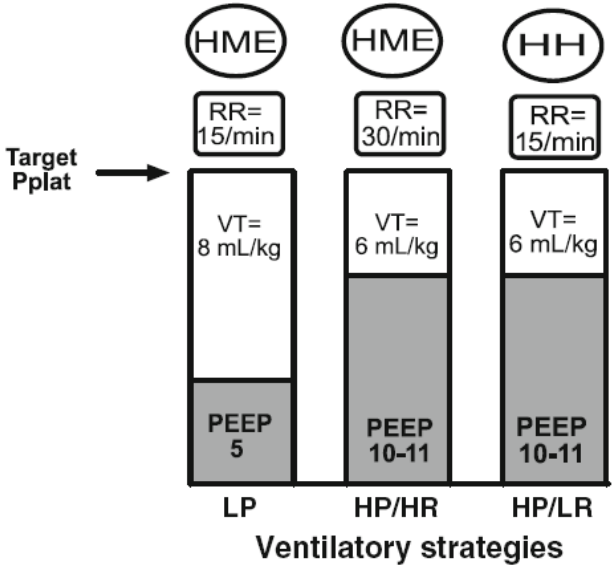
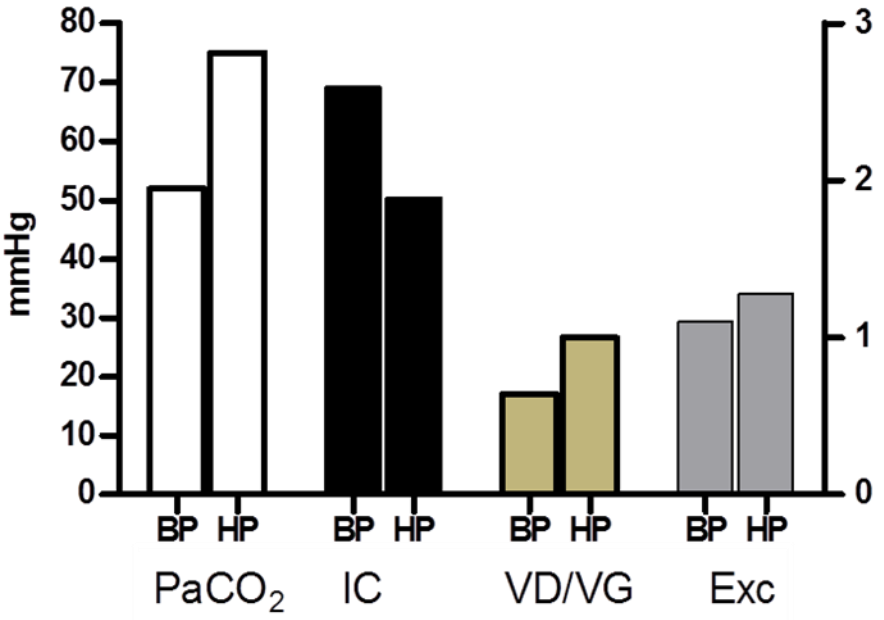


Fig. 1 Proposed approach to preventing acute cor pulmonale and limiting its consequences: a *right* ventricular protective approach. *RR* respiratory rate, *RV* right ventricular, *HME* heat and moisture exchanger, *PP* prone positioning, *PEEP* positive end-expiratory pressure. *Avoid any intrinsic PEEP. **Replace HME by a heated humidifier

