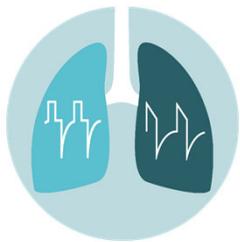




Physiopathologie respiratoire

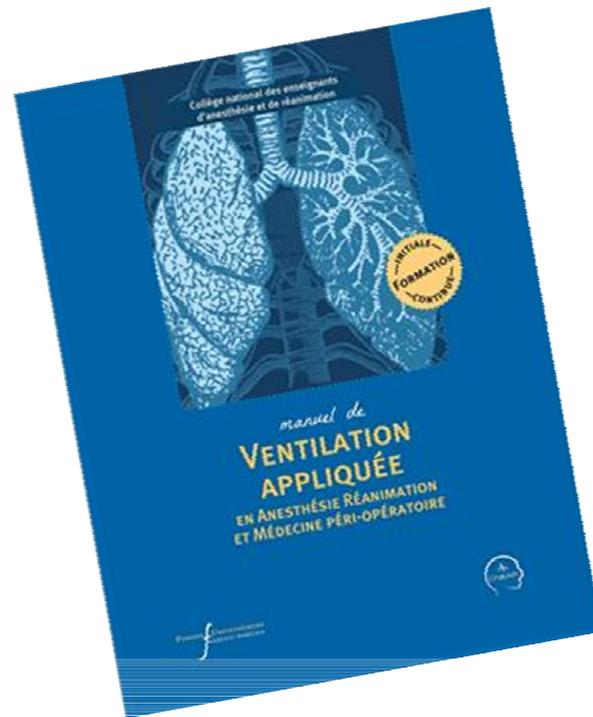
Ventilation artificielle



Pr Hadrien Rozé

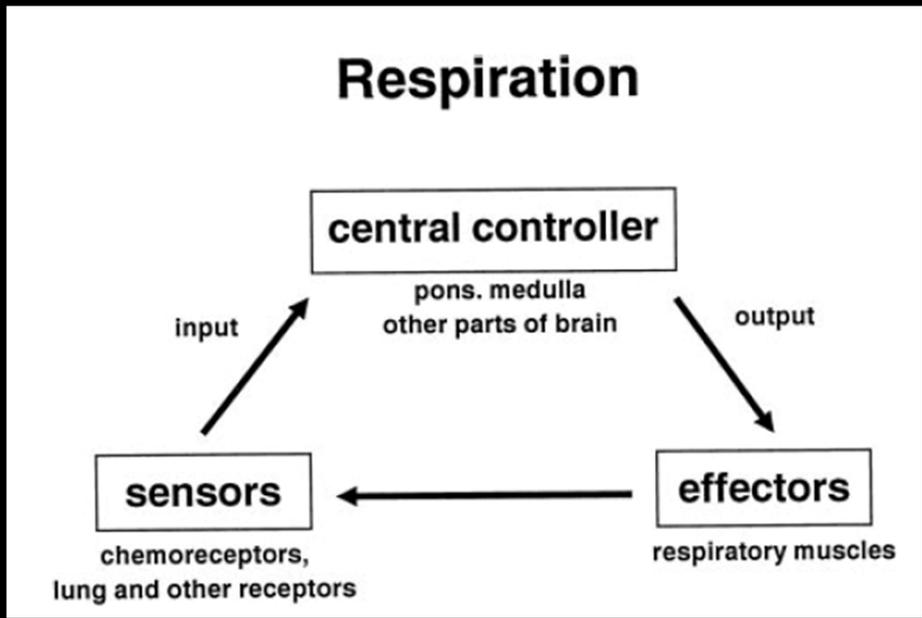
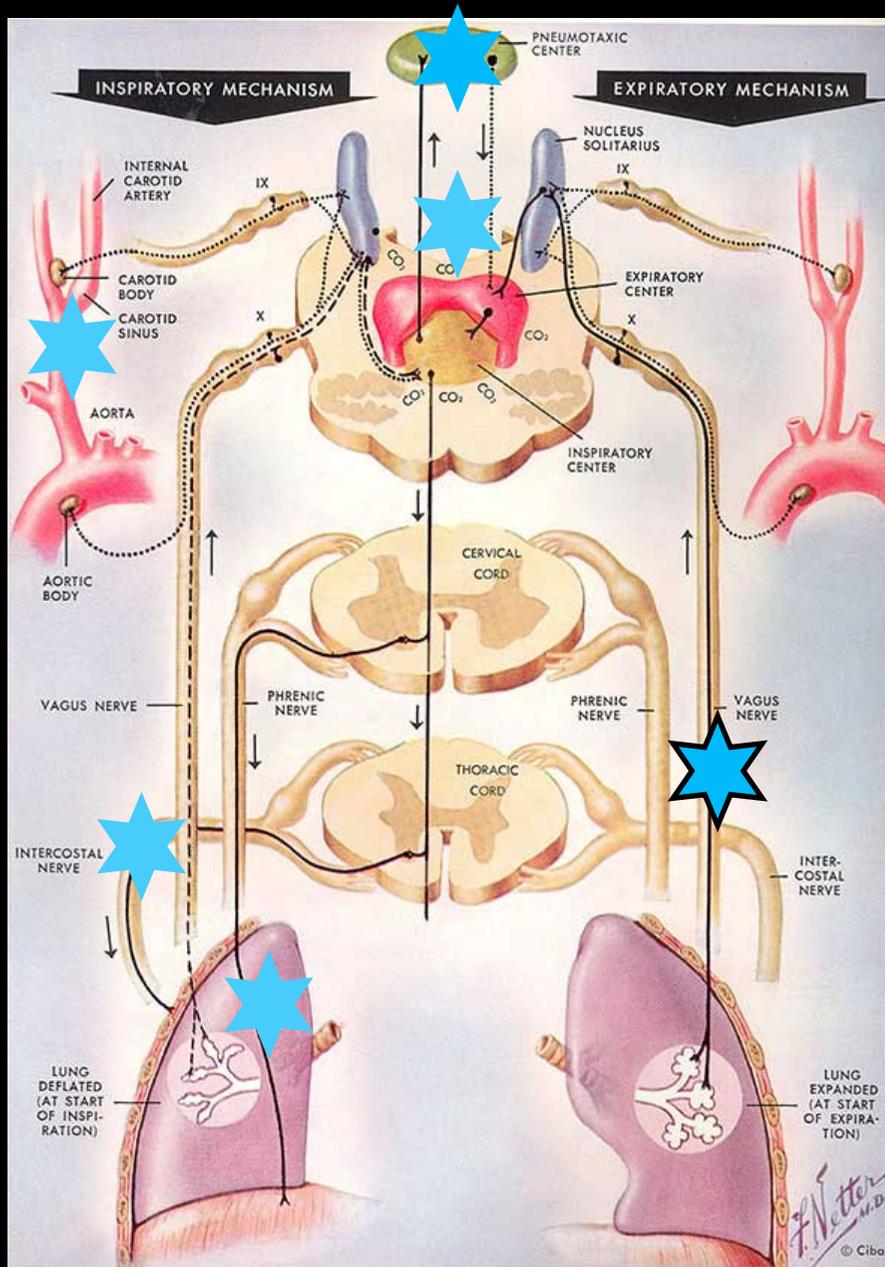


Référentiels



Physiopathologie respiratoire

Innervation Contrôle ventilatoire



CHEST 2000; 117:205-225

Acidose respiratoire
post opératoire

Muscles accessoires



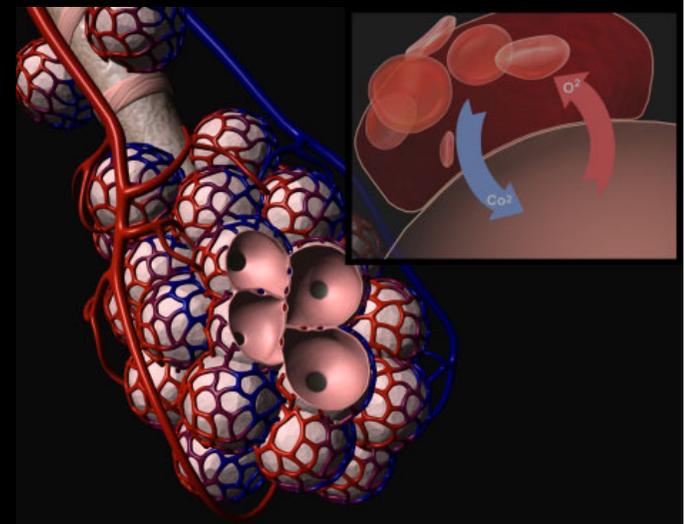
Définition

- Incapacité du poumon à assurer une oxygénation satisfaisante et/ou de prévenir une rétention de CO_2 :

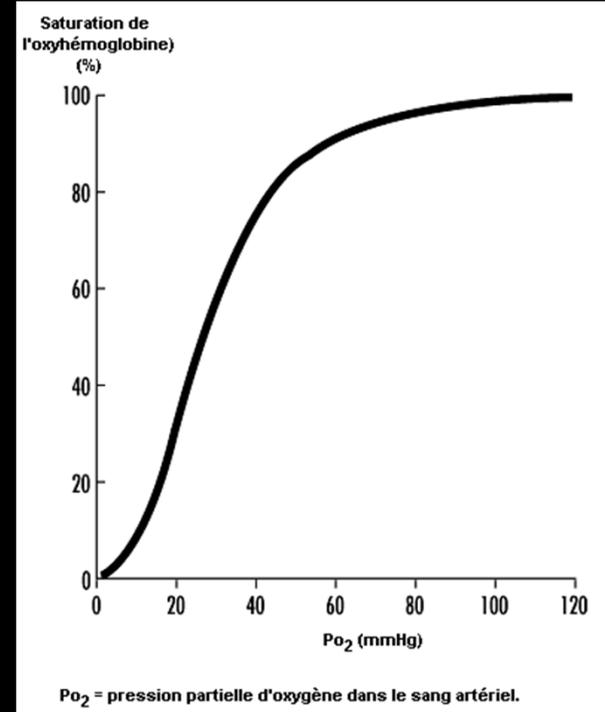
- Hypoxie < 60 mmHg

- Hypercapnie > 50 mmHg

Ces valeurs limites dépendent de l'histoire clinique



Maintenir CaO₂



Contenu
O₂ ml

15
10
5

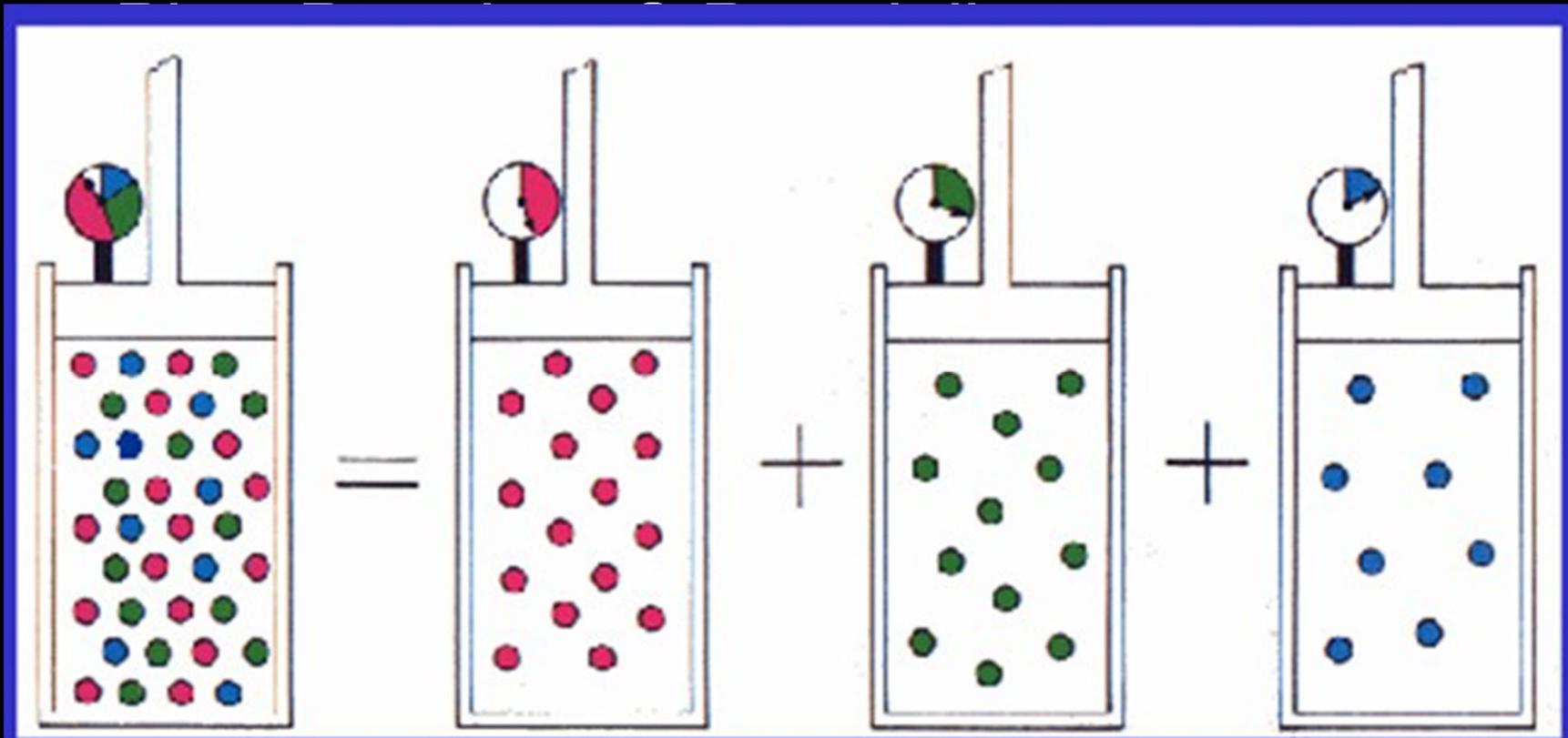
$$\text{CaO}_2 = \text{POxHbxSaO}_2 + 0,003 \text{ PaO}_2$$

200 400 600 PaO₂ mmHg

4 Causes de l' hypoxémie

- L' hypoventilation
- L' anomalie de diffusion
- Le shunt
- L' inégalité des rapports ventilation/perfusion

Loi des gaz



Hypoventilation

- Hypercapnie:

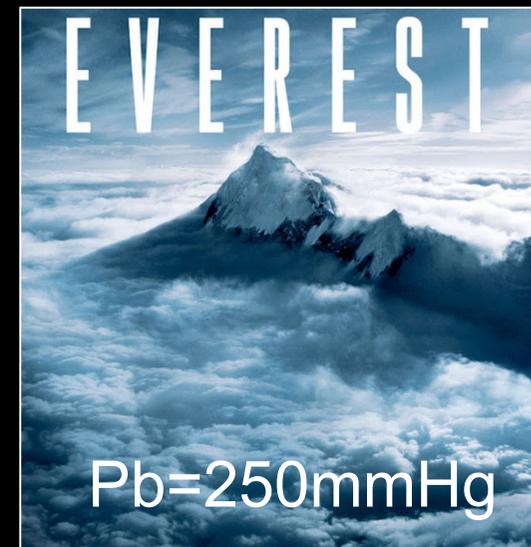
- $P_{aCO_2} = K \times V_{CO_2} / V_A$

- Hypoxémie:

- $P_{A}O_2 = P_{i}O_2 - P_{A}CO_2 / R$

- $P_{i}O_2 = F_{i}O_2 \times (P_b - P_{H_2O})$

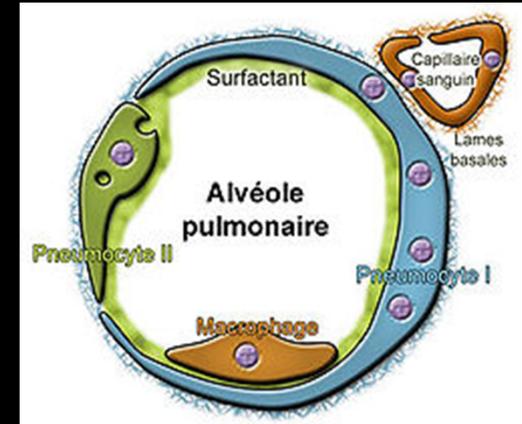
- $P_{A}O_2 = F_{i}O_2 \times (P_b - P_{H_2O}) - P_{A}CO_2 / R$



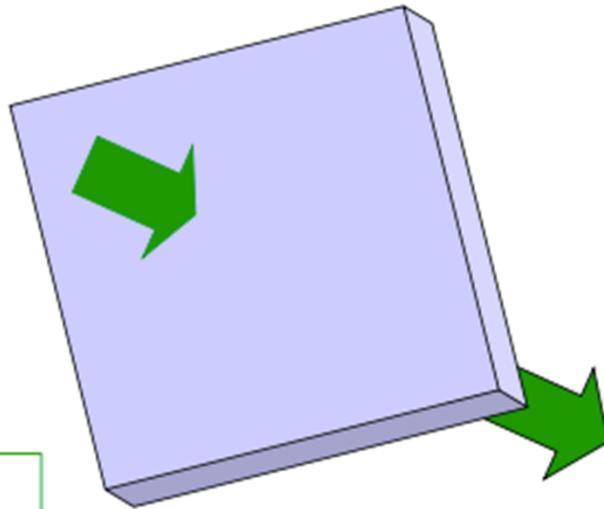
Etiologies

- Dépression des centres respiratoires : médicaments
- Atteinte du bulbe rachidien : encéphalite, TC, hémorragie, tumeur...
- Atteinte de la corne antérieure : poliomyélite
- Atteinte des nerfs des muscles respiratoires : Guillain Barré, diphtérie
- Atteinte des muscles respiratoires : dystrophie musculaire progressive
- Lésions de la cage thoracique : volet costal
- Obstruction des voies aériennes supérieures : tumeurs

Anomalies de diffusion



P_1



Membrane:
épaisseur (e)
surface (s)

Gaz (D):
solubilité
PM

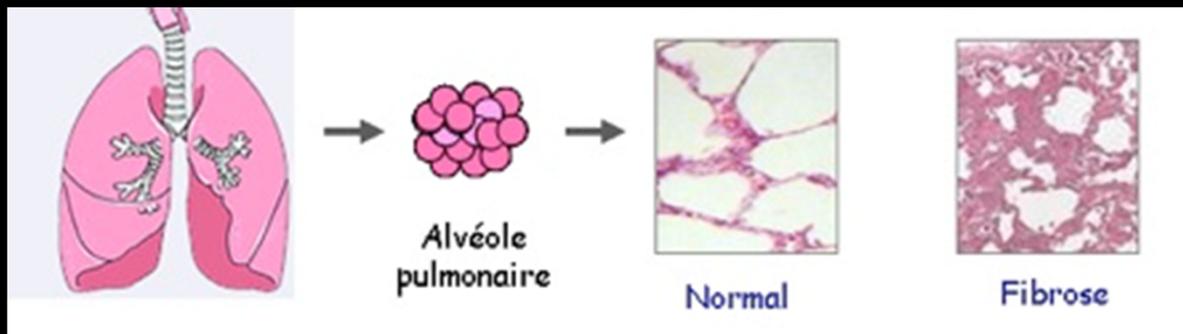
P_2

$$dQ / dt = (D \cdot s \cdot dP) / e$$

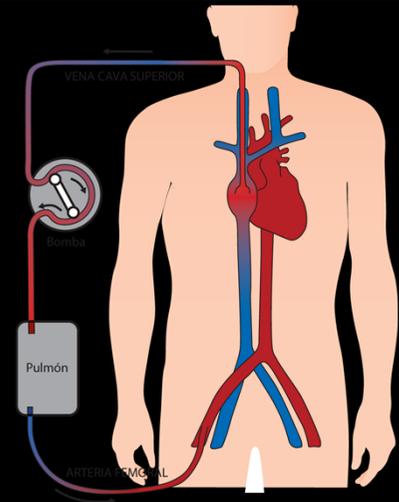
équilibre au 1/3.
cœur droit
ventilation

Etiologie

- Asbestose, sarcoidose, granulomatoses, fibrose interstitielle pulmonaire, sclerodermie , lupus ...