Vieillard-Baron, ICM 2013

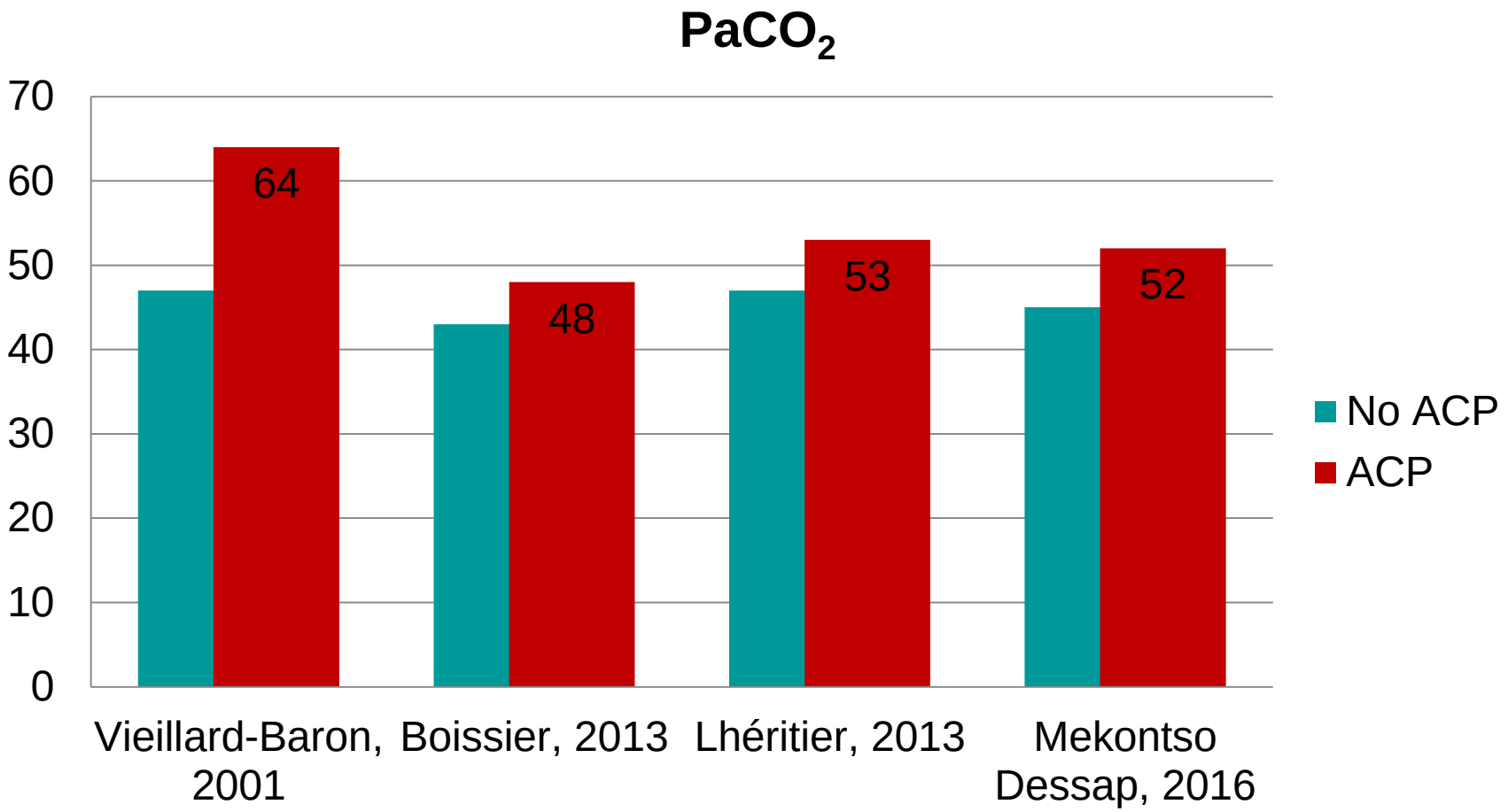
Hypercapnie et dysfonction vasculaire pulmonaire



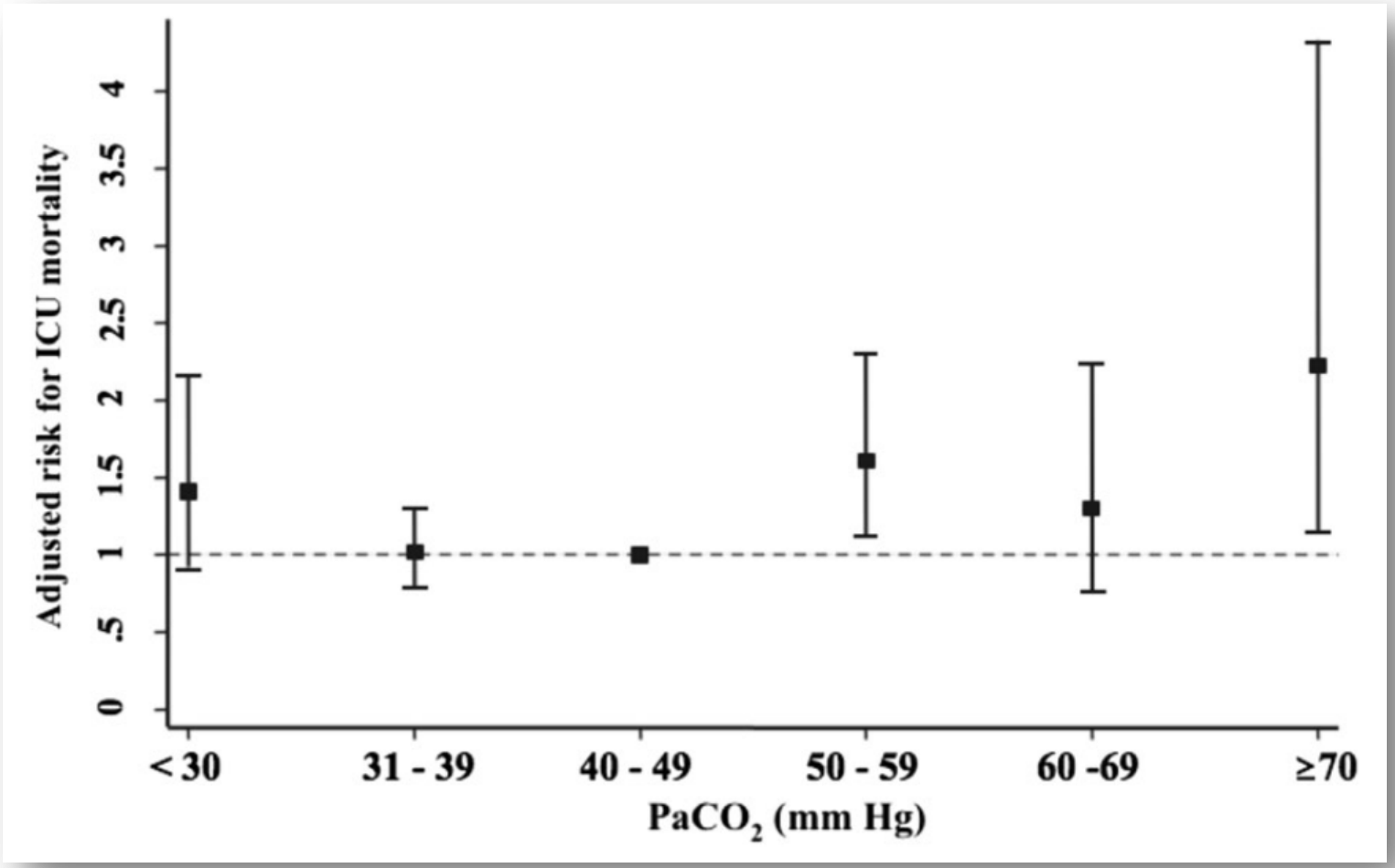


Mekontso Dessap, ICM 2009

Hypercapnie et dysfonction vasculaire pulmonaire