Le shunt



- Du sang veineux atteint le système artériel :

$$\text{Calcul : } Q_S/Q_T = (C_c' - C_a) / (C_c' - C_v)$$

- C_c' calculé sous O_2 pur ($S_c' O_2 = 100\%$)
- C_a GDS et C_v KT dans l'AP

normale < 10%

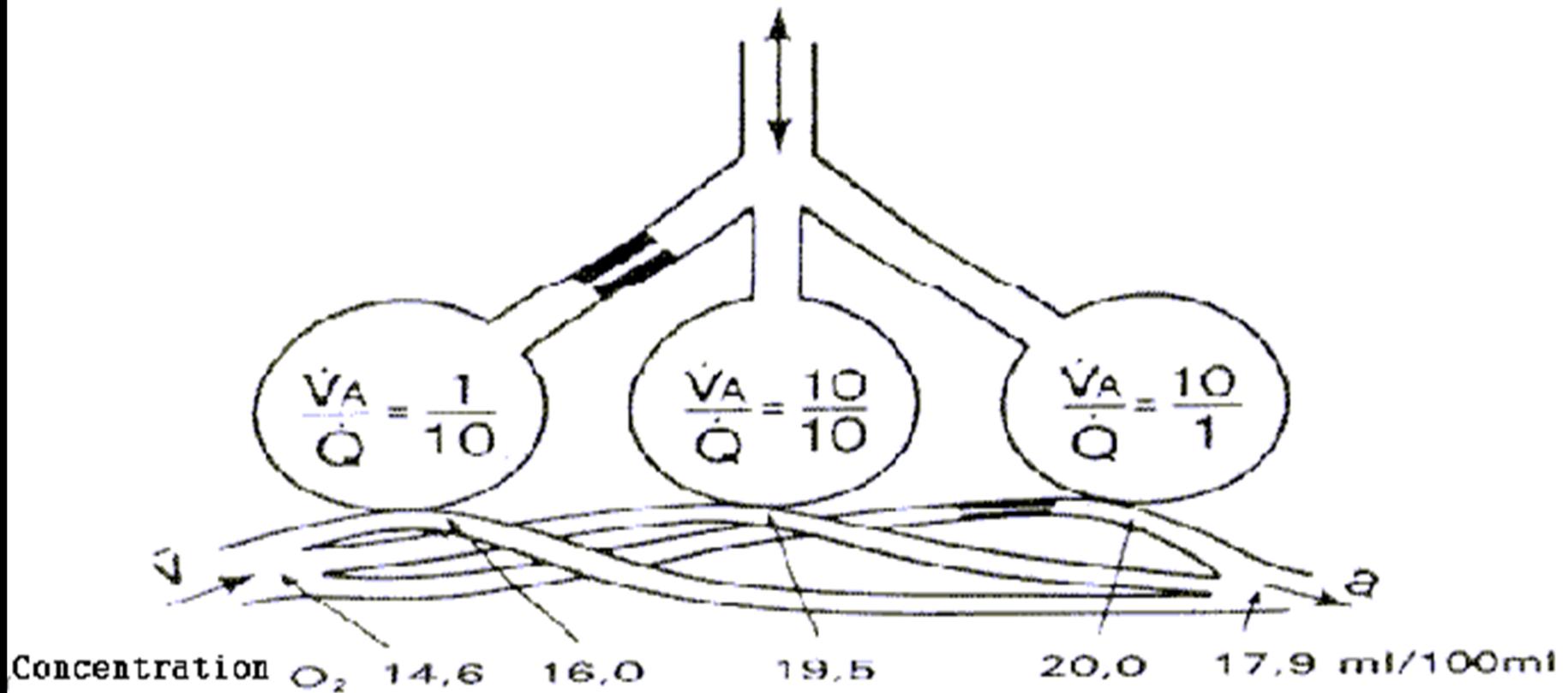
$PaCO_2$ rarement élevée car hyperventilation

Etiologies

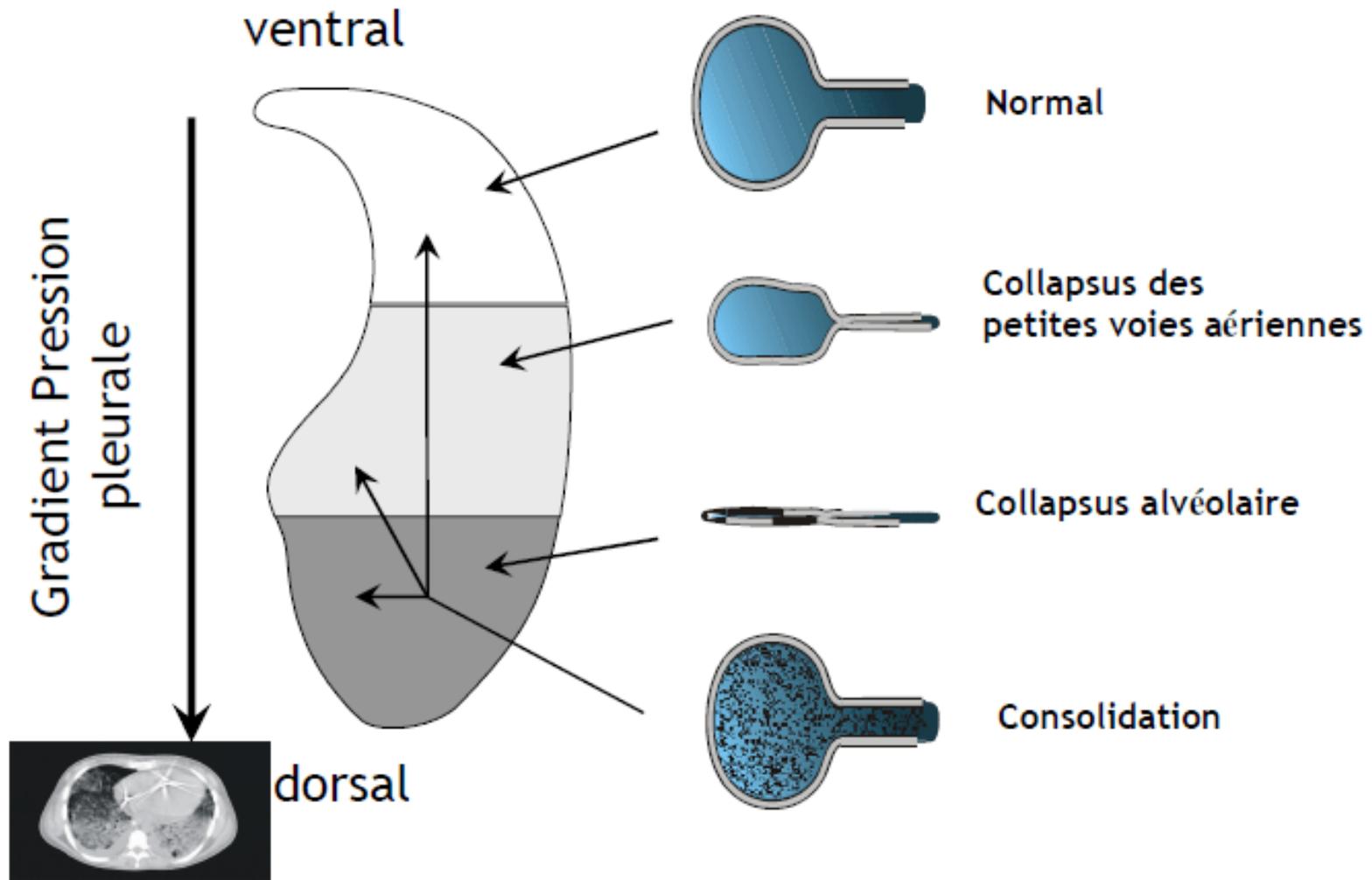
- shunt vrai
 - Fistules artério-veineuses Syndrome hépatopulmonaire des Cirrhoses
 - Canal artériel, CIV, CIA et HTAP
- effet shunt
 - = $V_A/Q \rightarrow 0$ correspond à une inégalité des rapports ventilation / perfusion
 - Atélectasies de l' anesthésie générale, PFLA, SDRA etc ...

Measurement of continuous distributions of ventilation-perfusion ratios: theory

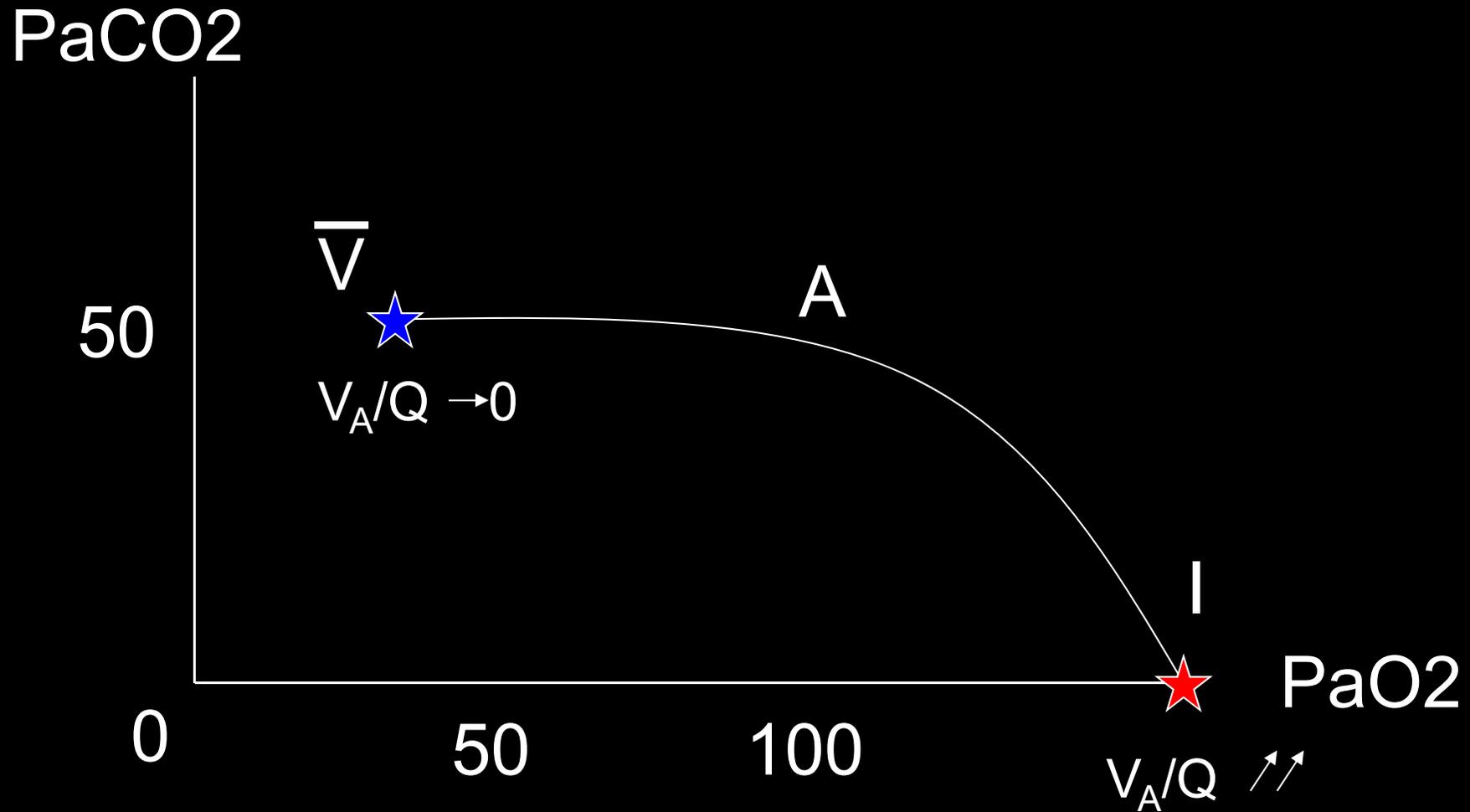
PETER D. WAGNER, HERBERT A. SALTZMAN, AND JOHN B. WEST
Department of Medicine, University of California, San Diego, La Jolla, California 92037



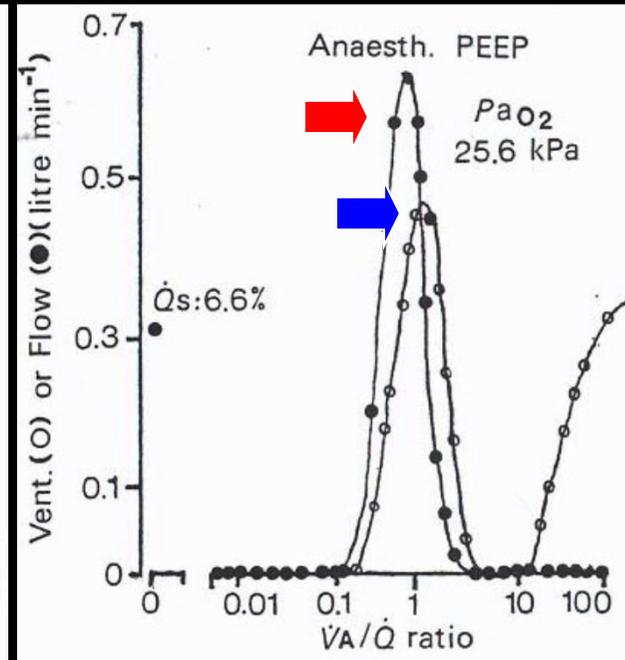
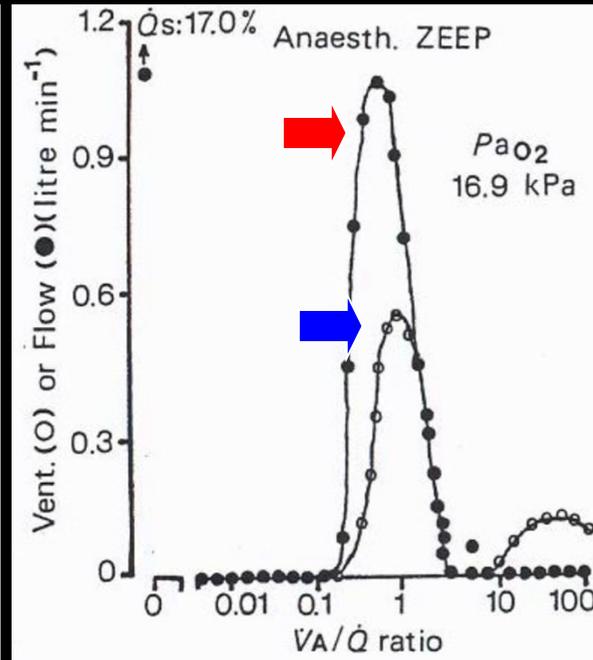
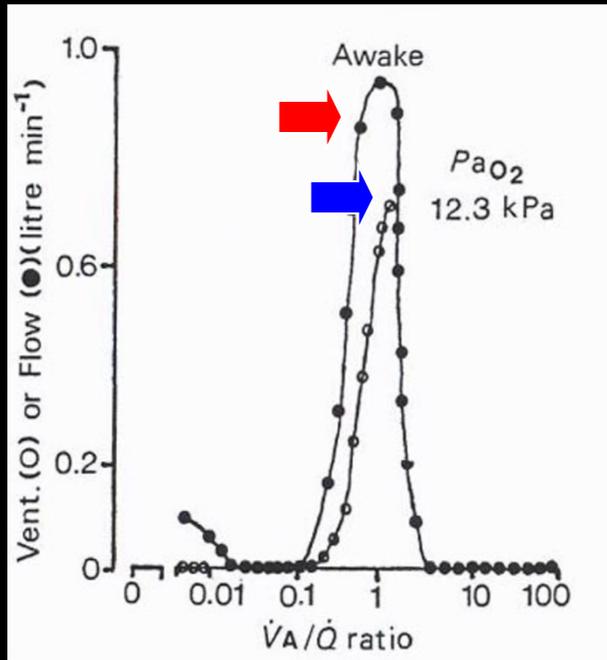
Inégalités des V_A/Q



Inégalités des V_A/Q



MESURE DES V_A/Q



Patient avant induction

Patient après induction

Patient avec une PEP

→ Q

→ V_A

Wagner PD, Saltzman HA, West JB.

Measurement of continuous distributions of ventilation-perfusion ratios: theory.

J Appl Physiol. 1974 May;36(5):588-99.

ADAPTATION

- $V_A/Q \searrow \Rightarrow PaO_2 \searrow PaCO_2 \nearrow$
- Stimulation des chémorécepteurs périphériques et centraux :
Hyperventilation, **VPH**, agents vaso actifs, système nerveux autonome...
- $PaO_2 \nearrow PaCO_2 \searrow$

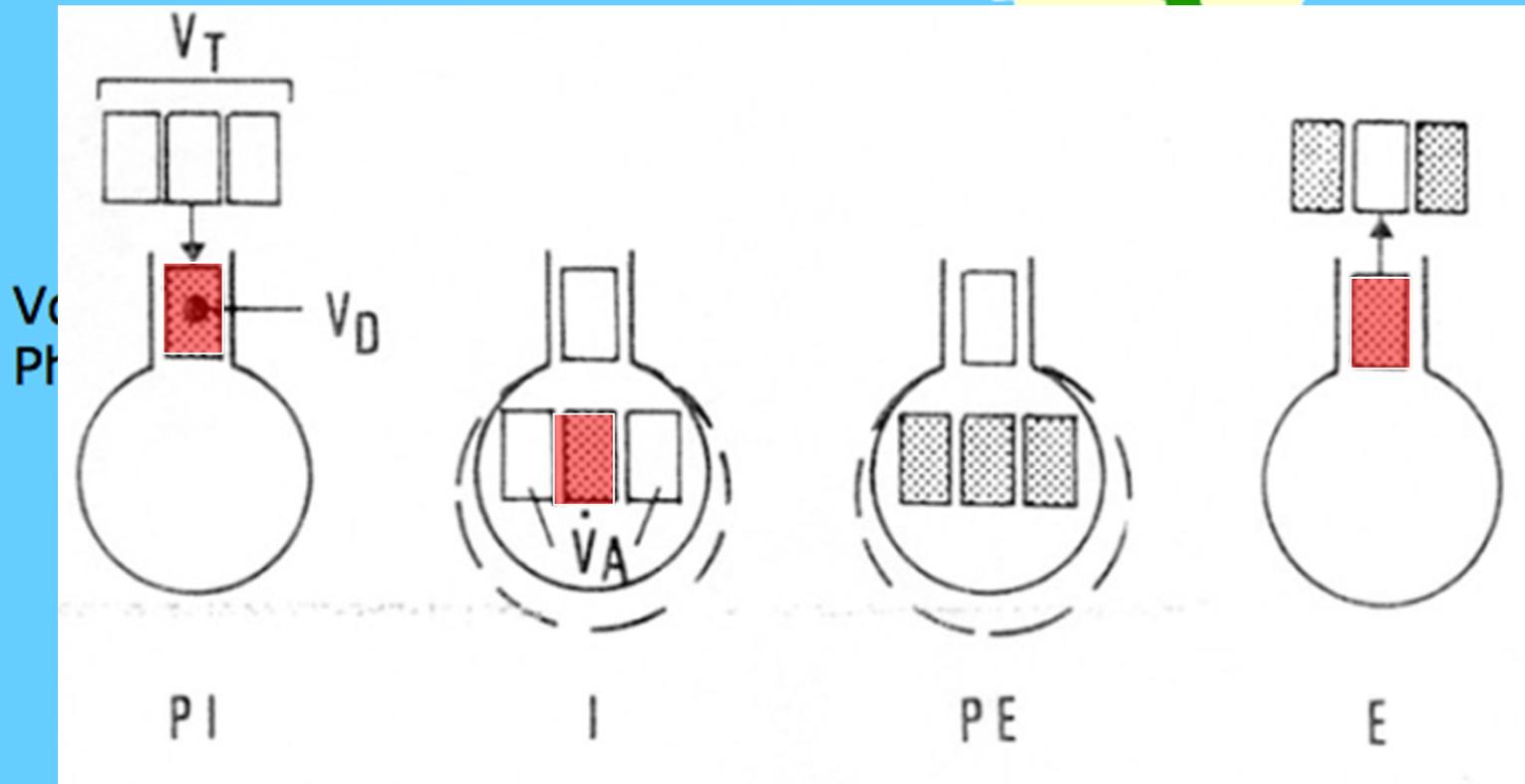
Etiologies

- Pneumopathie infectieuse
- Embolie pulmonaire, embolie graisseuse, chest syndrome, TRALI
- OAP
- SDRA pulmonaires et extrapulmonaires
- Insuffisance respiratoire chronique décompensée, surinfection, bronchospasme: aggravation des inégalité des V_A/Q augmentation du W respiratoire.
- Atélectasies, inhalation, pneumo-hémothorax, contusion pulmonaire

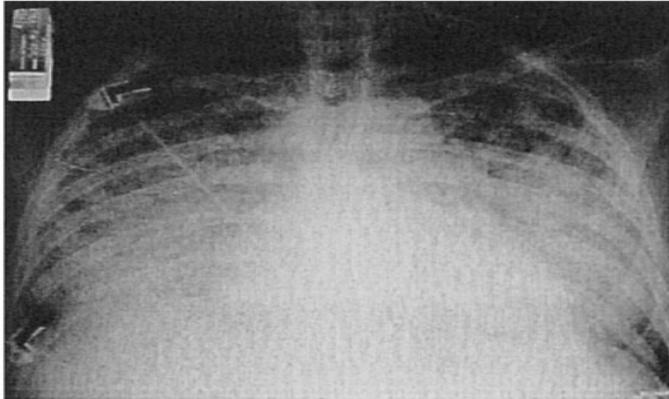
V 'Alvéolaire et PaCO₂

PaCO₂ = $\frac{\text{Production de Co}_2}{\text{Ventilation Alvéolaire}}$

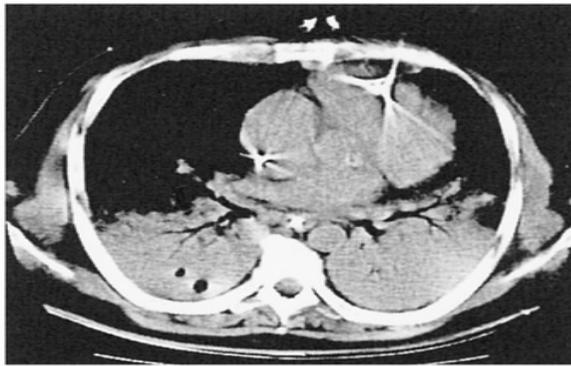
PaCO₂ = $\frac{V'CO_2}{V'Courante - V'Esace Mort}$



Améliorer la ventilation alvéolaire



**$FiO_2 = 100\%$, $TV = 4 \text{ mL/kg}$,
 $PEEP = 0 \text{ cm H}_2\text{O}$**

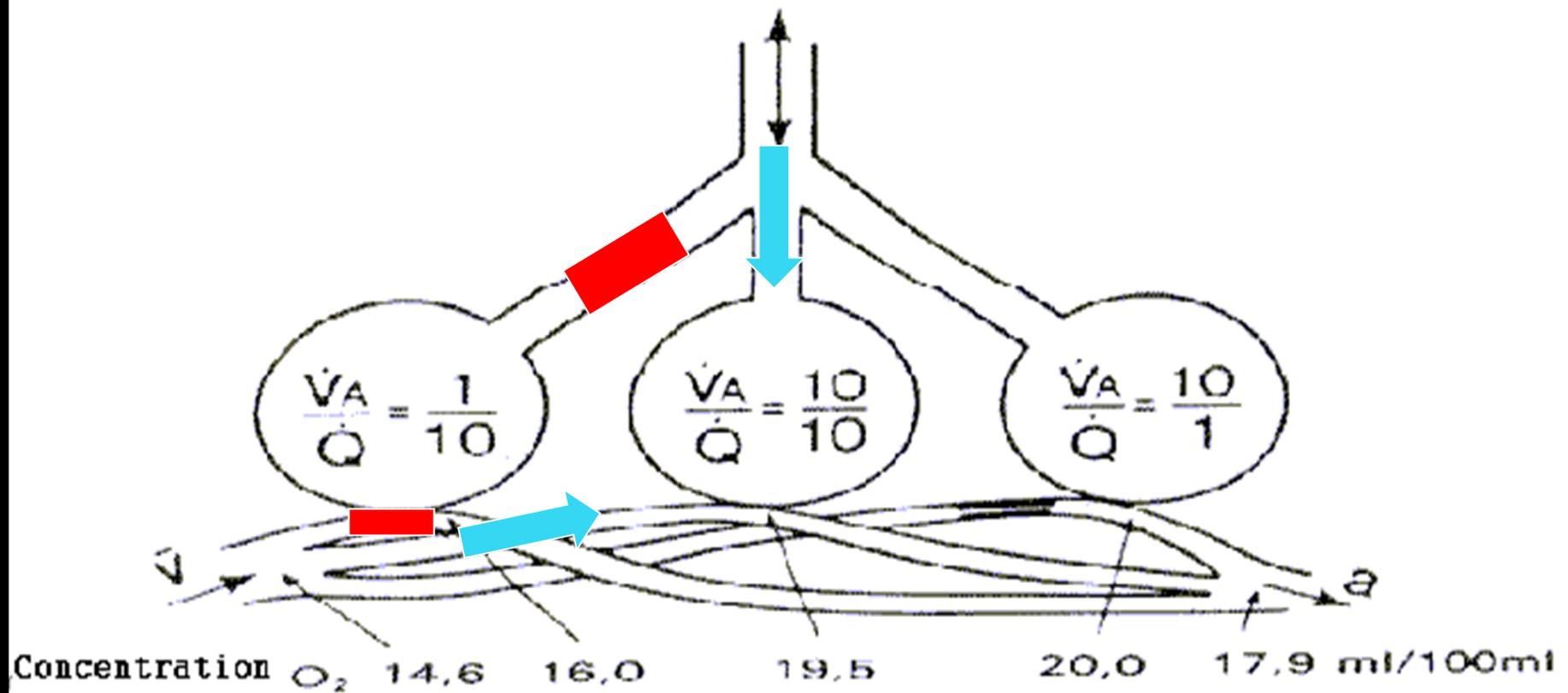


**Nonaerated tissue = 55.6%
 $PaO_2/FiO_2 = 100$**

Trouble de la ventilation



Stimulation de la VPH



Débit cardiaque et V_a/q

Il y peut y avoir en pratique clinique une amélioration de la PaO_2 sans recrutement alvéolaire :

-La diminution du débit cardiaque entraîne une diminution de l'effet shunt (ex verticaliser un patient en ARDS)
redistribution du sang des zones de hauts vers bas V_a/Q
(effet du NO inhalé) .On observe alors une augmentation de l'espace mort et donc de la $PaCO_2$.