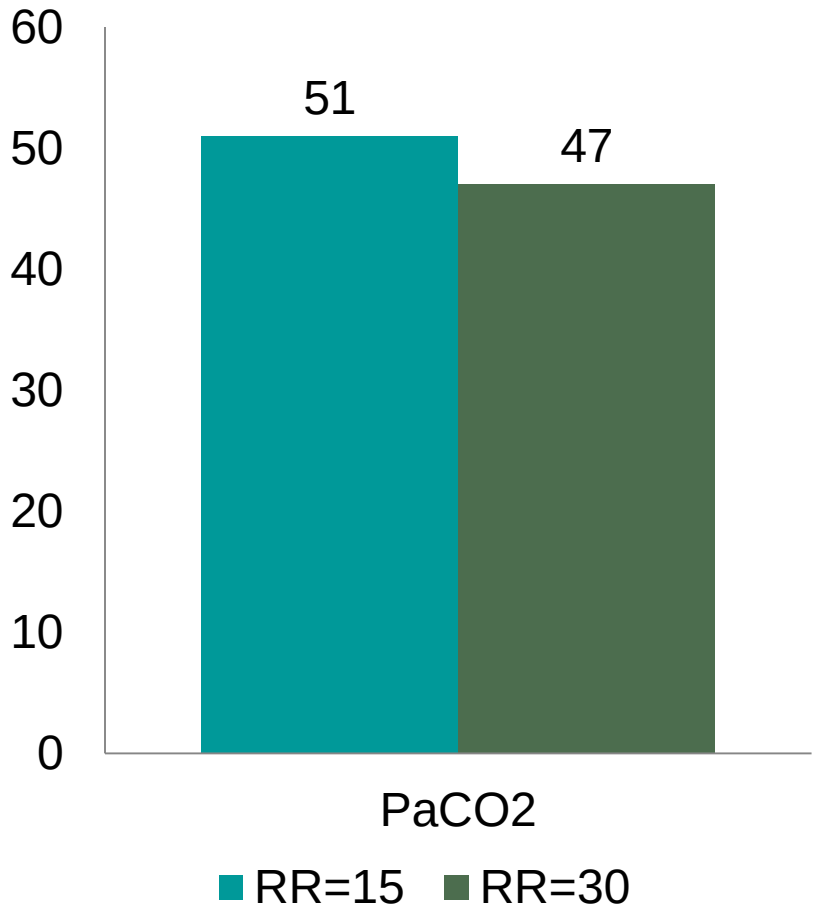


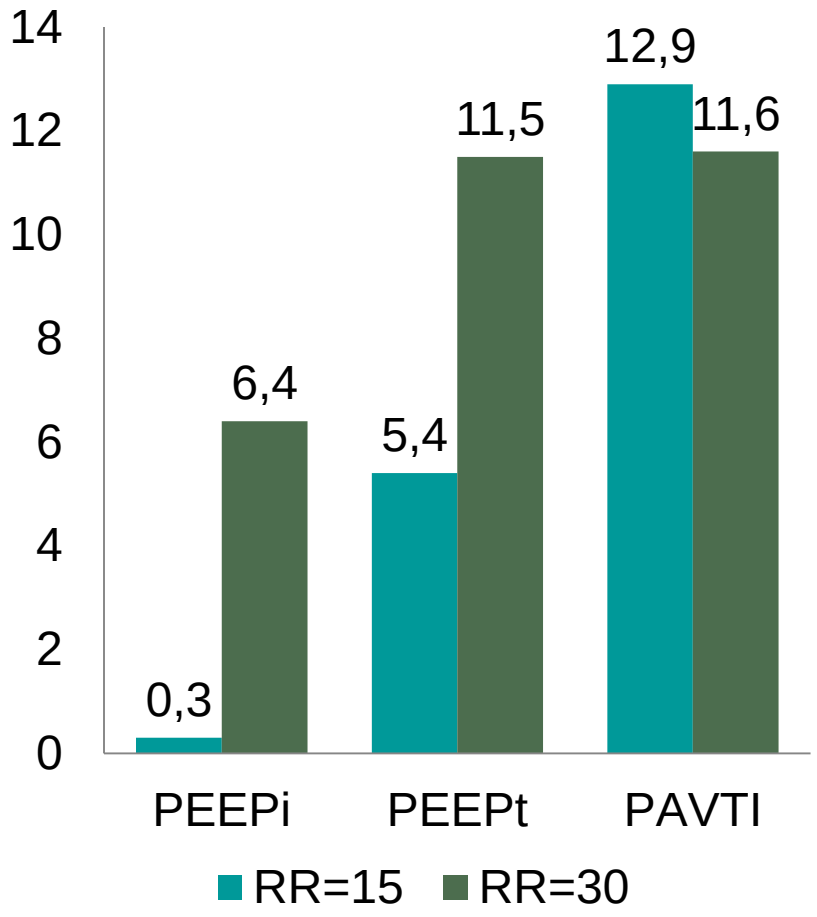
Hypercapnie et mortalité du SDRA



Nin, ICM 2017
(n=1899)