Par contre à ventilation alvéolaire constante une diminution de la $PaCO_2$ correspond plus spécifiquement à un recrutement alvéolaire.

Jerome Aboab
Bruno Louis
Bjorn Jonson
Laurent Brochard

Relation between $\text{PaO}_2/\text{F}_1\text{O}_2$ ratio and F_1O_2 : a mathematical description

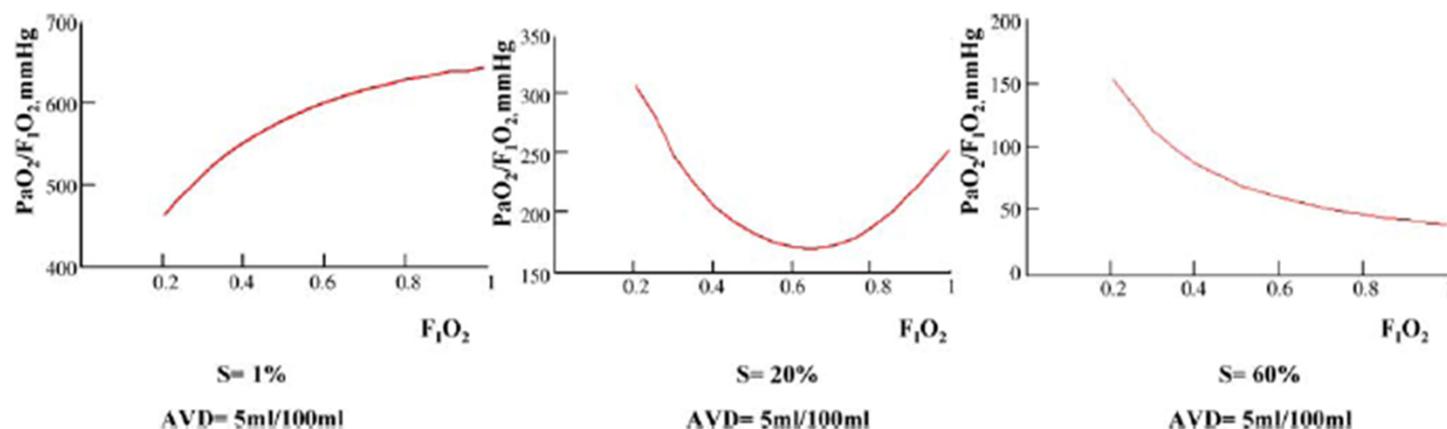


Fig. 1 Relation between $\text{PaO}_2/\text{F}_1\text{O}_2$ and F_1O_2 for a constant arterio-venous difference (AVD) and different shunt levels (S)

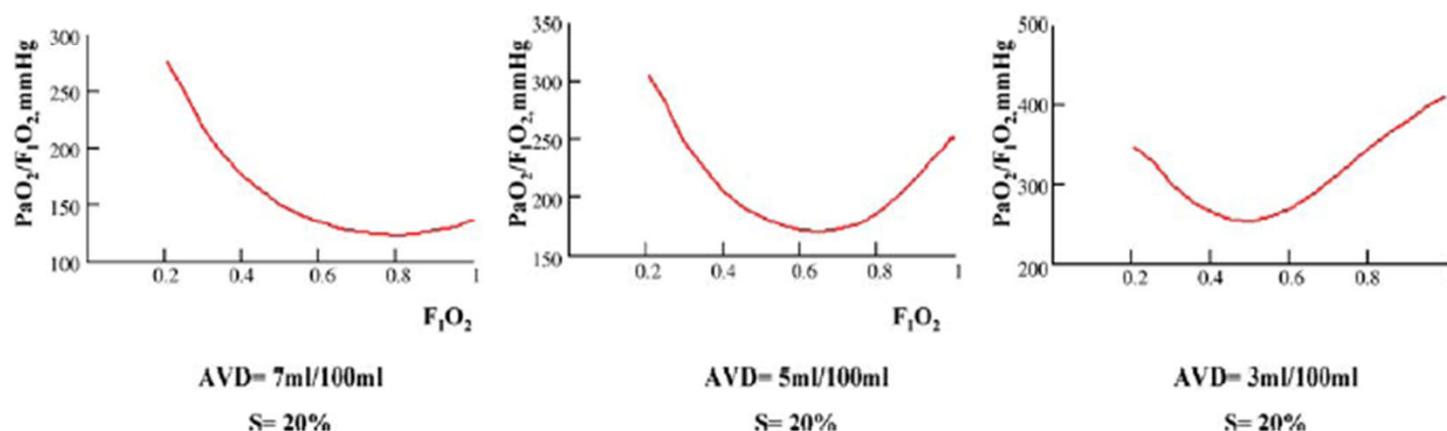


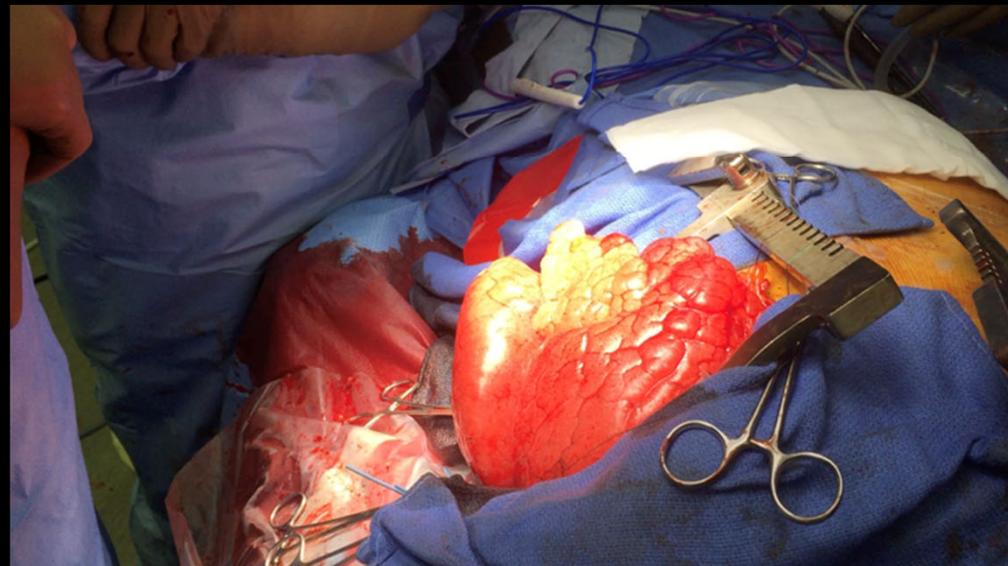
Fig. 2 Relation between $\text{PaO}_2/\text{F}_1\text{O}_2$ and F_1O_2 for a constant shunt (S) level and different values of arterio-venous differences (AVD)

Capacités pulmonaires

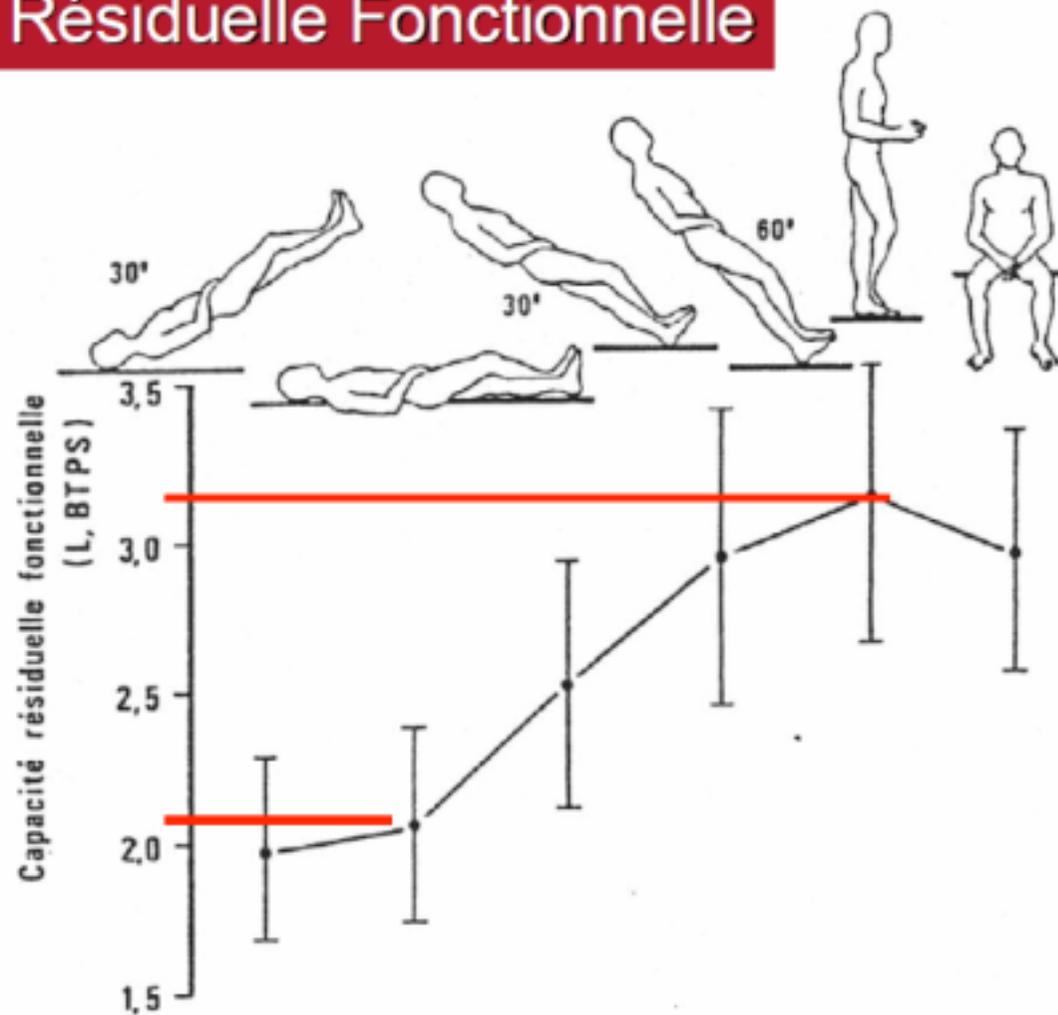
- Capacité pulmonaire totale =
capacité vitale + volume résiduel
 $= 3,6 \text{ à } 4,8 \text{ L} + 1,2 \text{ à } 2,4 \text{ L}$
- Capacité vitale = VRE + VC + VRI
 $= 1 \text{ à } 1,2 \text{ L} + 0,5 \text{ L} + 2,1 \text{ à } 3,1 \text{ L}$
- CRF = VR + VRE
 $= 1,2 \text{ à } 2,4 \text{ L} + 1 \text{ à } 1,2 \text{ L}$



COPD



Effets de la position sur la Capacité Résiduelle Fonctionnelle



GDS

- Ph
- PaO₂
- PaCO₂
- HCO₃⁻
- SaO₂
- Hypoxémie, Hyper Hypocapnie, Acidose
Alcalose, métabolique, respiratoire

Cas clinique N° 1

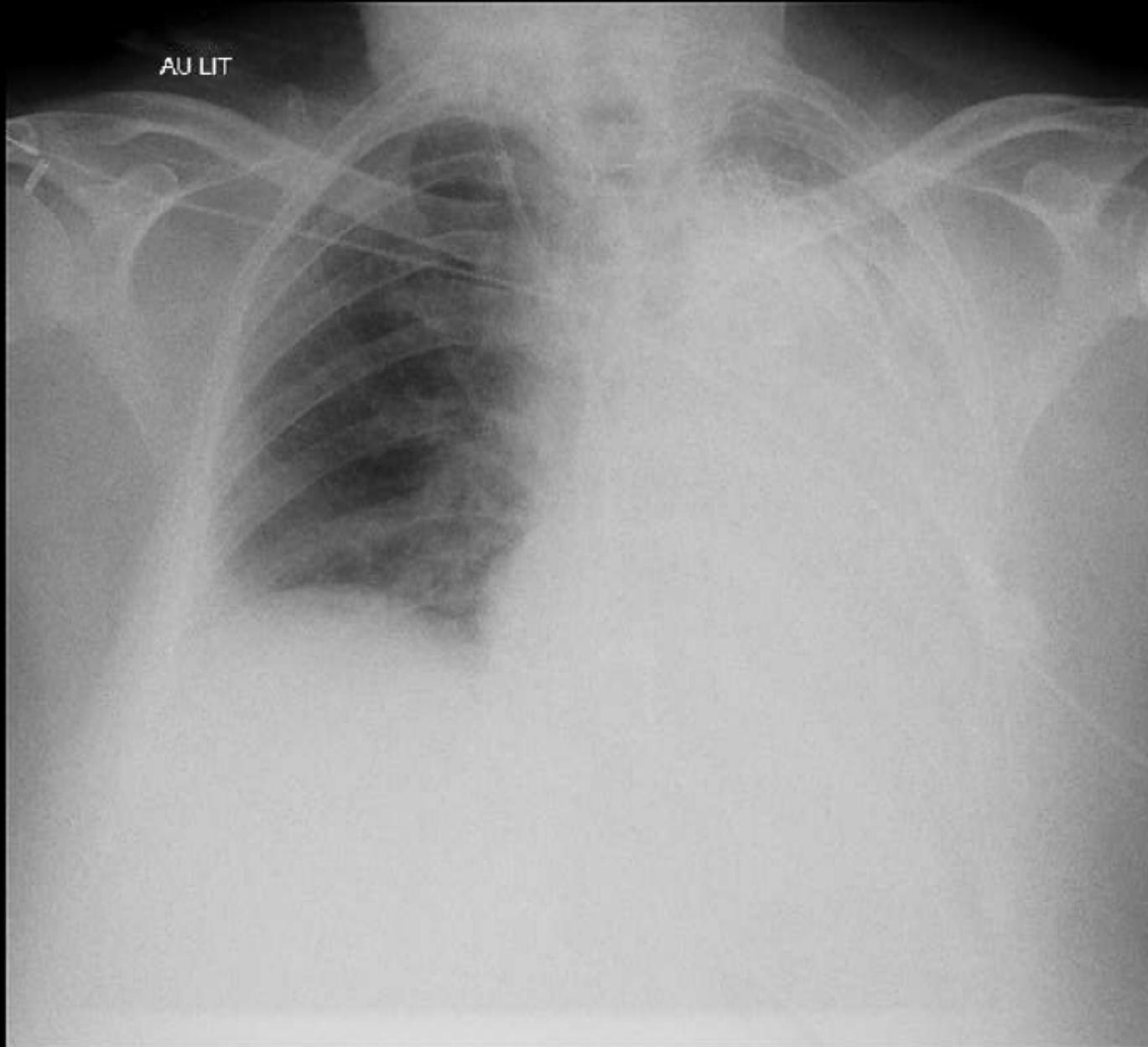
- Mr X. Toxicomane
- Admis au SAU pour coma par overdose.
- FR : 10
- GDS en AA:
 - PO₂ : 50 mmHg
 - PCO₂ : 60 mmHg
 - pH : 7,25
 - Bicar : 22 mmol/l
 - BE : - 2

Analyse GDS

- Hypoventilation alvéolaire
 - Hypoxie
 - Hypercapnie
- Acidose mixte
 - Hypercapnie
 - Souffrance tissulaire (faible)
- Cause :
 - Bradypnée
 - PNP ?

- Injection de Narcan.
- FR : 32
- GDS en AA:
 - PO₂ : 60 mmHg
 - PCO₂: 25 mmHg
 - pH : 7, 46
 - Bicar : 22 mmol/l
- RT

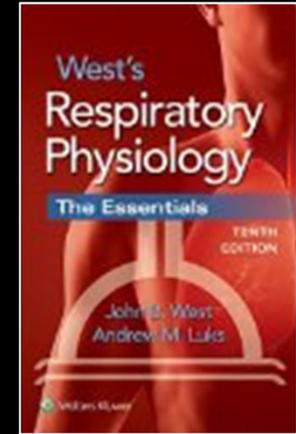
AU LIT



Analyse des GDS

- Hypoxie
- Hypocapnie par hyperventilation
- Hétérogénéité des rapports ventilation perfusion
- RT: PNP poumon G

RÉFÉRENCES



- **West JB.** Pulmonary Pathophysiologie - the essential. 1995 édition Pradel.