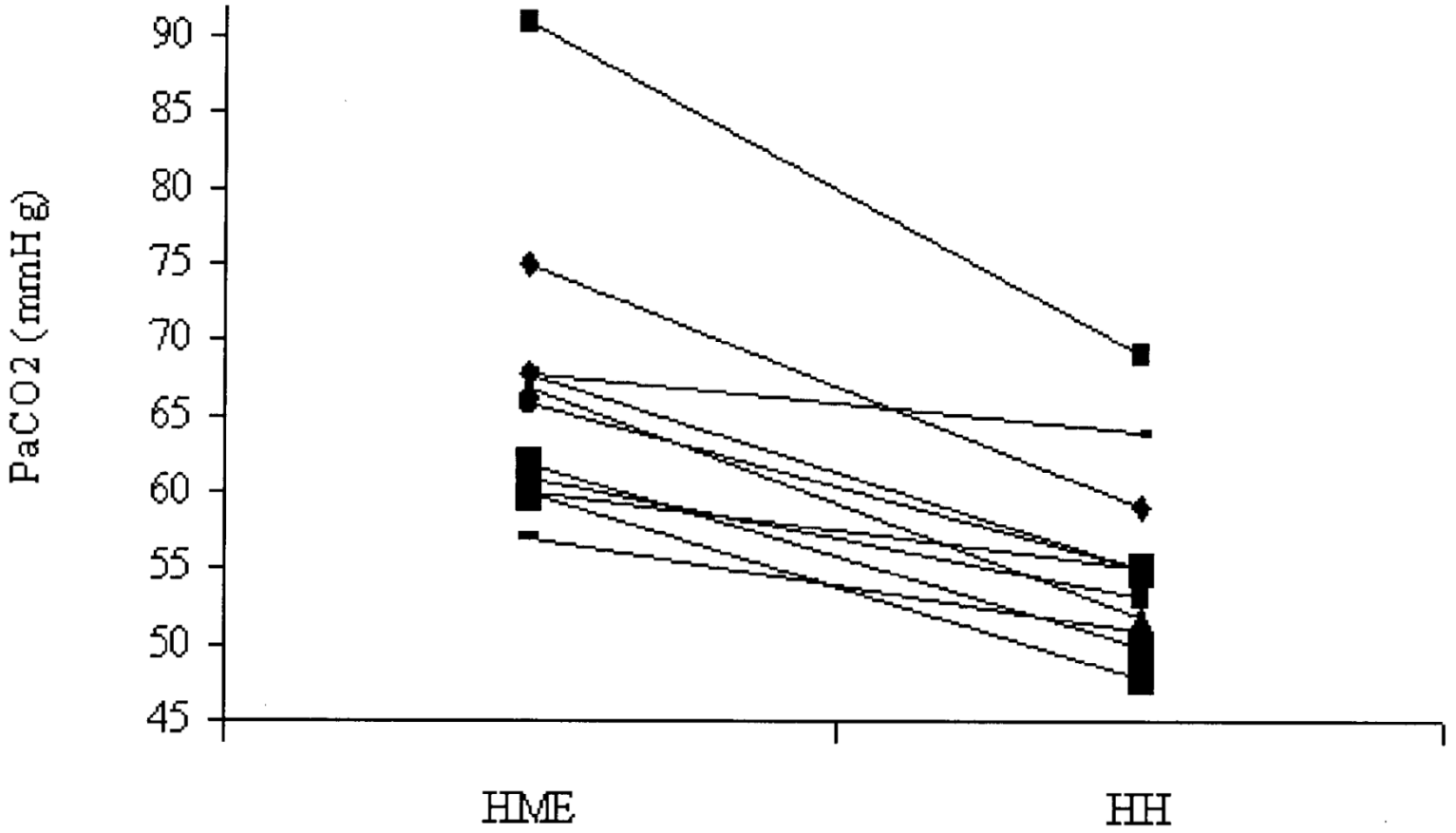
$PaCO_2$ et FR





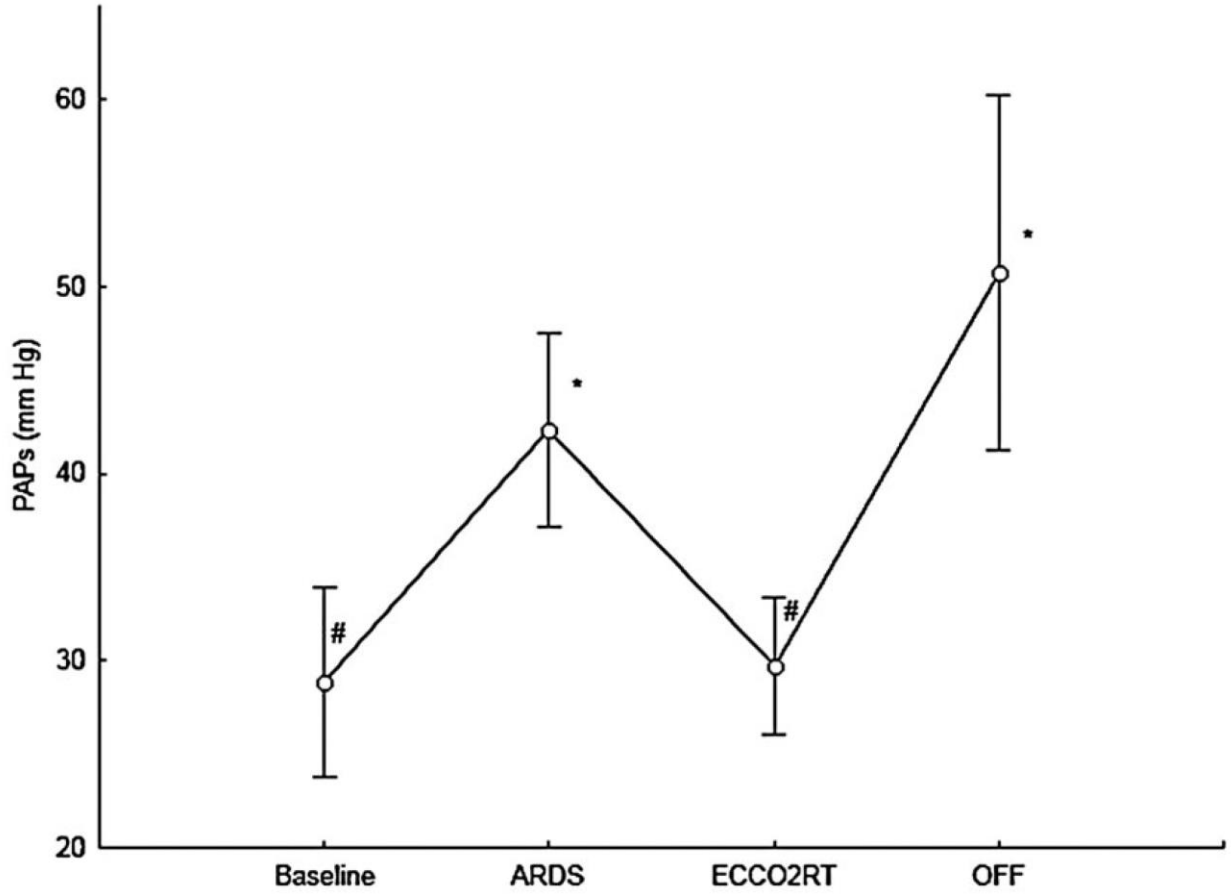
Vieillard-Baron, CCM 2002

$PaCO_2$ et humidicateur chauffant



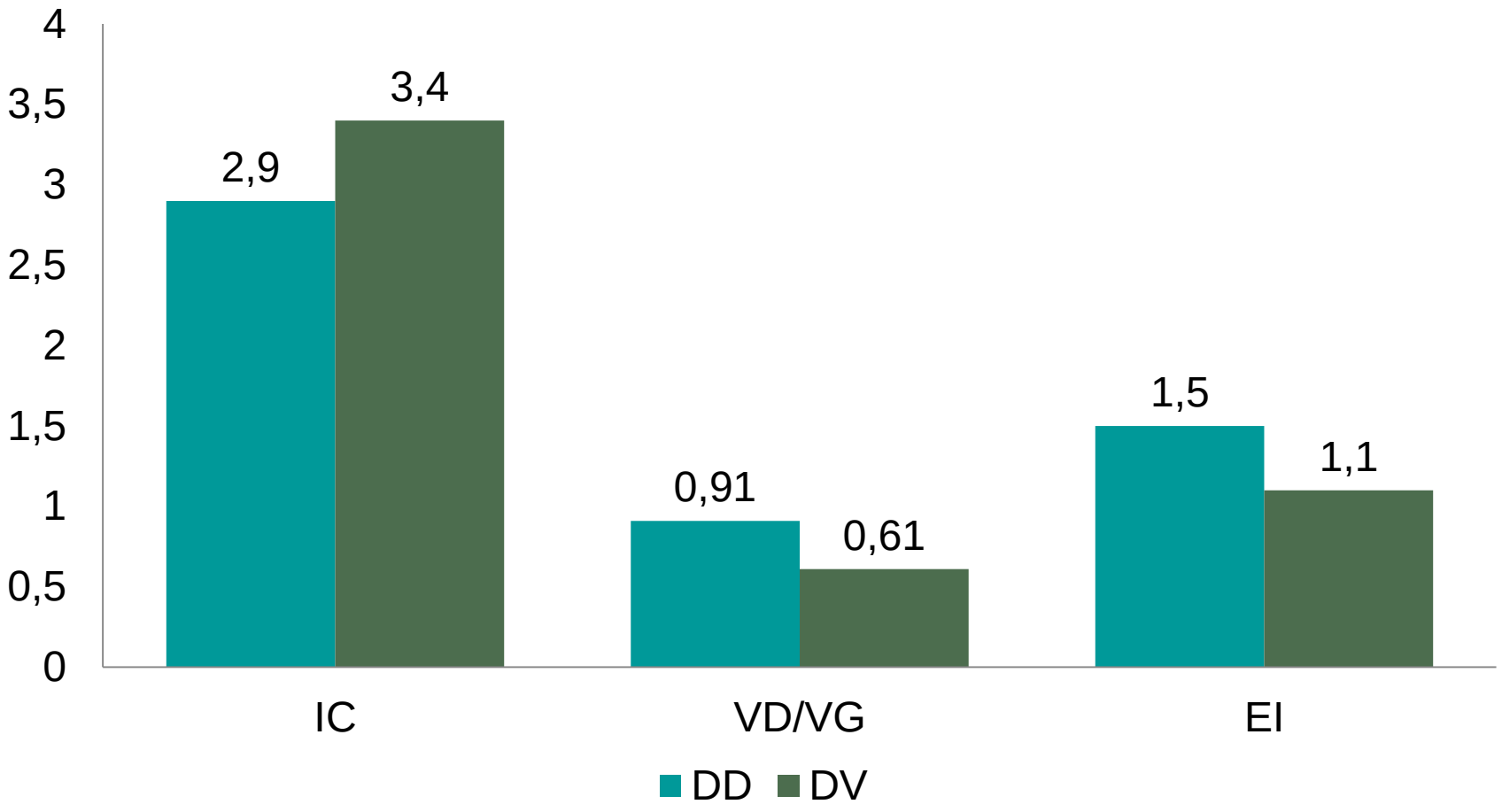
Prin, ICM 2002

$ECCO_2$-R ?



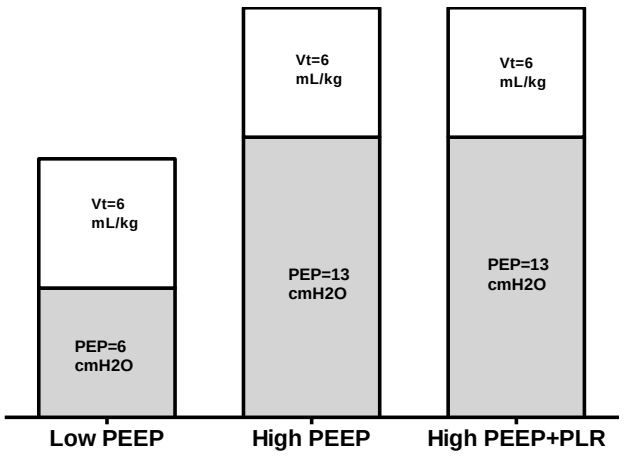
Porcine ARDS
Morimont, Anesthesiol Scand 2015