You Tube

<https://www.youtube.com/watch?v=qLroD-Qcg4o>



Les lésions induites par la ventilation

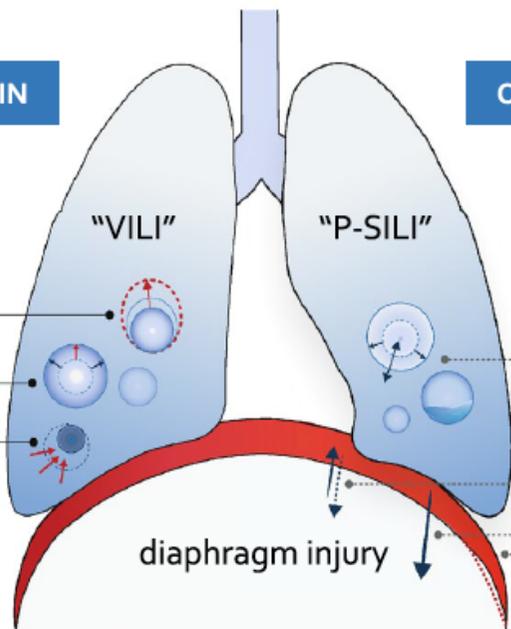
NARRATIVE REVIEW

Clinical strategies for implementing lung and diaphragm-protective ventilation: avoiding insufficient and excessive effort



MINIMIZING (BABY) LUNG STRESS & STRAIN

- breath-stacking dyssynchrony
↓
- excessive inspiratory assist → high V_T , ΔP
- excessive PEEP → overdistention
- insufficient PEEP → derecruitment



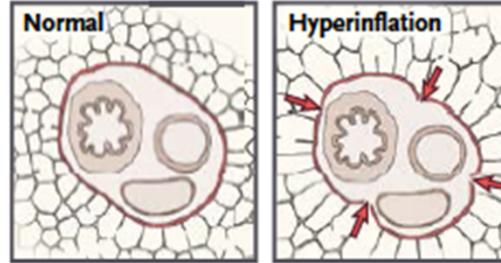
OPTIMIZING DIAPHRAGM EFFORT & SYNCHRONY

- insufficient assist, high effort/drive
↓
- injurious efforts
- eccentric injury ← expiratory dyssynchrony
- longitudinal atrophy ← excessive PEEP
- disuse atrophy ← excessive assist, low effort/drive

Lésions Ruptures ViLi Barotraumatismes



B Ventilation at high lung volume

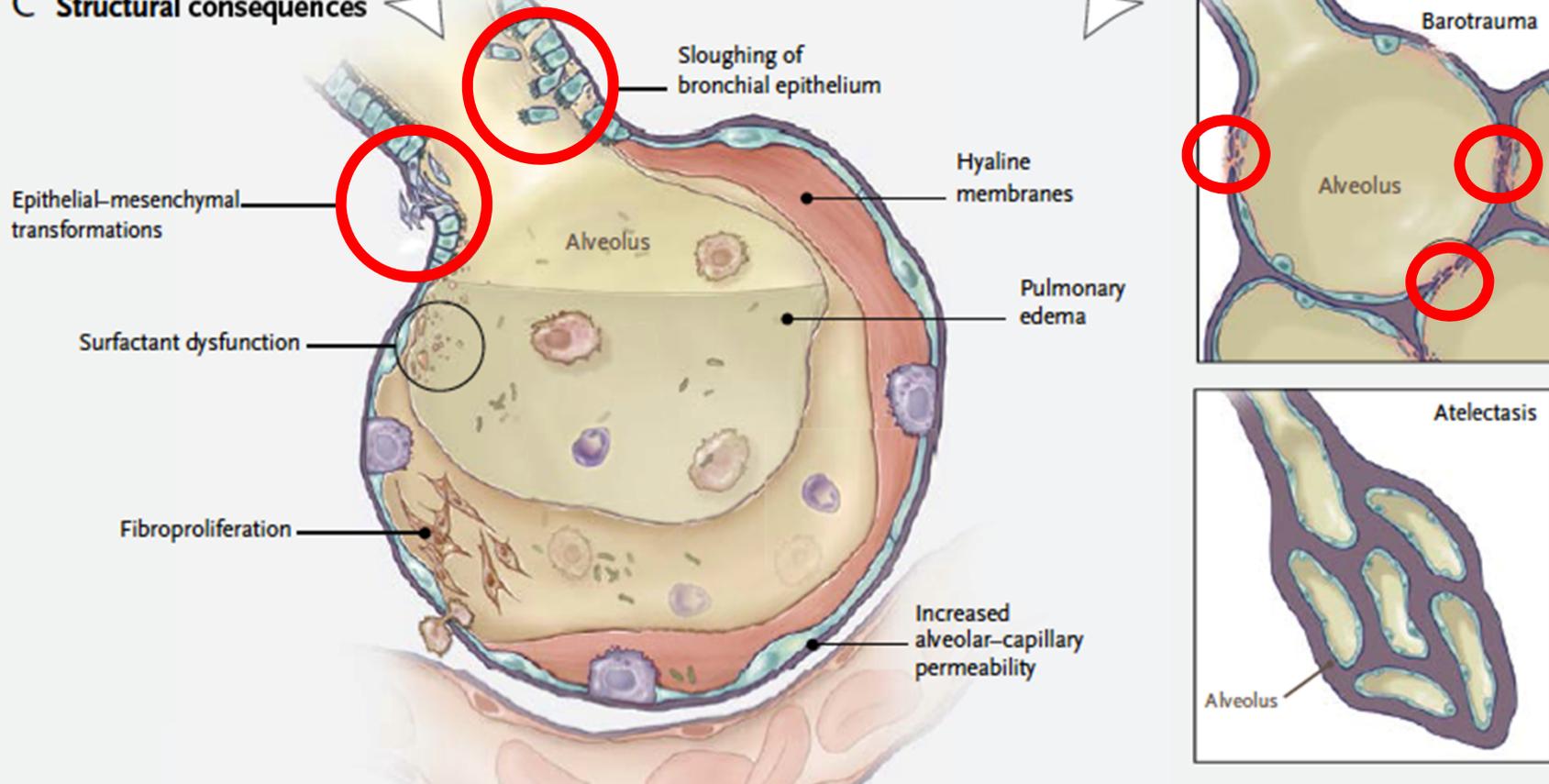


Air leaks



Overdistention

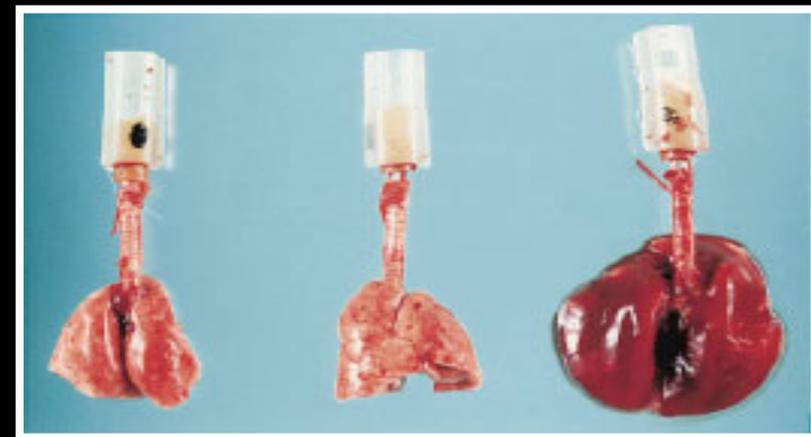
C Structural consequences



Lésions induites par la ventilation



P_{plat}/PEP



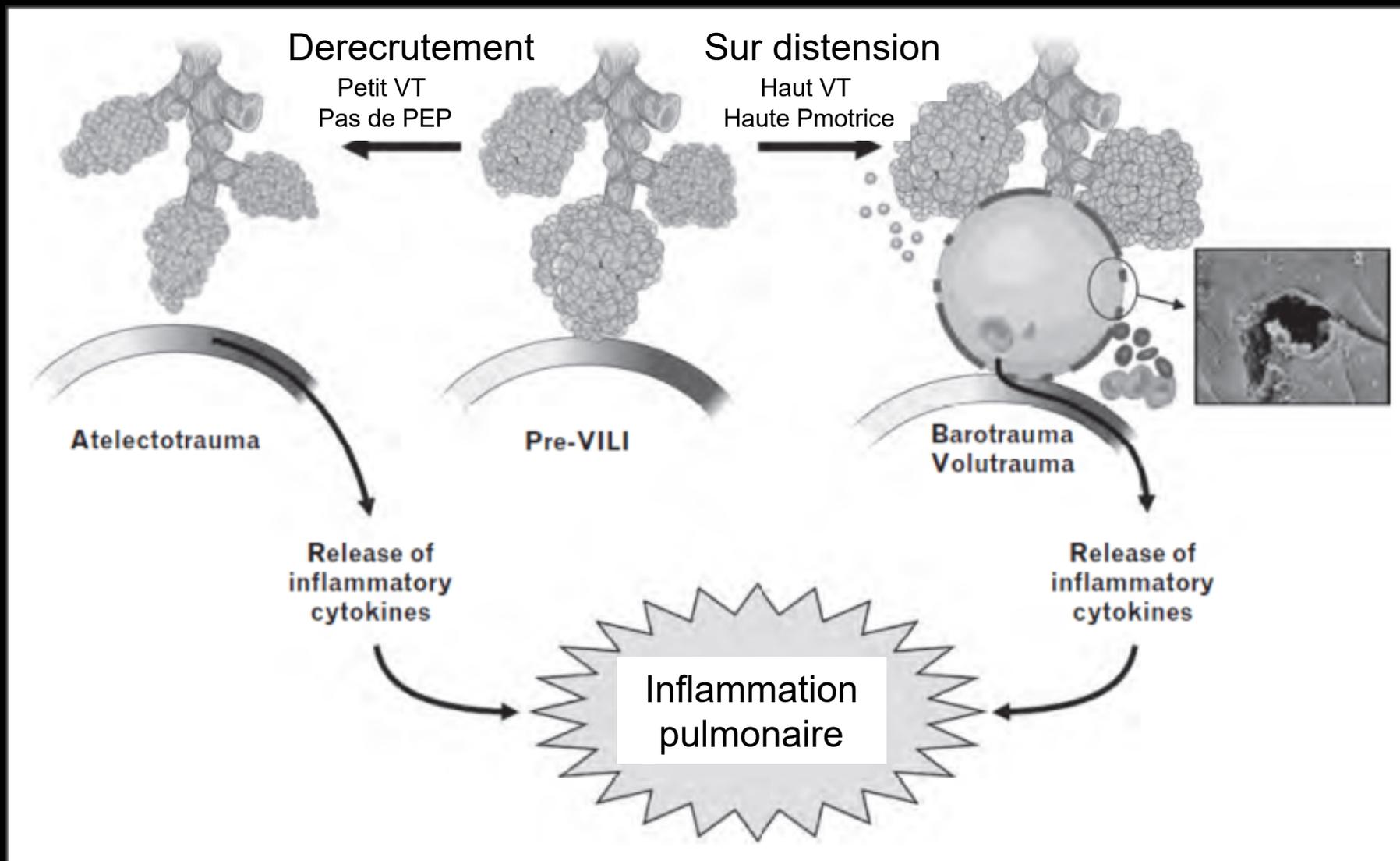
Dreyfuss D, Saumon G

Ventilator-induced lung injury: lessons from experimental studies.
Am J Respir Crit Care Med. 1998 ;157:294-323. Review.

Experimental Pulmonary Edema due to Intermittent Positive Pressure Ventilation with High Inflation Pressures. Protection by Positive End-Expiratory Pressure¹⁻⁴

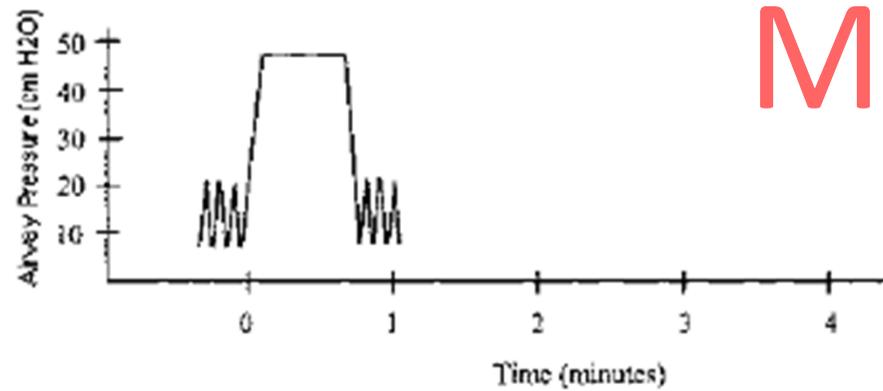
HERBERT H. WEBB and DONALD F. TIERNEY

AMERICAN REVIEW OF RESPIRATORY DISEASE, VOLUME 110, 1974

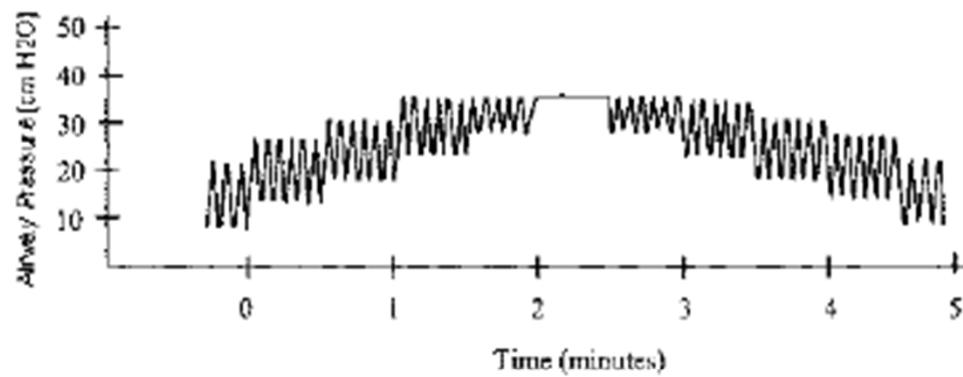


MRA

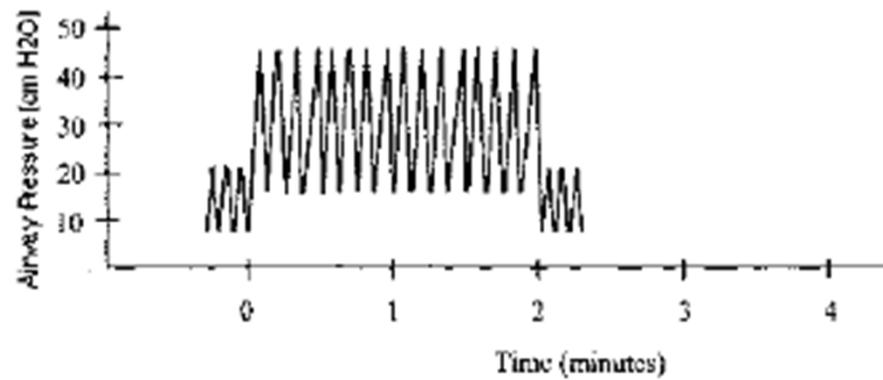
Sustained
Inflation (SI)



Incremental
PEEP (IP)



Pressure
Control
Ventilation
(PCV)



Temps 40 secondes

Bénéfices/Risques



- Bénéfices:
 - Augmenter le volume pulmonaire aéré
 - Améliorer l'oxygénation
- Risques:
 - Surdistension
 - Barotraumatisme
 - Dégradation hémodynamique

VNI

Curative

Preventive

Acute respiratory failure:

YES

(present)

Objective:

to avoid intubation

Acute respiratory failure:

NO

(not present, but at risk)

Objective:

to avoid the development
of acute respiratory failure

CPAP

NIV
(=PSV+PEEP)

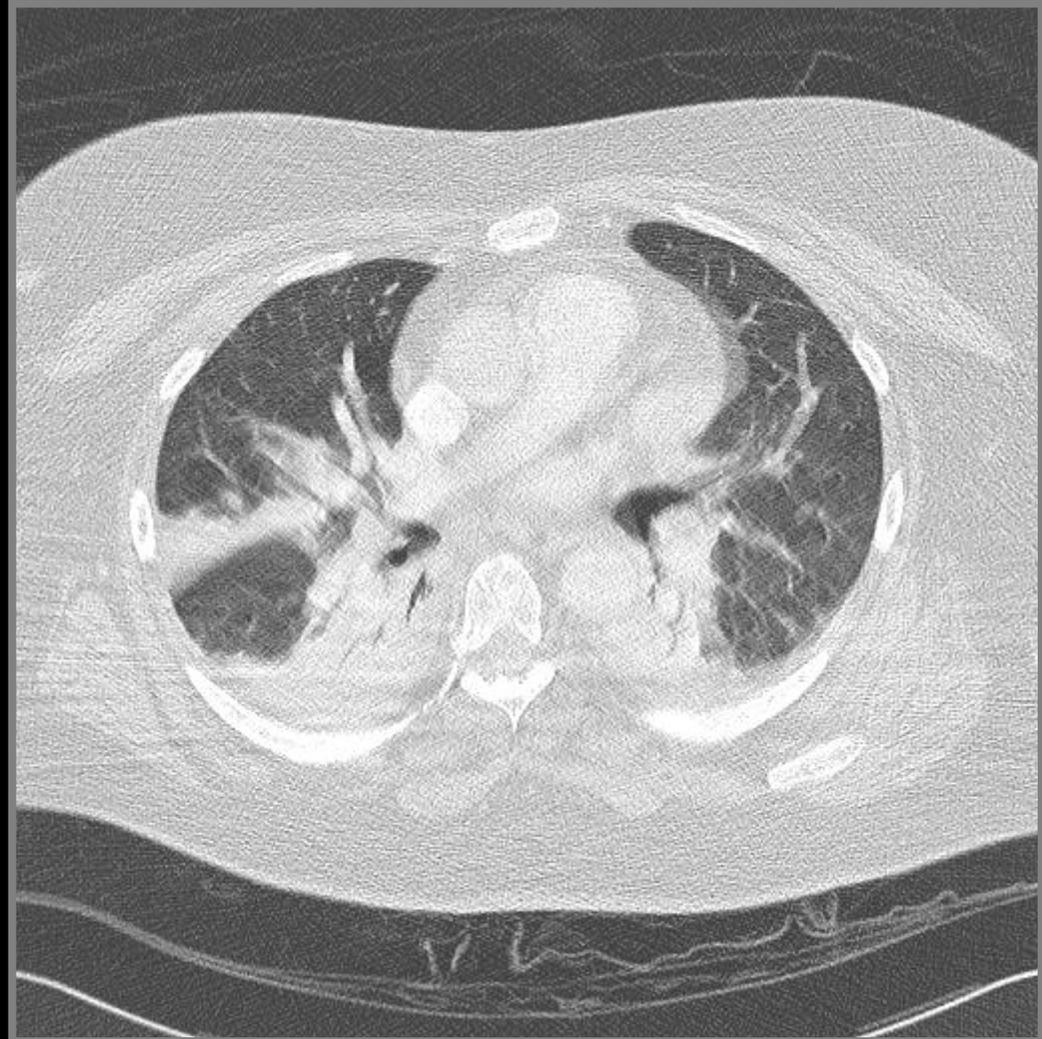
CPAP

NIV
(=PSV+PEEP)

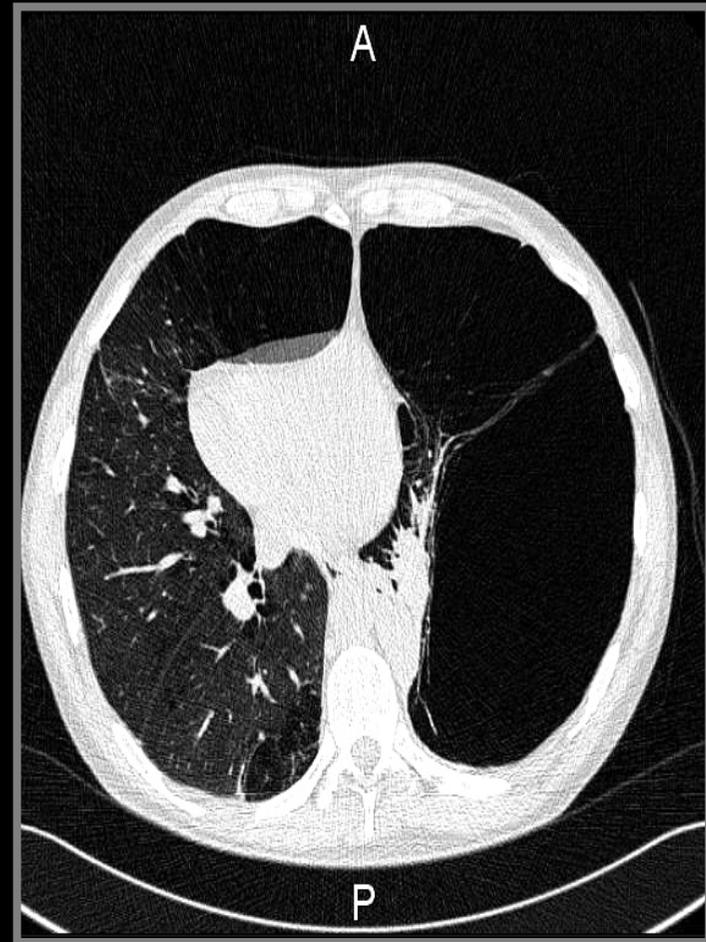
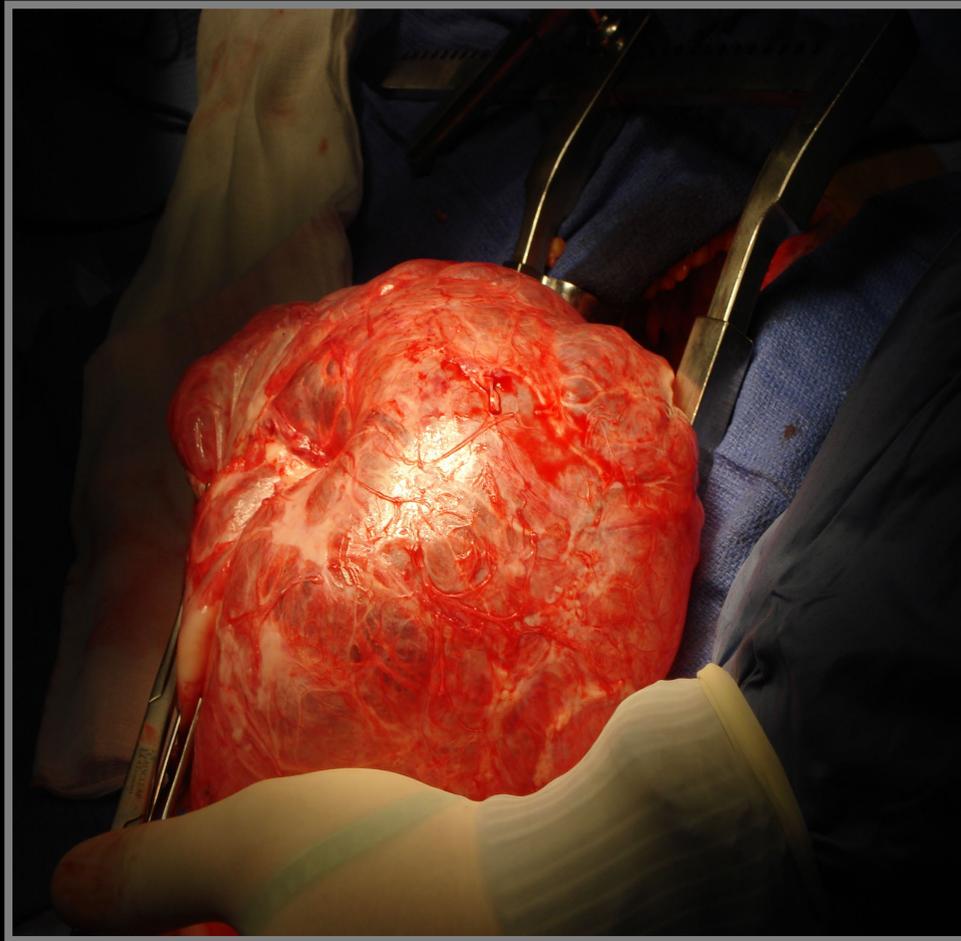
Atelectasies de l'obésité



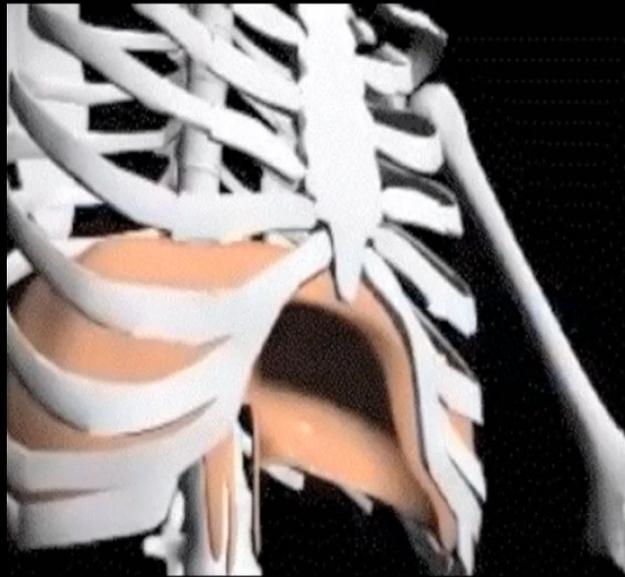
J2 Post Op
Anneau
Gastrique
coelio



Chirurgie l' emphysème



Dysfonction Diaphragmatique



The NEW ENGLAND JOURNAL of MEDICINE

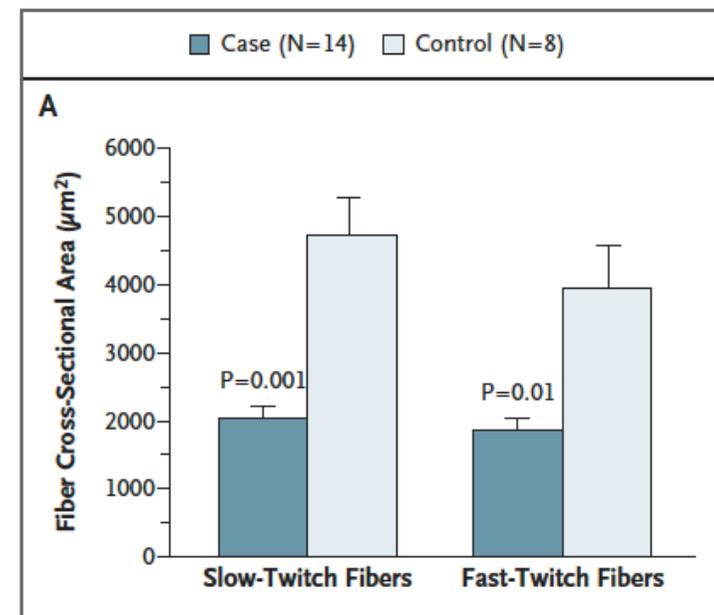
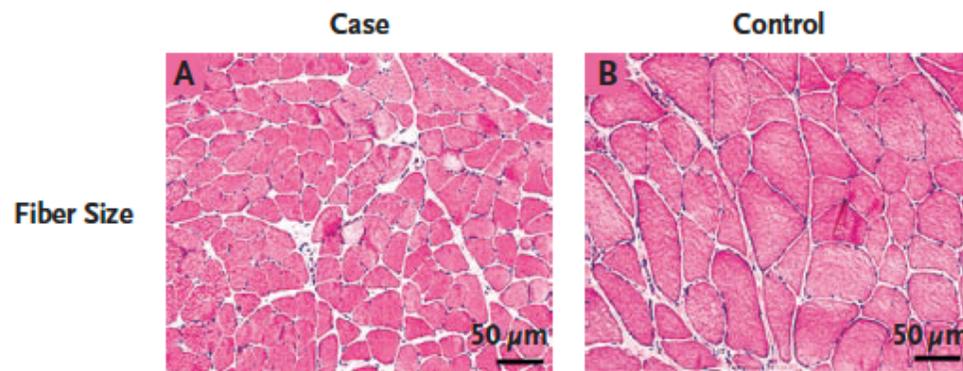
ESTABLISHED IN 1812

MARCH 27, 2008

VOL. 358 NO. 13

Rapid Disuse Atrophy of Diaphragm Fibers in Mechanically Ventilated Humans

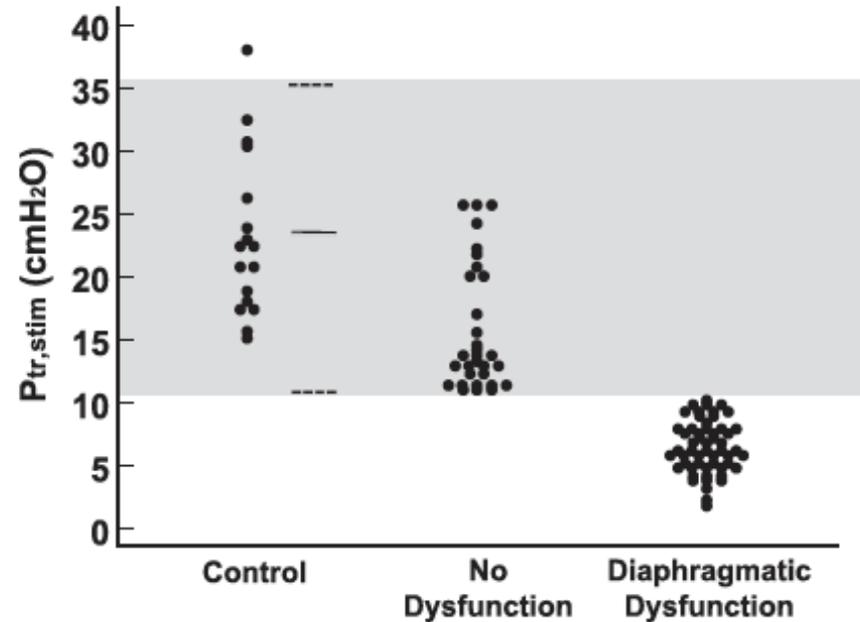
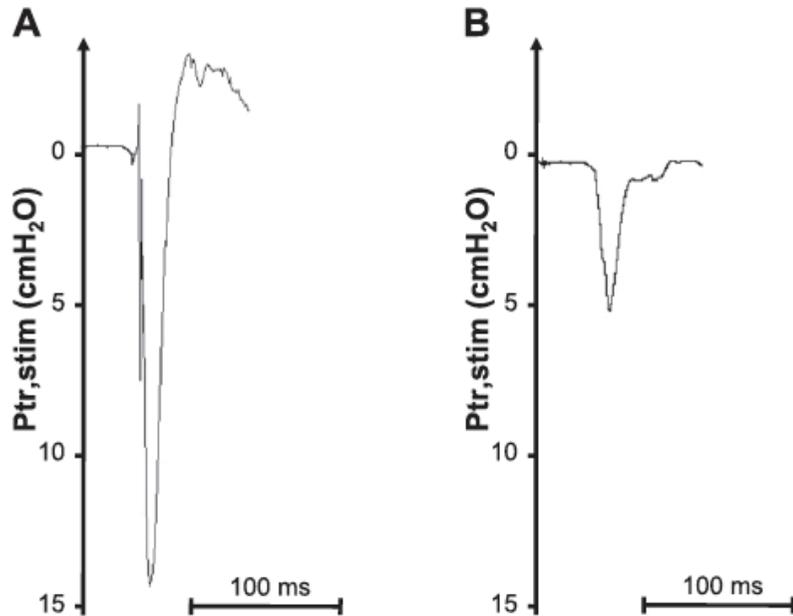
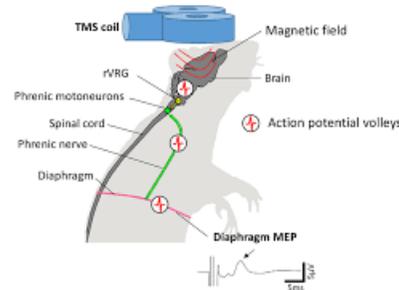
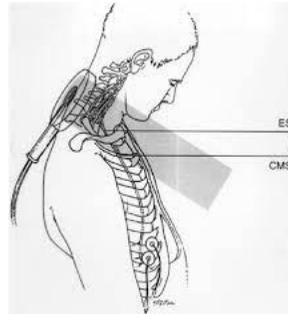
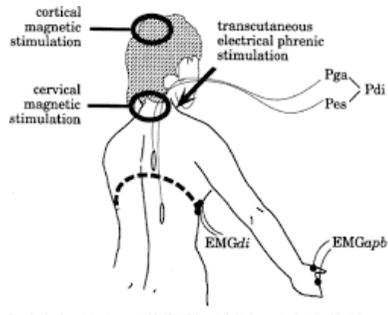
Sanford Levine, M.D., Taitan Nguyen, B.S.E., Nyali Taylor, M.D., M.P.H., Michael E. Friscia, M.D.,
Murat T. Budak, M.D., Ph.D., Pamela Rothenberg, B.A., Jianliang Zhu, M.D., Rajeev Sachdeva, M.D.,
Seema Sonnad, Ph.D., Larry R. Kaiser, M.D., Neal A. Rubinstein, M.D., Ph.D., Scott K. Powers, Ph.D., Ed.D.,
and Joseph B. Shrager, M.D.



Diaphragm Dysfunction on Admission to the Intensive Care Unit

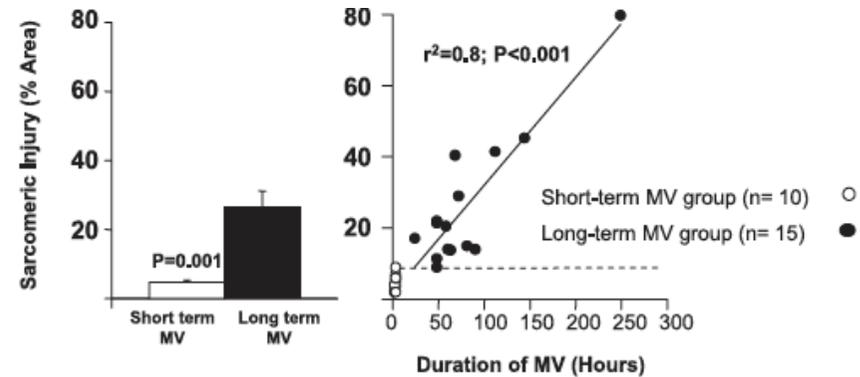
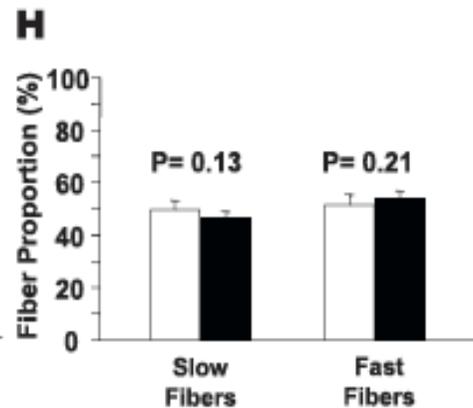
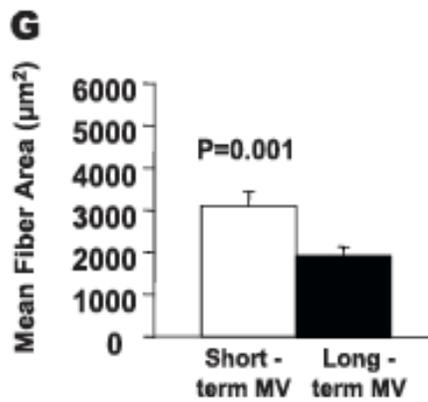
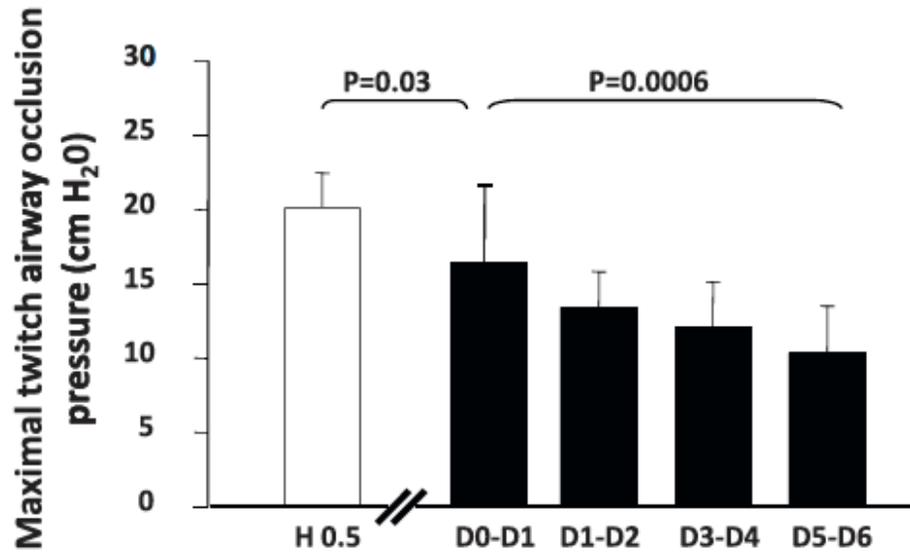
Prevalence, Risk Factors, and Prognostic Impact—A Prospective Study

Alexandre Demoule^{1,2,3}, Boris Jung^{4,5}, H el ene Prodanovic², Nicolas Molinari⁶, Gerald Chanques^{4,5}, Catherine Coirault³, Stefan Matecki^{5,7}, Alexandre Duguet^{1,2}, Thomas Similowski^{1,2*}, and Samir Jaber^{4,5*}



Rapidly Progressive Diaphragmatic Weakness and Injury during Mechanical Ventilation in Humans

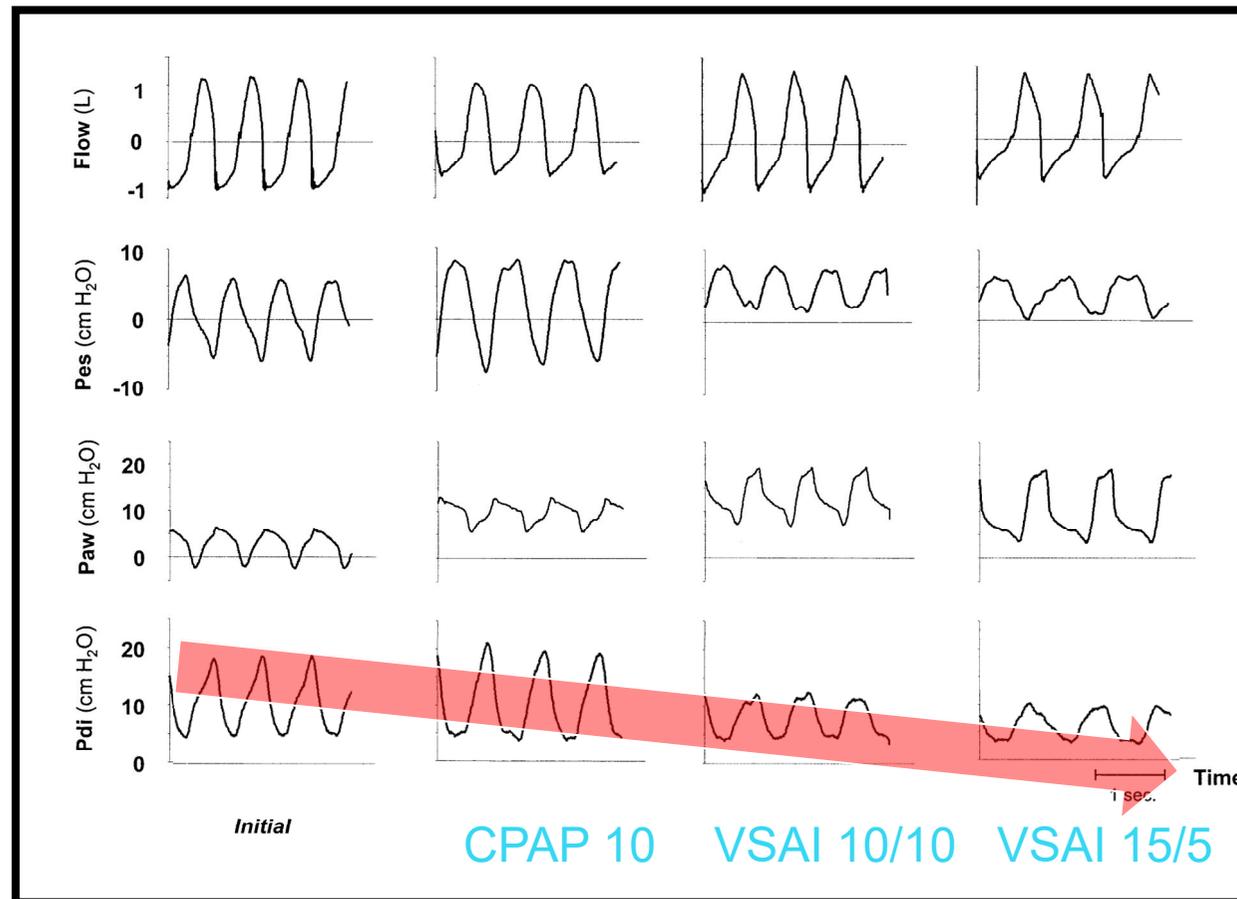
Samir Jaber^{1,2,6}, Basil J. Petrof³, Boris Jung^{1,2}, Gérald Chanques^{1,2}, Jean-Philippe Berthet⁴, Christophe Rabuel⁵, Hassan Bouyabrine⁶, Patricia Courouble^{1,2}, Christelle Koechlin-Ramonatxo⁷, Mustapha Sebbane^{1,2}, Thomas Similowski⁸, Valérie Scheuermann⁹, Alexandre Mebazaa⁵, Xavier Capdevila^{1,2}, Dominique Mornet², Jacques Mercier^{2,10}, Alain Lacampagne⁹, Alexandre Philips², and Stefan Matecki^{2,10}



CPAP vs VSAI: (PEP ou PEP+Aide)

Pression

Effort



	CON Group (n = 22)	NPPV Group (n = 22)	NPPV+RM Group (n = 22)	Overall Group Effect
P_{max} , cm H ₂ O	35 [32-39]	32 [29-36]	29 [28-34]*	$P = 0.03$
E_{rs} , cm H ₂ O ml ⁻¹	34 [27-39]	20 [17-25]*	13 [11-20]*†	$P < 0.001$
VTe, ml	485 [430-546]	458 [420-550]	475 [425-550]	$P = 0.94$
RR, c min ⁻¹	20 [18-20]	20 [20-20]	20 [20-21]	$P = 0.15$

Noninvasive Ventilation and Alveolar Recruitment Maneuver Improve Respiratory Function during and after Intubation of Morbidly Obese Patients

A Randomized Controlled Study

Emmanuel Futier, M.D.,* Jean-Michel Constantin, M.D., Ph.D.,† Paolo Pelosi, M.D., Ph.D.,‡
 Gerald Chanques, M.D., Ph.D.,§ Alexandre Massone, M.D.,|| Antoine Petit, M.D.,#
 Fabrice Kwiatkowski, Ph.D.,** Jean-Etienne Bazin, M.D., Ph.D.,†† Samir Jaber, M.D., Ph.D.‡‡

Accurate oxygen delivery

Conventional cannula

Inspiration cycle

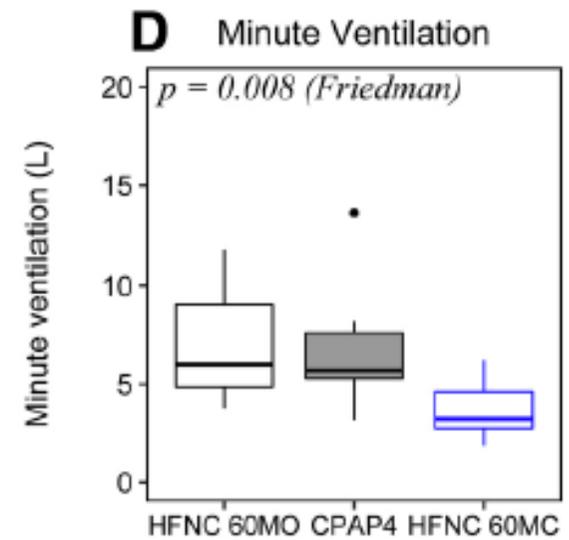
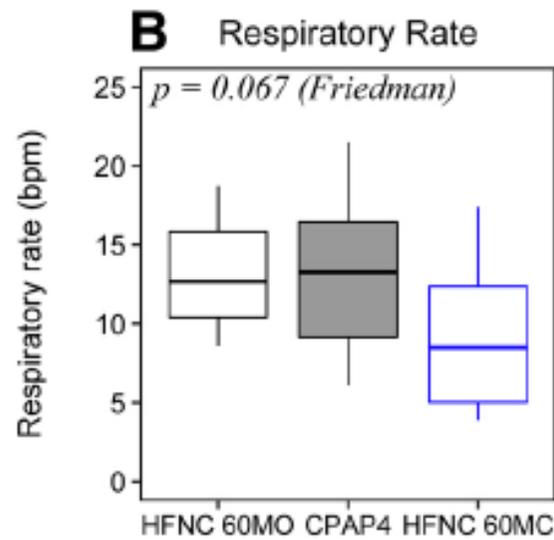
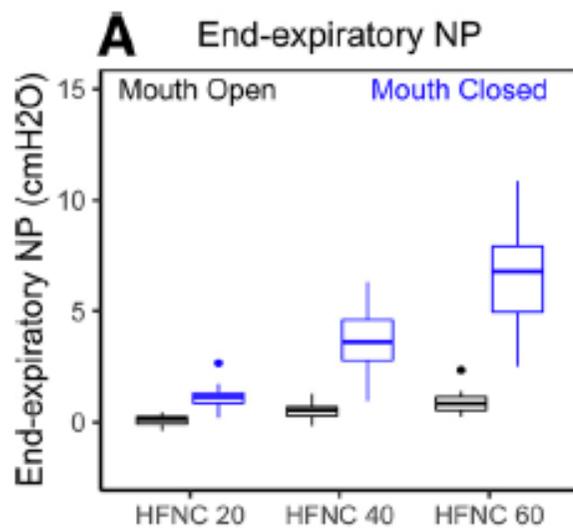
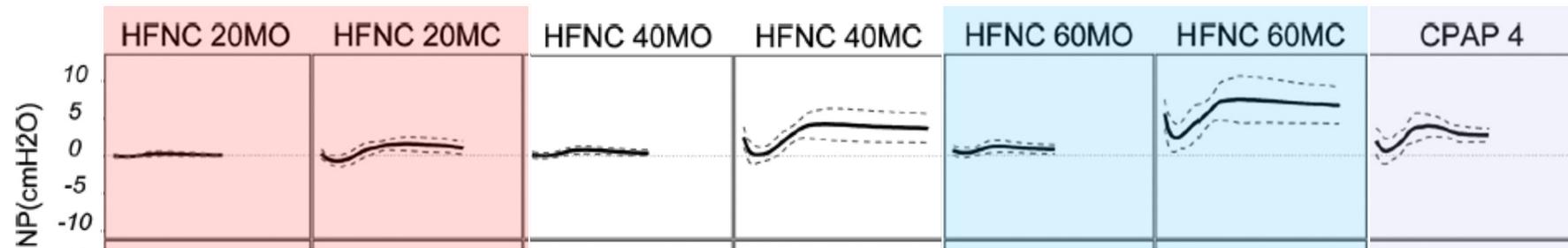
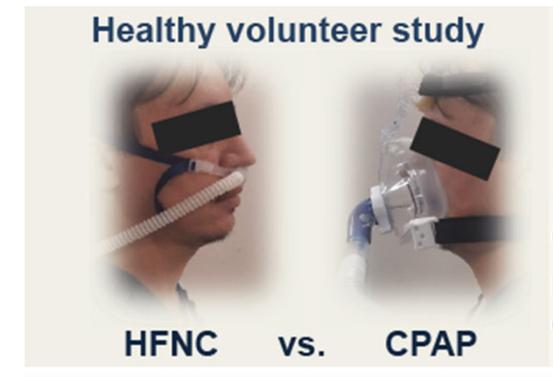
Room air dilutes oxygen
supplied by cannula