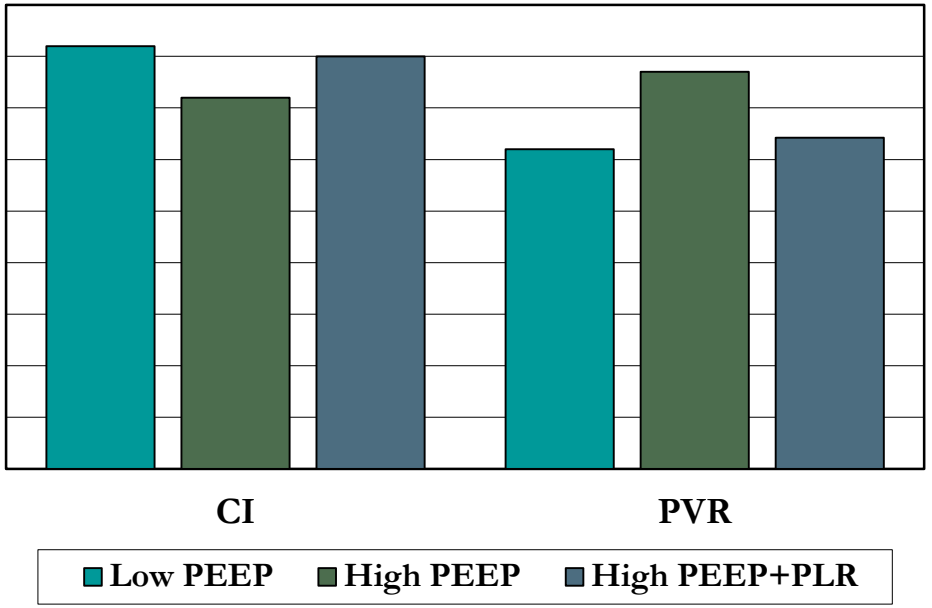
DV



Vieillard-Baron, Chest 2007

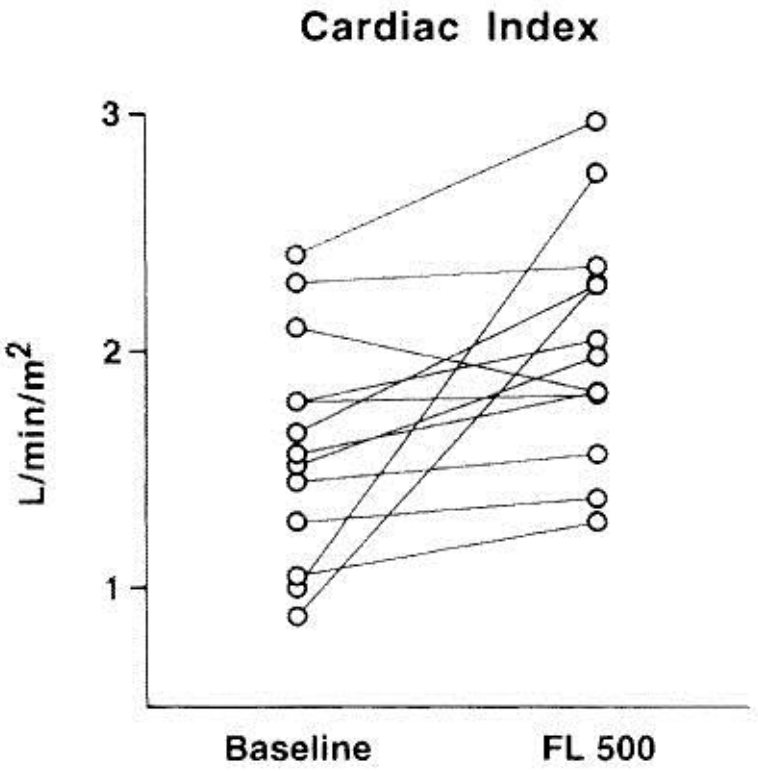
Remplissage vasculaire

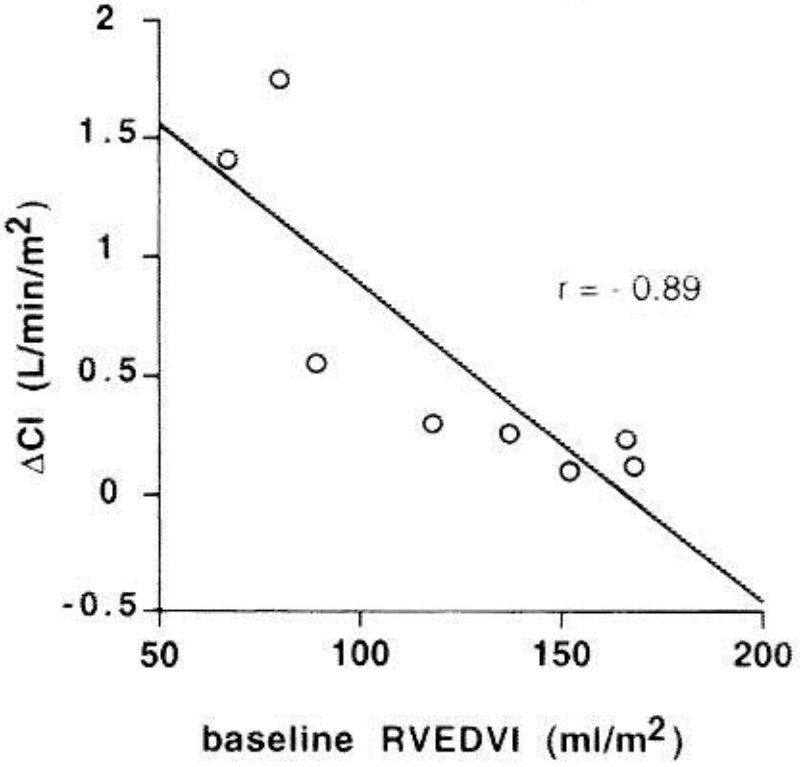




Fougères, CCM 2009

Remplissage vasculaire ?





EP massive
Mercat, CCM 1999

Conclusions

La dysfonction vasculaire pulmonaire:

- Est présente chez un nombre significatif de patients en SDRA
- Semble associée à un pronostic péjoratif
- Peut être détectée par différents outils, notamment l'échocardiographie
- Devrait motiver une stratégie ventilatoire spécifique