Oxygénation à haut débit

RESEARCH ARTICLE

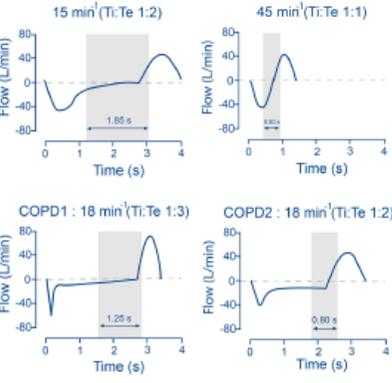
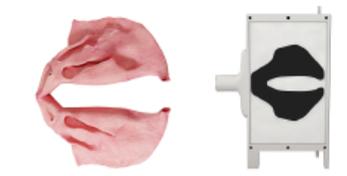
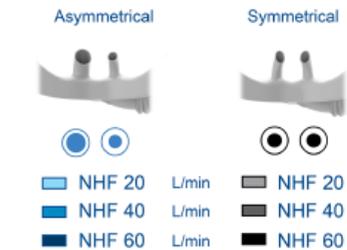
High-flow nasal cannula compared with continuous positive airway pressure: a bench and physiological study

© Fernando Vieira,^{1,2} Frank Silva Bezerra,^{1,2,4} Remi Coudroy,^{1,2,6,7} Annia Schreiber,^{1,2} Irene Telias,^{1,2,3} Sebastián Dubo,^{1,8} Giulia Cavalot,^{1,2,5} Sergio Martins Pereira,^{1,2,9,10} Thomas Piraino,^{1,2} and Laurent Jean Brochard^{1,2}

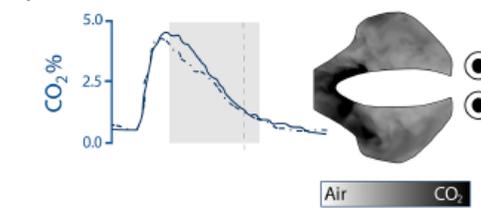
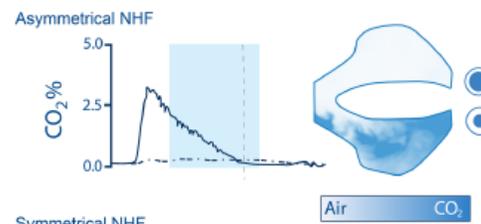
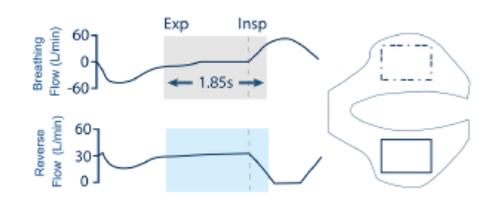
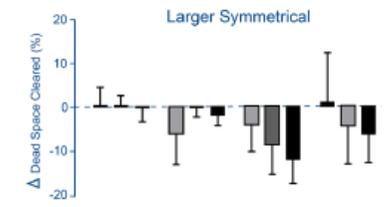
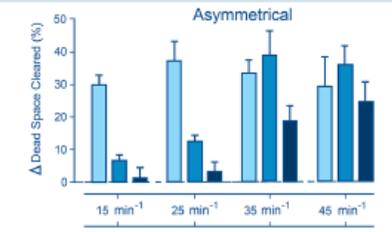
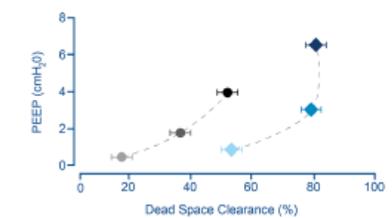


Asymmetrical nasal high flow ventilation improves clearance of CO₂ from the anatomical dead space and increases positive airway pressure

Methods



Results



Conclusion

Asymmetrical NHF increases dead space clearance by reverse flow through the choanae and accelerates purging of expired gas via the less occluded nare. Larger asymmetrical interface may increase airway pressure and reduce risk of a complete occlusion.

ROX Index

$$\text{ROX} = (\text{SpO}_2/\text{FIO}_2)/\text{respiratory rate}$$

Success : ROX \geq 4.88

Consider Intubation: < 3.85

SpO₂: 94%

FIO₂: 0.6

SpO₂/FIO₂: 157

Rate: 25

ROX: 6.27

SpO₂: 92%

FIO₂: 0.8

SpO₂/FIO₂: 115

Rate: 35

ROX: 3.29



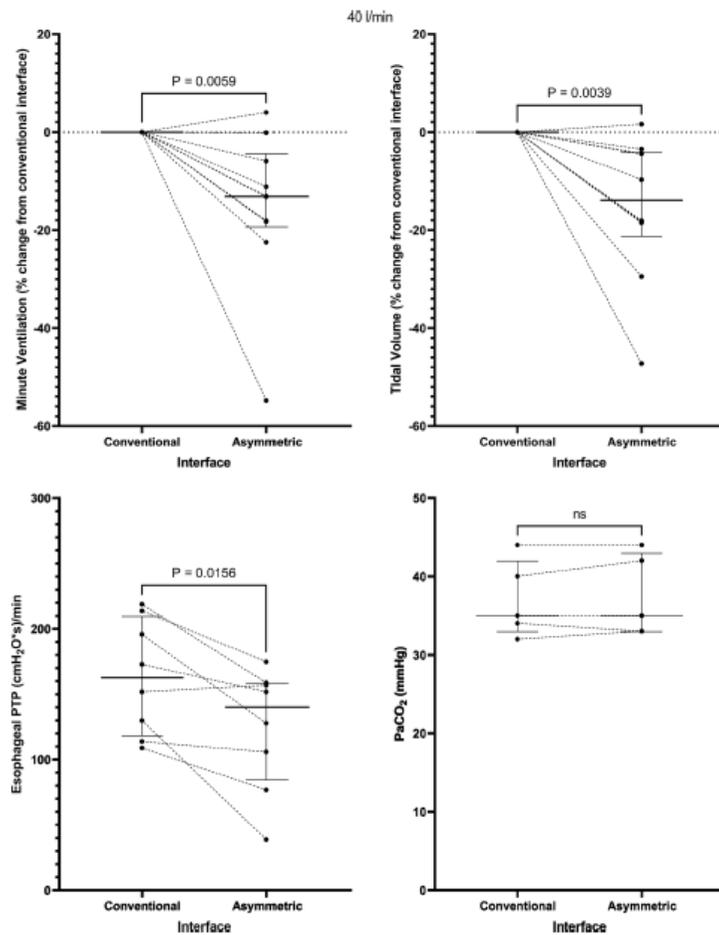
RESEARCH

Open Access

Effects of an asymmetrical high flow nasal cannula interface in hypoxemic patients



Douglas Slobod^{1,2}, Elena Spinelli¹, Stefania Crotti¹, Alfredo Lissoni¹, Alessandro Galazzi³, Giacomo Grasselli^{1,4} and Tommaso Mauri^{1,4*}



FLOW = 60 L/min to the patient
FiO2 = 100 %



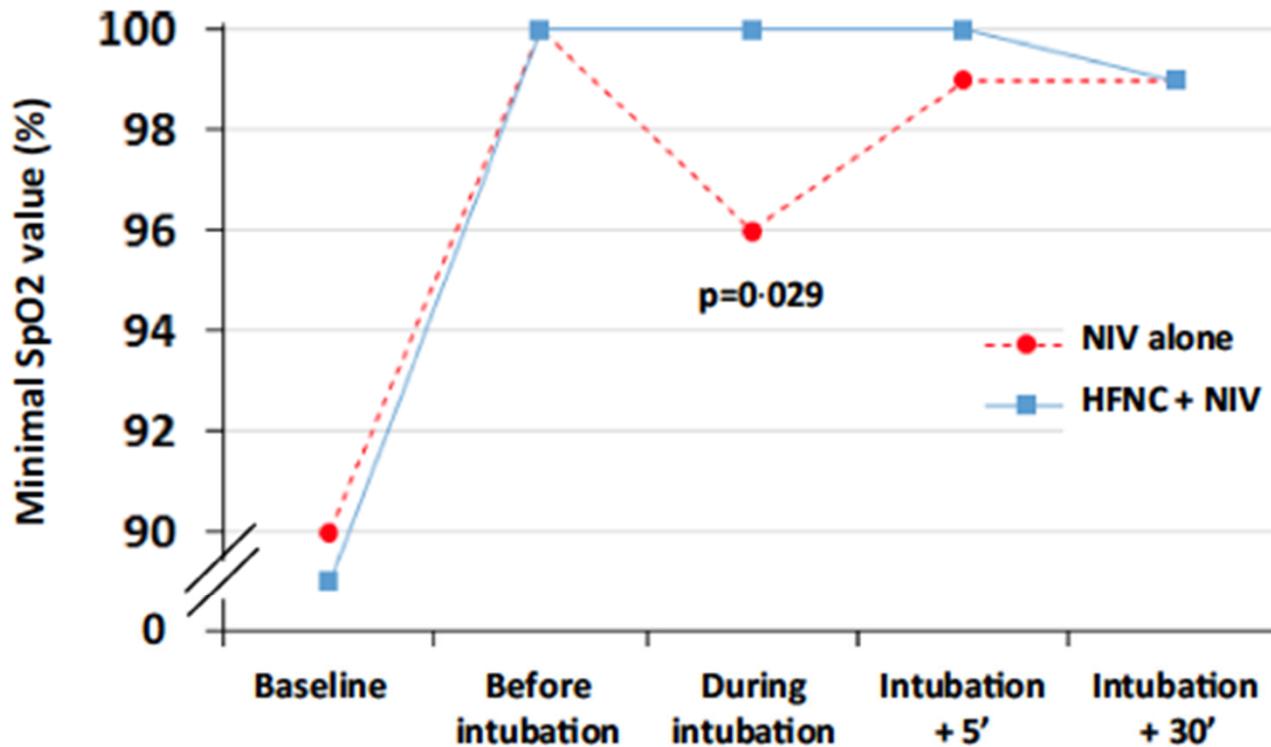
HFNC
device blur



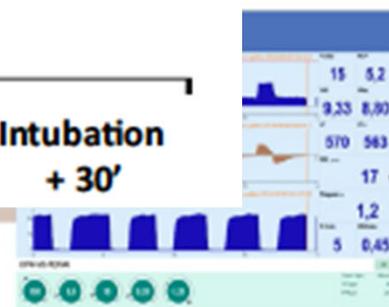
FLOW = 60 L/min to the
room atmosphere
FiO2 = 100 %

**A. Interventional group =
Real HFNC + NIV**
(patient received 4 min HFNC oxygen flow = 60 L/min)

PS = 10 cm H2O
PEEP = 5 cm H2O
FiO2=100%



NIV
screen/
ventilator



PS = 10 cm H2O
PEEP = 5 cm H2O
FiO2=100%

**B. Reference group =
Sham HFNC + NIV**
(patient received 4 min HFNC oxygen flow = 0 L/min)

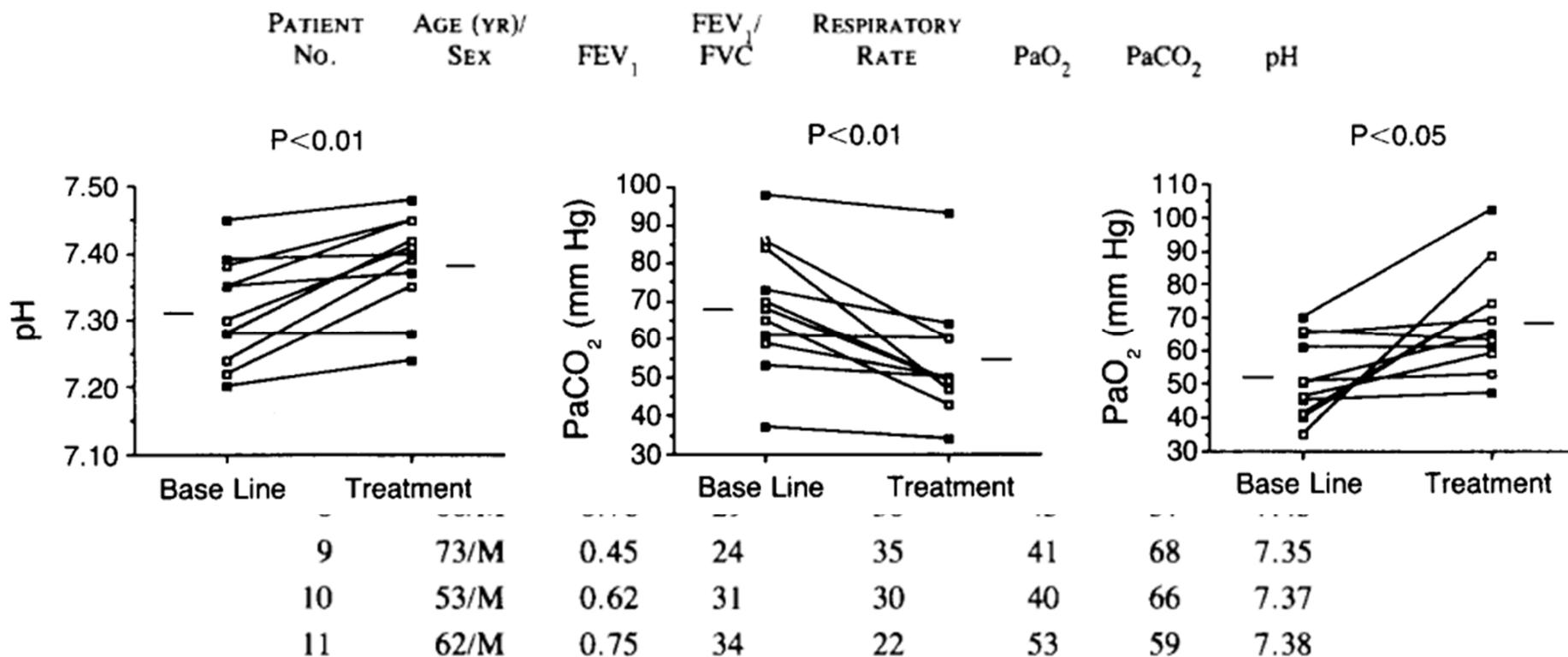
Eviter l'intubation et ses complications (PAVM)

- VNI curative du BPCO:
diminuer le W et l'acidose hypercapnique

Incidences des pneumonies			
	VI	VNI	p
Brochard, NEJM, 1995	7/42 17%	2/43 5%	0,009
Antonelli, NEJM, 1998	8/32 25%	1/32 3%	0,03
Nava, Ann Intern Med, 1998	7/25 28%	0/25 0%	0,01



Reversal of acute exacerbation of chronic obstructive lung disease by inspiratory assistance with a face mask



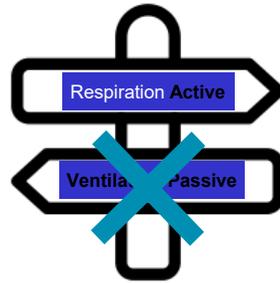


**Noninvasive ventilation for acute exacerbation of
chronic obstructive pulmonary disease.**

85 patients BPCO VNI : masque facial, Aide inspiratoire

La **VNI** permet de **réduire** :

- l' **intubation** de **74 à 26 %**
- la **durée de séjour** hospitalier
- les **complications** en réanimation de **48 à 16 %**
- la **mortalité** de **29 à 9 %**



Ventilation spontanée



LETTER TO THE EDITOR

Open Access

Spontaneous breathing, transpulmonary pressure and mathematical trickery



Lucia

LETTER TO THE EDITOR

Open Access

P-SILI is not justification for intubation of COVID-19 patients



Martin J

LETTER TO THE EDITOR

Open Access

COVID-19: scientific reasoning, pragmatism and emotional bias



Luciano

LETTER TO THE EDITOR

Open Access

P-SILI as justification for intubation in COVID-19: readers as arbiters



Martin J. Tobin*, Amal Jubran and Franco Laghi

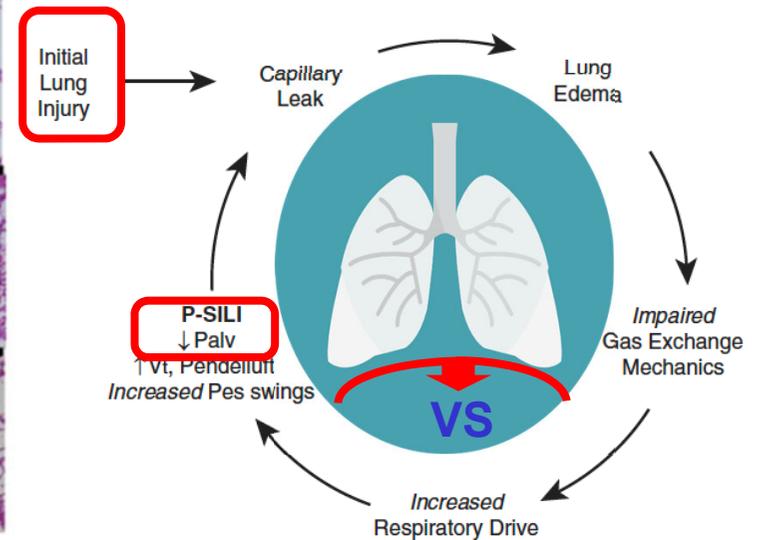
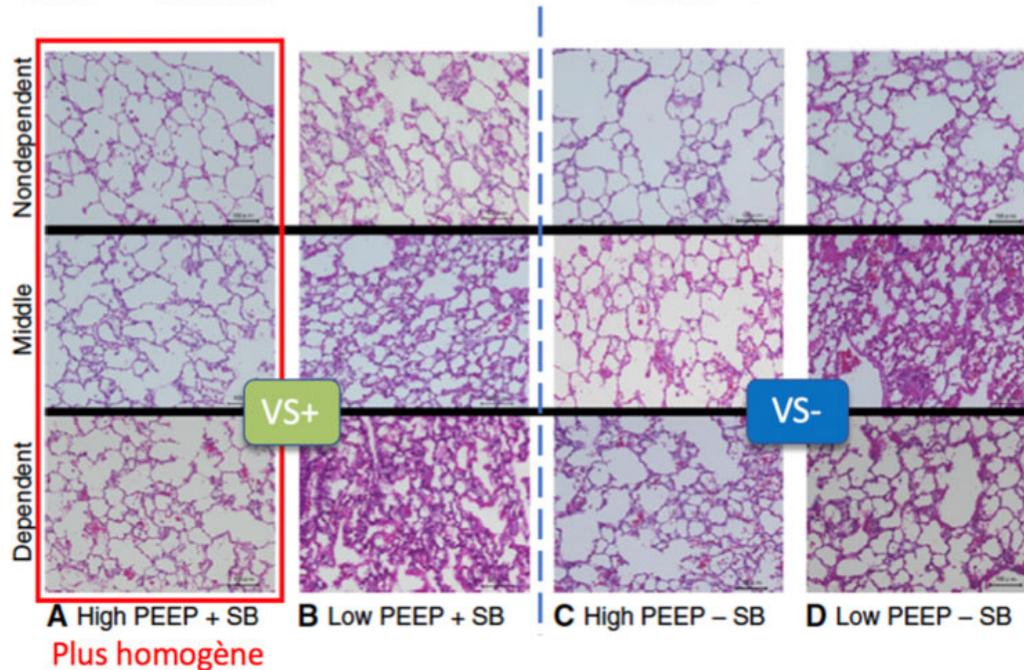
High Positive End-Expiratory Pressure Renders Spontaneous Effort Noninjurious

Caio C. A. Morais^{1*}, Yukiko Koyama^{2*}, Takeshi Yoshida^{2,3*}, Glaucio M. Plens¹, Susimeire Gomes¹, Cristhiano A. S. Lima¹, Ozires P. S. Ramos¹, Sérgio M. Pereira¹, Naomasa Kawaguchi⁴, Hirofumi Yamamoto⁴, Akinori Uchiyama², João B. Borges⁵, Marcos F. Vidal Melo⁶, Mauro R. Tucci¹, Marcelo B. P. Amato¹, Brian P. Kavanagh³, Eduardo L. V. Costa¹, and Yuji Fujino²

Am J Respir Crit Care Med Vol 197, Iss 10, pp 1285-1296, May 15, 2018

$$P_{alv} = PEEP + VT/Crs - P_{mus}$$

Palv plus negative si moins de PEEP et/ou si Pmus augmente



Grace à la PEEP, la VNI et la CPAP évitent une pression alvéolaire trop négative (PSiLi)

Effect of Helmet Noninvasive Ventilation vs High-Flow Nasal Oxygen on Days Free of Respiratory Support in Patients With COVID-19 and Moderate to Severe Hypoxemic Respiratory Failure

The HENIVOT Randomized Clinical Trial

Domenico Luca Grieco, MD; Luca S. Menga, MD; Melania Cesarano, MD; Tommaso Rosà, MD; Savino Spadaro, MD, PhD; Maria Maddalena Bitondo, MD; Jonathan Montomoli, MD, PhD; Giulia Falò, MD; Tommaso Tonetti, MD; Salvatore L. Cutuli, MD; Gabriele Pintaudi, MD; Eloisa S. Tanzarella, MD; Edoardo Piervincenzi, MD; Filippo Bongiovanni, MD; Antonio M. Dell'Anna, MD; Luca Delle Cese, MD; Cecilia Berardi, MD; Simone Carelli, MD; Maria Grazia Bocci, MD; Luca Montini, MD; Giuseppe Bello, MD; Daniele Natalini, MD; Gennaro De Pascale, MD; Matteo Velardo, PhD; Carlo Alberto Volta, MD; V. Marco Ranieri, MD; Giorgio Conti, MD; Salvatore Maurizio Maggiore, MD, PhD; Massimo Antonelli, MD; for the COVID-ICU Gemelli Study Group



POPULATION

88 Men
21 Women

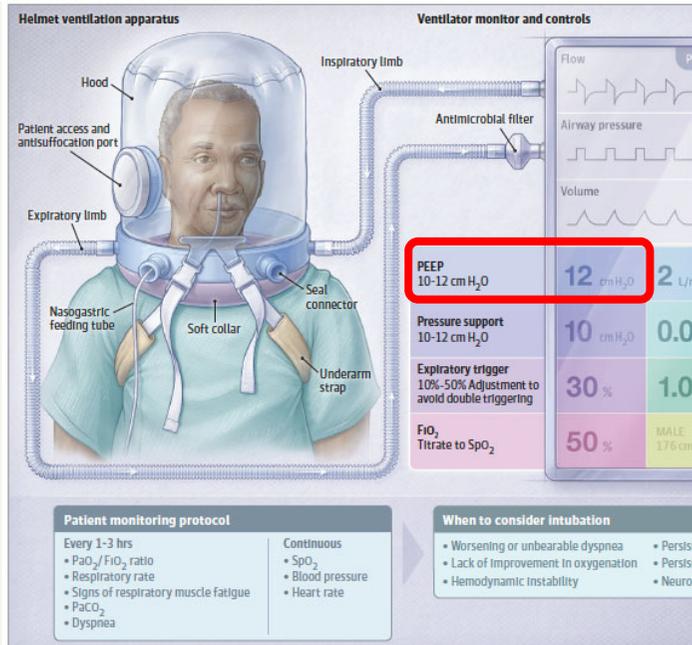


Adults in the intensive care unit with COVID-19 and moderate to severe hypoxemic respiratory failure

Median age: 65 years

LOCATIONS

4 ICUs in Italy



FINDINGS

Median respiratory support-free days



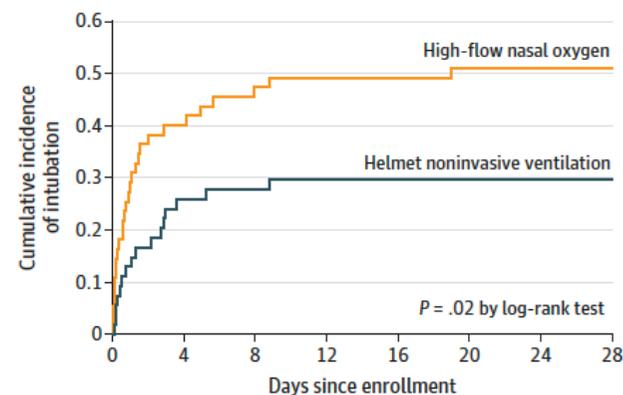
Mean between-group difference was not statistically significant:

2 days (95% CI, -2 to 6)

Effect of Helmet Noninvasive Ventilation vs High-Flow Nasal Oxygen on Days Free of Respiratory Support in Patients With COVID-19 and Moderate to Severe Hypoxemic Respiratory Failure

The HENIVOT Randomized Clinical Trial

Domenico Luca Grieco, MD; Luca S. Menga, MD; Melania Cesarano, MD; Tommaso Rosà, MD; Savino Spadaro, MD, PhD; Maria Maddalena Biton; Jonathan Montomoli, MD, PhD; Giulia Falò, MD; Tommaso Tonetti, MD; Salvatore L. Cutuli, MD; Gabriele Pintaudi, MD; Eloisa S. Tanzarella, MD; Edoardo Piervincenzi, MD; Filippo Bongiovanni, MD; Antonio M. Dell'Anna, MD; Luca Delle Cese, MD; Cecilia Berardi, MD; Simone Carelli, MD; Maria Grazia Bocci, MD; Luca Montini, MD; Giuseppe Bello, MD; Daniele Natalini, MD; Gennaro De Pascale, MD; Matteo Velardo, PhD; Carlo Alberto Volta, MD; V. Marco Ranieri, MD; Giorgio Conti, MD; Salvatore Maurizio Maggiore, MD, PhD; Massimo Antonelli, MD; for the COVID-ICU Gemelli Study Group



Outcome	No. (%)		Absolute or mean difference (95% CI) ^b	Odds ratio (95% CI)	P value ^c
	Helmet noninvasive ventilation (n = 54) ^a	High-flow nasal oxygen (n = 55) ^a			
Secondary outcomes					
Intubation within 28 d from enrollment	16 (30)	28 (51)	-21 (-38 to -3)	0.41 (0.18 to 0.89)	.03
Intubation within 28 d from enrollment, after adjudication of intubation criteria by external experts	15 (28)	28 (51)	-23 (-39 to -5)	0.37 (0.17 to 0.82)	.02
Causes of endotracheal intubation					
Hypoxemia ^f	15 (28)	27 (49)	-21 (-38 to -3)	0.40 (0.18 to 0.88)	.03
Signs of respiratory muscles fatigue	13 (24)	24 (44)	-20 (-36 to -2)	0.41 (0.18 to 0.93)	.04
Intolerance to treatment	11 (20)	5 (9)	11 (-2 to 25)	2.56 (0.82 to 7.94)	.11
Worsening or unbearable dyspnea	9 (17)	25 (45)	-29 (-44 to -11)	0.24 (0.10 to 0.59)	.002
SpO ₂ <90% for >5 min ^g	9 (17)	23 (42)	-25 (-40 to -8)	0.28 (0.11 to 0.68)	.006

Plus de PEEP avec la casque
moins d'hypoxémies et moins d'intubations

Effect of Noninvasive Ventilation Delivered by Helmet vs Face Mask on the Rate of Endotracheal Intubation in Patients With Acute Respiratory Distress Syndrome A Randomized Clinical Trial

Bhakti K. Patel, MD; Krysta S. Wolfe, MD; Anne S. Pohlman, MSN; Jesse B. Hall, MD; John P. Kress, MD

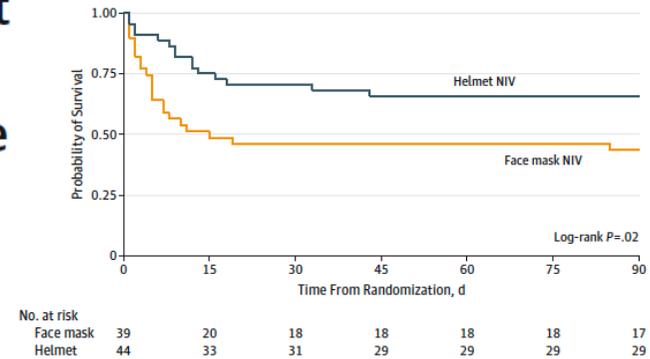


Table 2. Primary and Secondary Outcomes and Adverse Events

	Face Mask (n = 39)	Helmet (n = 44)	Absolute Difference (95% CI)	P Value
Primary outcome, No. (%)				
Endotracheal intubation	24 (61.5)	8 (18.2)	-43.3 (-62.4 to -24.3)	<.001
Reason for intubation				
Respiratory failure	20 (83.3)	3 (37.5)	-45.3 (-82.5 to -9.1)	.01
Circulatory failure	3 (12.5)	0 (0)	-12.5 (-25.7 to 0.7)	.55
Neurologic failure	1 (4.2)	5 (62.5)	58.3 (24.8 to 92.8)	.001
Secondary outcomes, median (IQR), d				
Ventilator-free days	12.5 (0.49-28)	28 (13.7-28)	8.4 (13.4 to 3.4)	<.001
ICU length of stay	7.8 (3.9-13.8)	4.7 (2.5-8.7)	-2.76 (-6.07 to 0.54)	.04
Hospital length of stay	15.2 (7.8-19.7)	10.1 (6.5-15.9)	-2.92 (-8.47 to 2.63)	.16
Mortality, No. (%)				
Hospital	19 (48.7)	12 (27.3)	-21.4 (-41.9 to -1.0)	.04
90 d ^a	22 (56.4)	15 (34.1)	-22.3 (-43.3 to -1.4)	.02
Adverse events				
Mask deflation	0 (0)	2 (4.5)		
Skin ulceration	3 (7.6)	3 (6.8)		

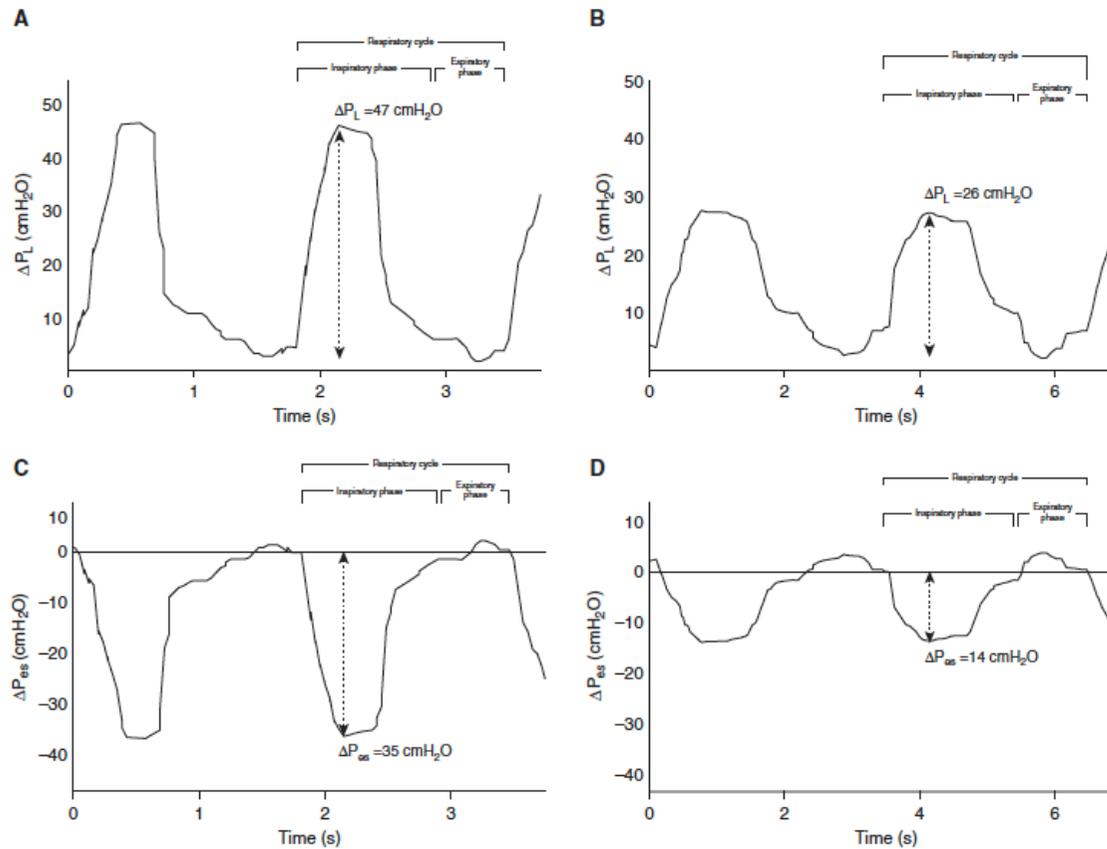
	Noninvasive Ventilation, Median (IQR)		P Value
	Face Mask (n = 39)	Helmet (n = 44)	
Respiratory support with NIV ^a			
Duration of NIV, h	26.4 (7.0-60.0)	19.8 (8.4-45.6)	.68
PEEP, cm H ₂ O	5.1 (5.0-8.0)	8 (5.0-10.0)	.006
Pressure support, cm H ₂ O	11.2 (10.0-14.5)	8 (5.6-10.0)	<.001
FiO ₂ , %	60 (50.0-68.6)	50 (40.0-60.0)	.02
SpO ₂ , %	95.3 (92.3-96.7)	96.2 (94.8-98.4)	.13
Respiratory rate, breaths/min			
Baseline	28.3 (22.1-34.4) ^b	27.7 (21.5-34.6) ^b	
After randomization	29.1 (22.1-37.6)	24.5 (20.4-30.5)	

Plus de PEEP avec la casque évitent une pression alvéolaire trop négative (PSiLi)

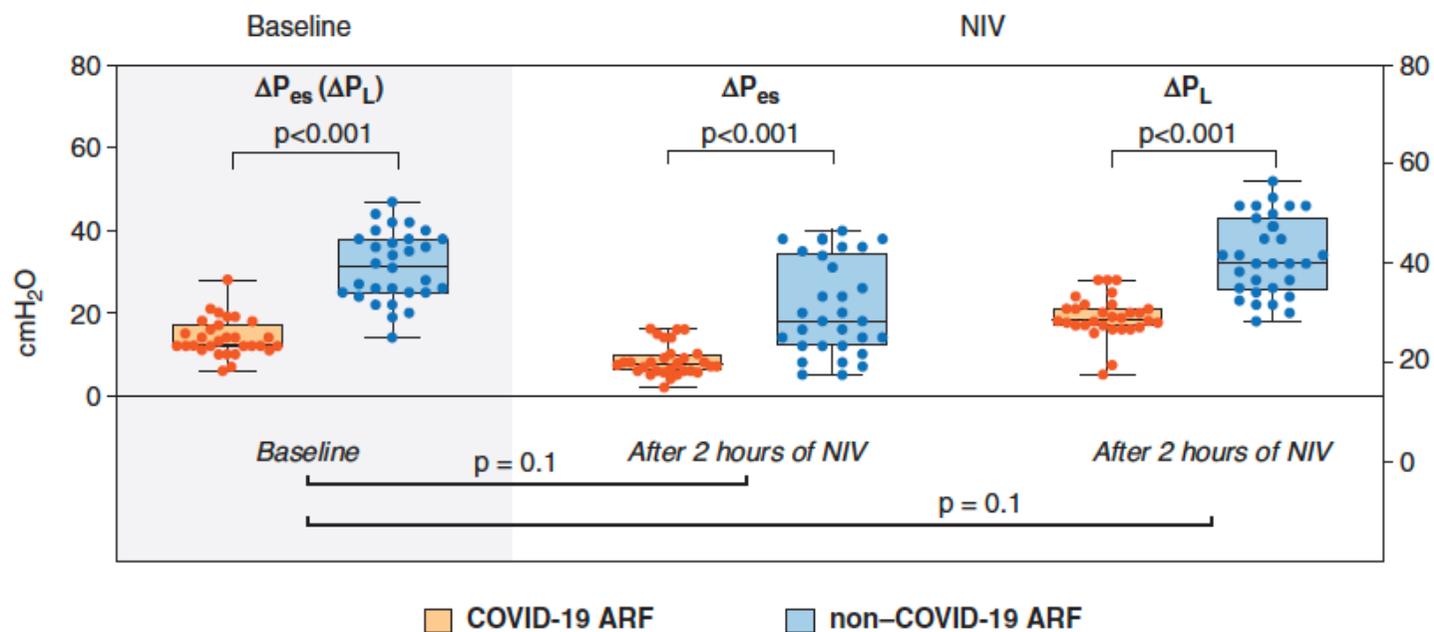
Early Inspiratory Effort Assessment by Esophageal Manometry Predicts Noninvasive Ventilation Outcome in *De Novo* Respiratory Failure

A Pilot Study

Roberto Tonelli^{1,2}, Riccardo Fantini¹, Luca Tabbi¹, Ivana Castaniere^{1,2}, Lara Pisani³, Maria Rosaria Pellegrino¹, Giovanni Della Casa⁴, Roberto D'Amico⁵, Massimo Girardis⁶, Stefano Nava³, Enrico M. Clini¹, and Alessandro Marchioni¹



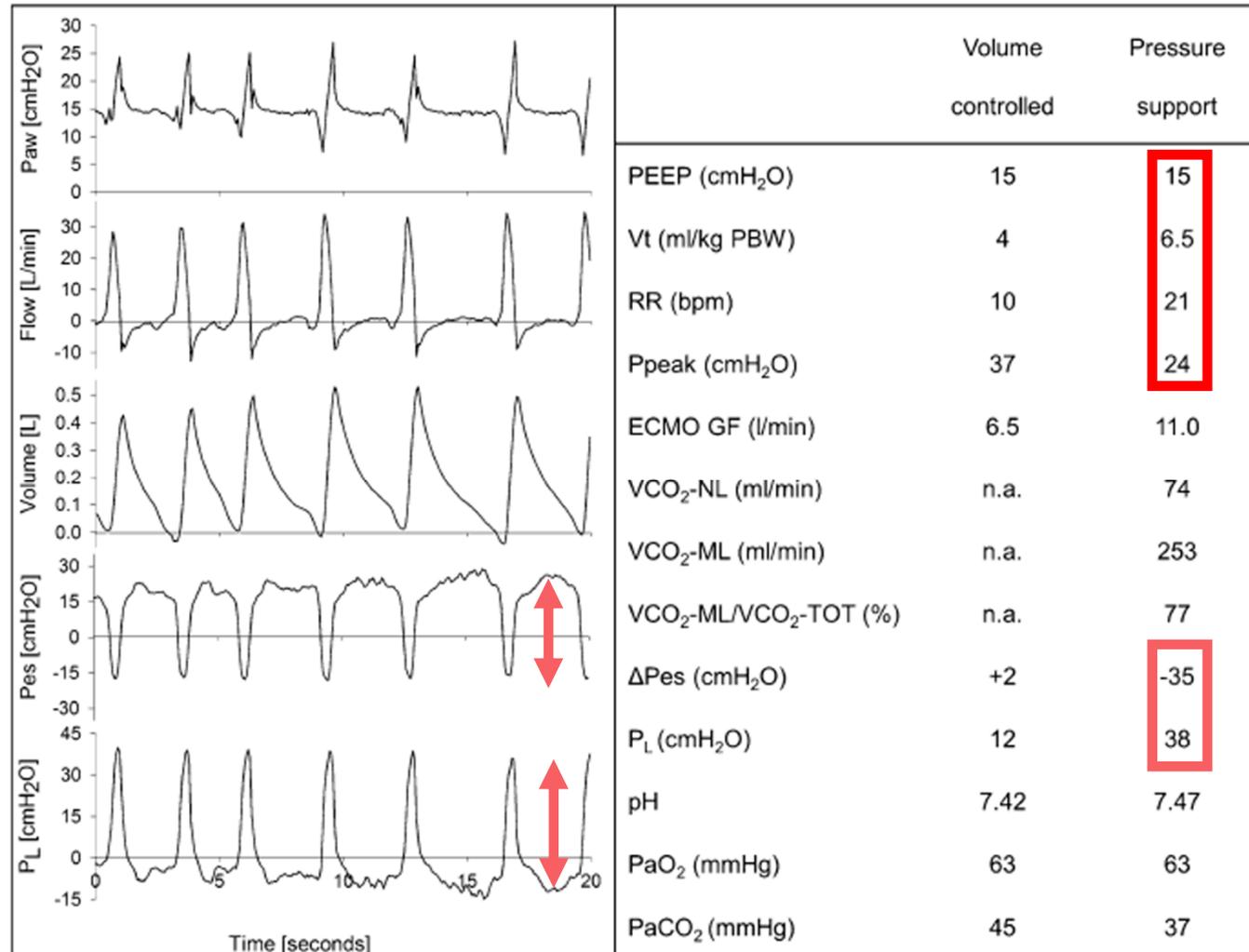
Inspiratory Effort and Lung Mechanics in Spontaneously Breathing Patients with Acute Respiratory Failure due to COVID-19: A Matched Control Study



Extremely high transpulmonary pressure in a spontaneously breathing patient with early severe ARDS on ECMO



Tommaso Mauri¹, Thomas Langer², Alberto Zanella¹, Giacomo Grasselli¹ and Antonio Pesenti^{1,2*}

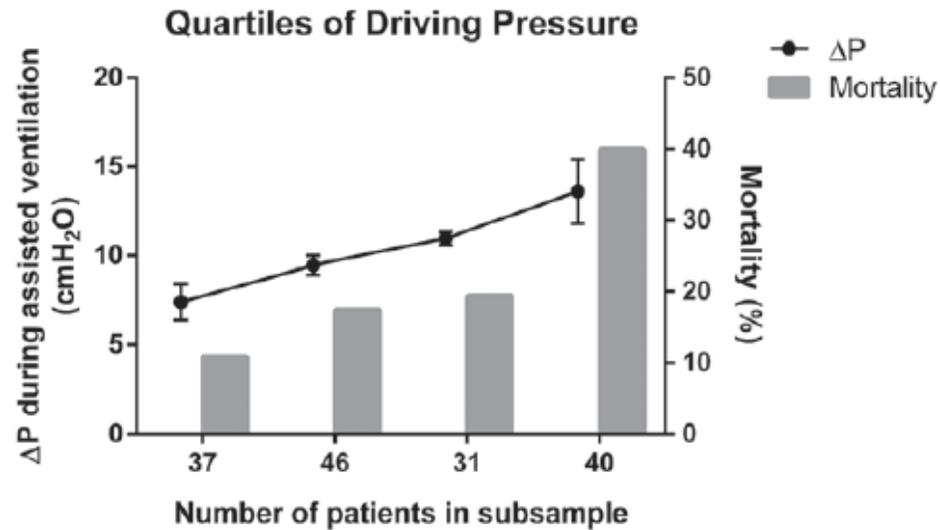
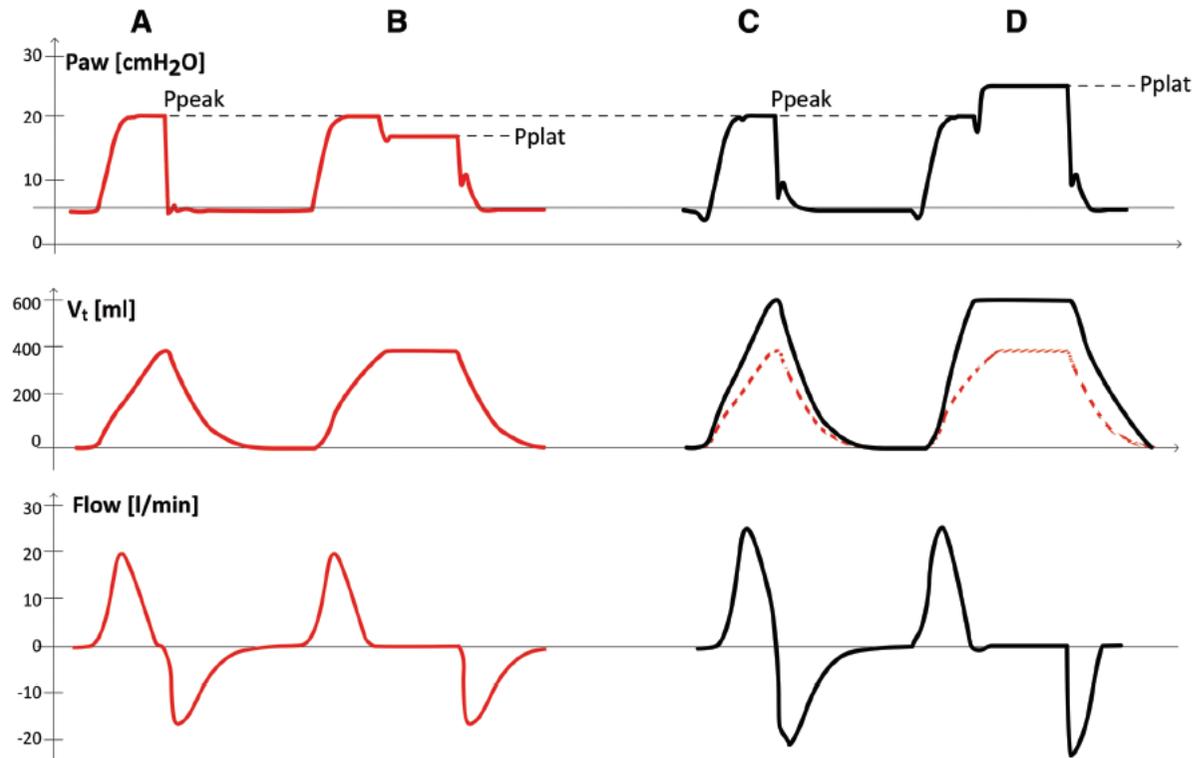
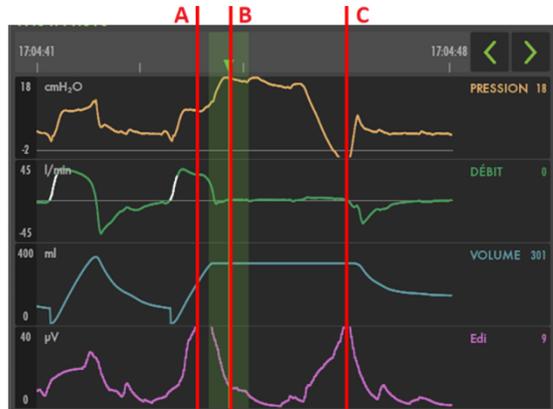


**Aide
à 9 cmH₂O**

Driving Pressure Is Associated with Outcome during Assisted Ventilation in Acute Respiratory Distress Syndrome

Giacomo Bellani, M.D., Ph.D., Alice Grassi, M.D., Simone Sosio, M.D., Stefano Gatti, M.D., Brian P. Kavanagh, M.B., Antonio Pesenti, M.D., Giuseppe Foti, M.D.

ANESTHESIOLOGY 2019; 131:594–604



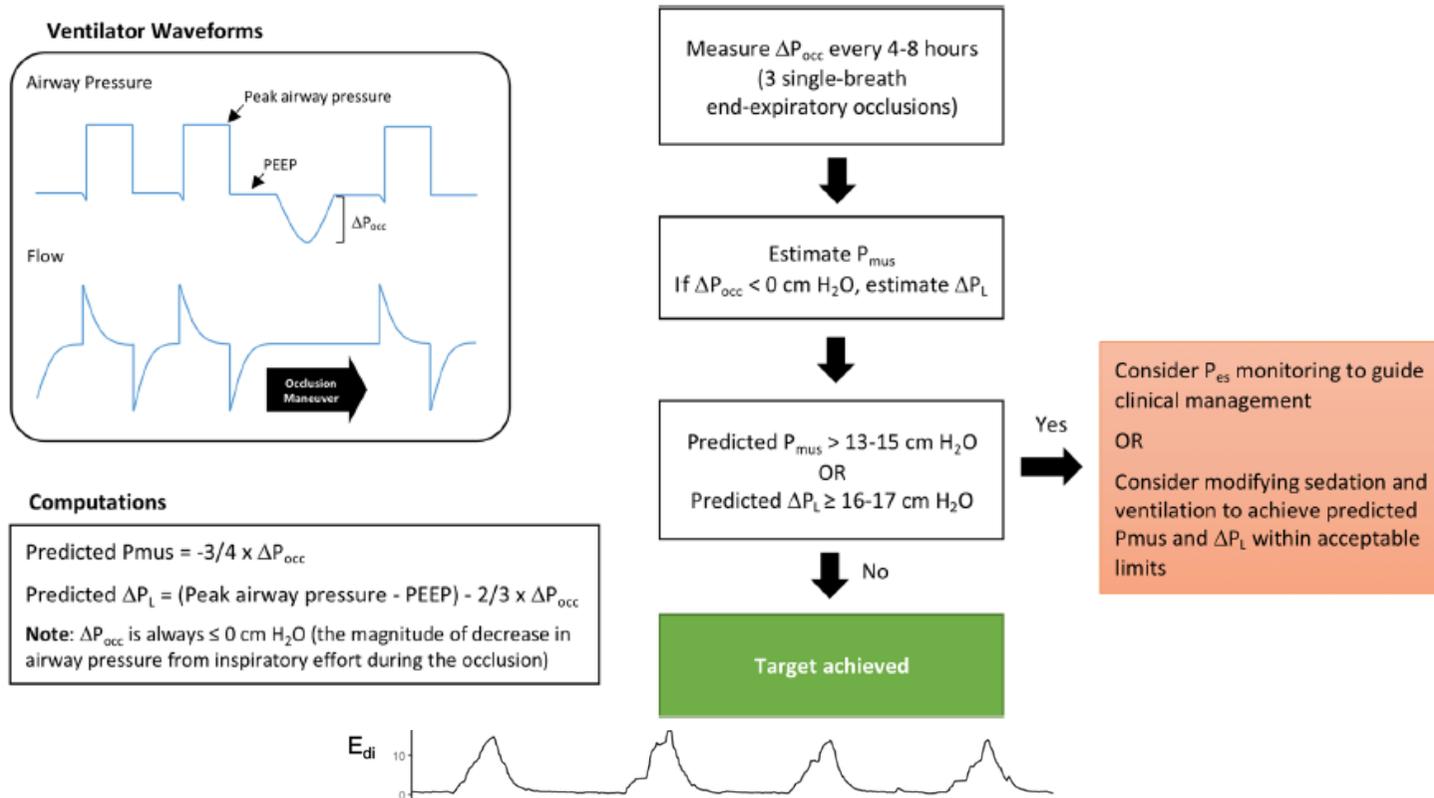
RESEARCH

Open Access



A novel non-invasive method to detect excessively high respiratory effort and dynamic transpulmonary driving pressure during mechanical ventilation

Michele Bertoni^{1,2}, Irene Talias^{3,4}, Martin Umer^{3,5}, Michael Long⁶, Lorenzo Del Sorbo^{3,5}, Eddy Fan^{3,5,7}, Christer Sinderby^{3,4}, Jennifer Beck^{3,4}, Ling Liu⁸, Haibo Qiu⁸, Jenna Wong⁵, Arthur S. Slutsky^{3,4}, Niall D. Ferguson^{3,5,7,9,10}, Laurent J. Brochard^{3,4} and Ewan C. Goligher^{3,5,10,11*}

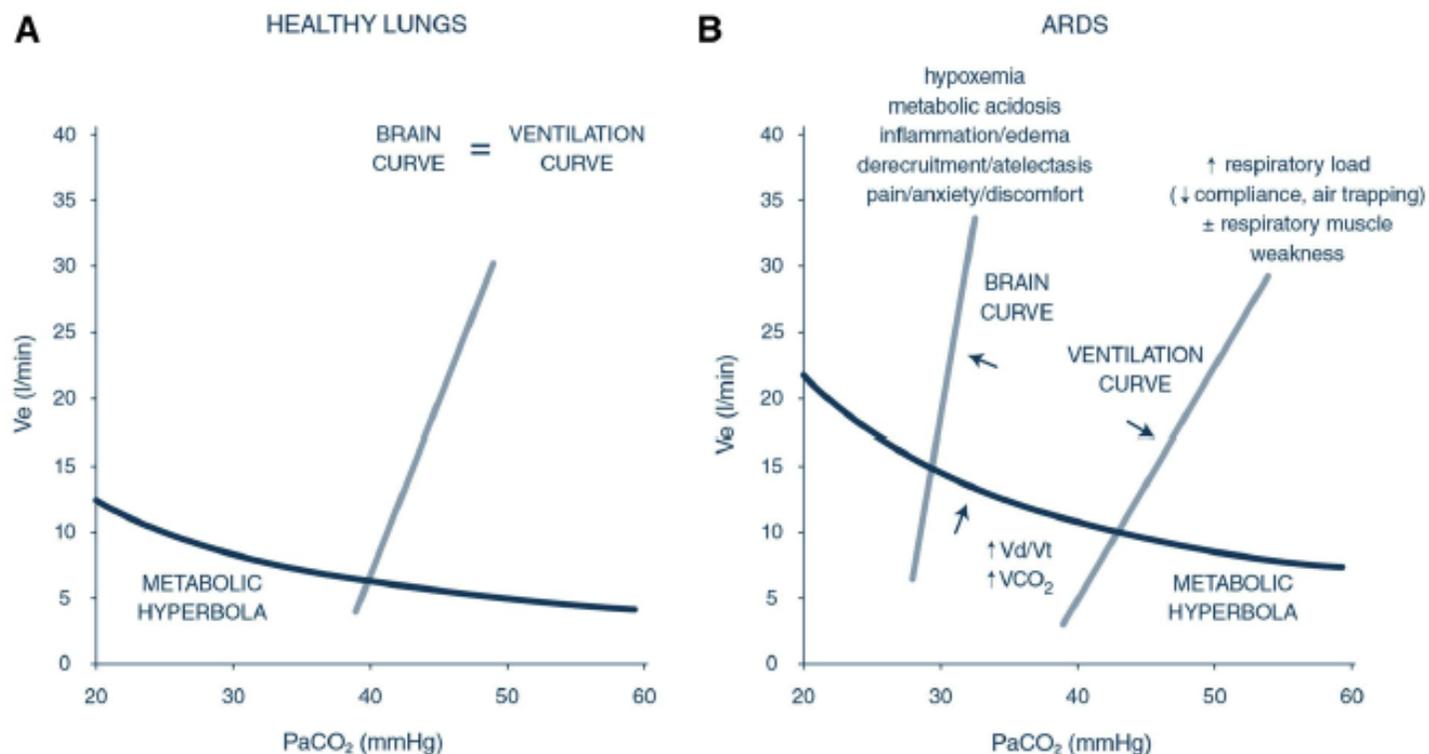


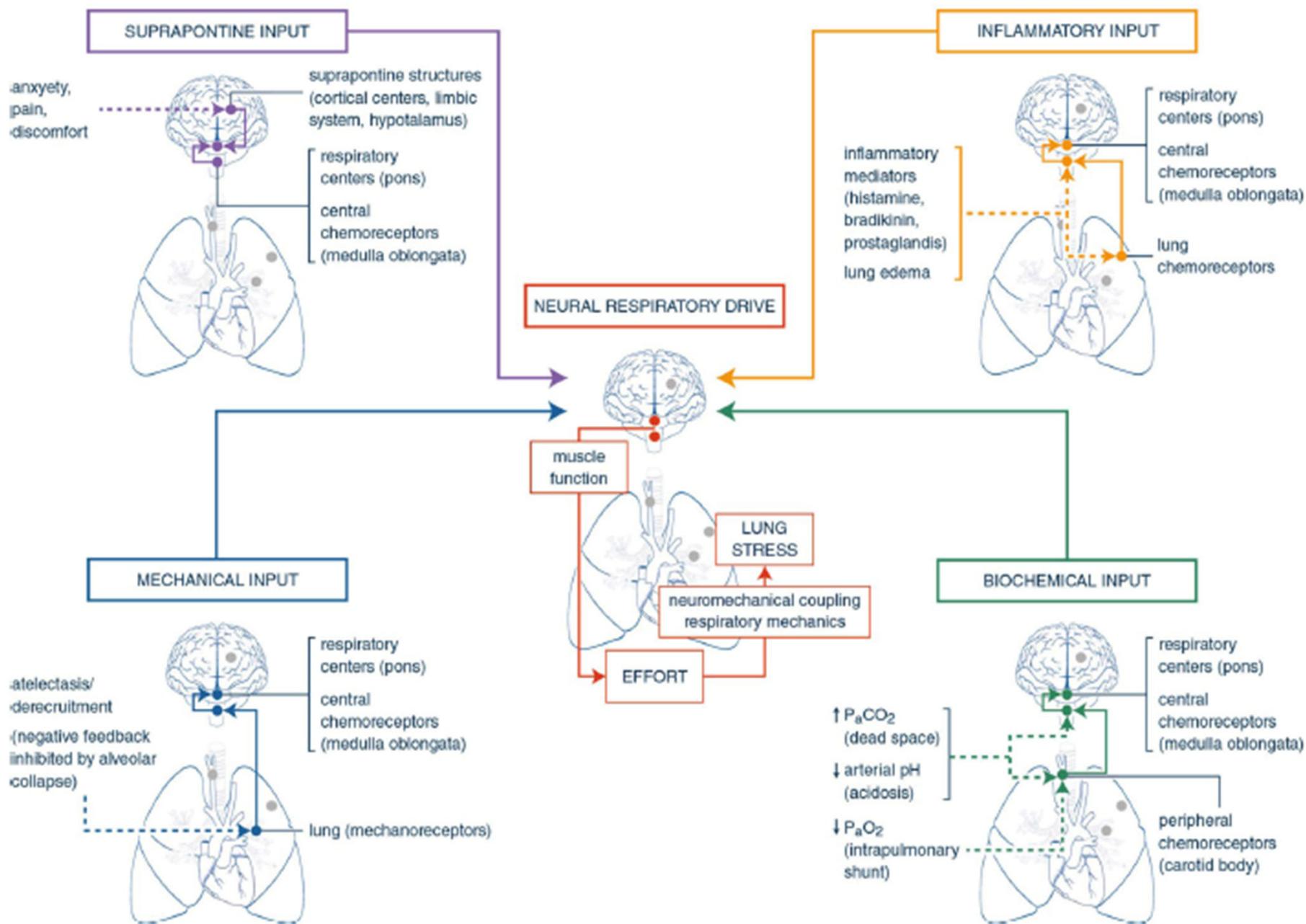
NARRATIVE REVIEW

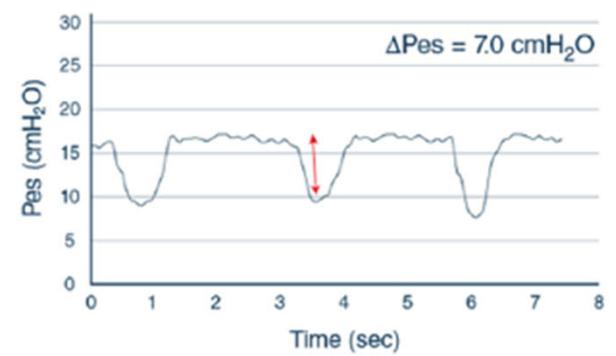
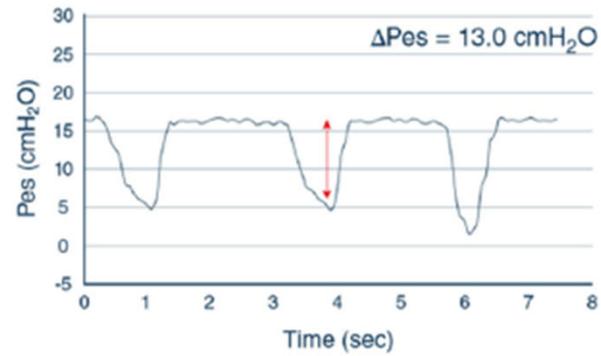
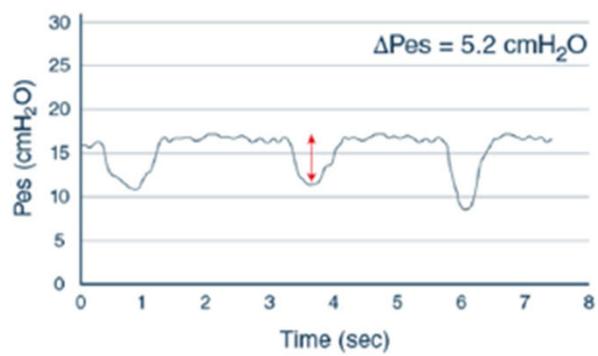
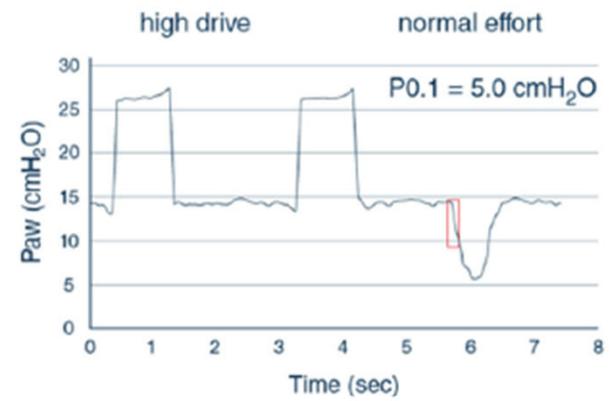
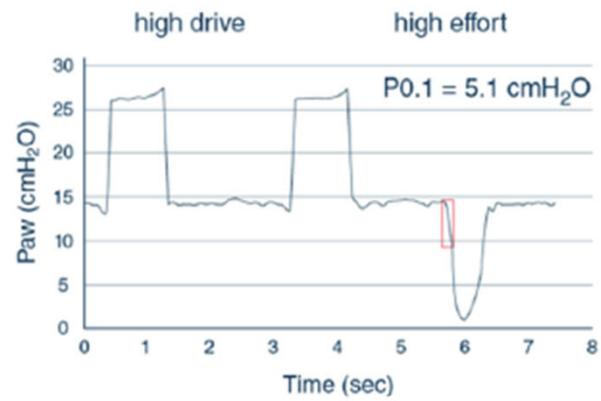
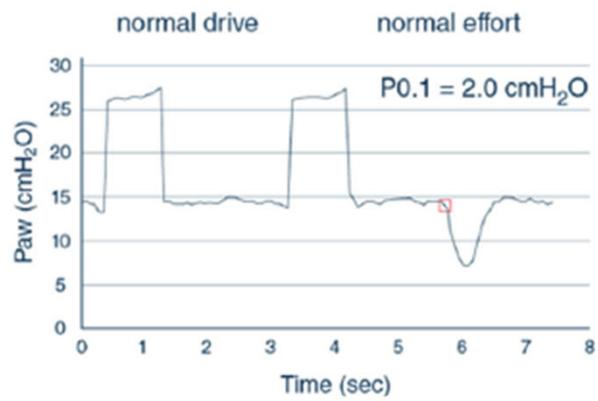
Respiratory drive in the acute respiratory distress syndrome: pathophysiology, monitoring, and therapeutic interventions



Elena Spinelli¹, Tommaso Mauri^{1,2*}, Jeremy R. Beitler³, Antonio Pesenti^{1,2} and Daniel Brodie³



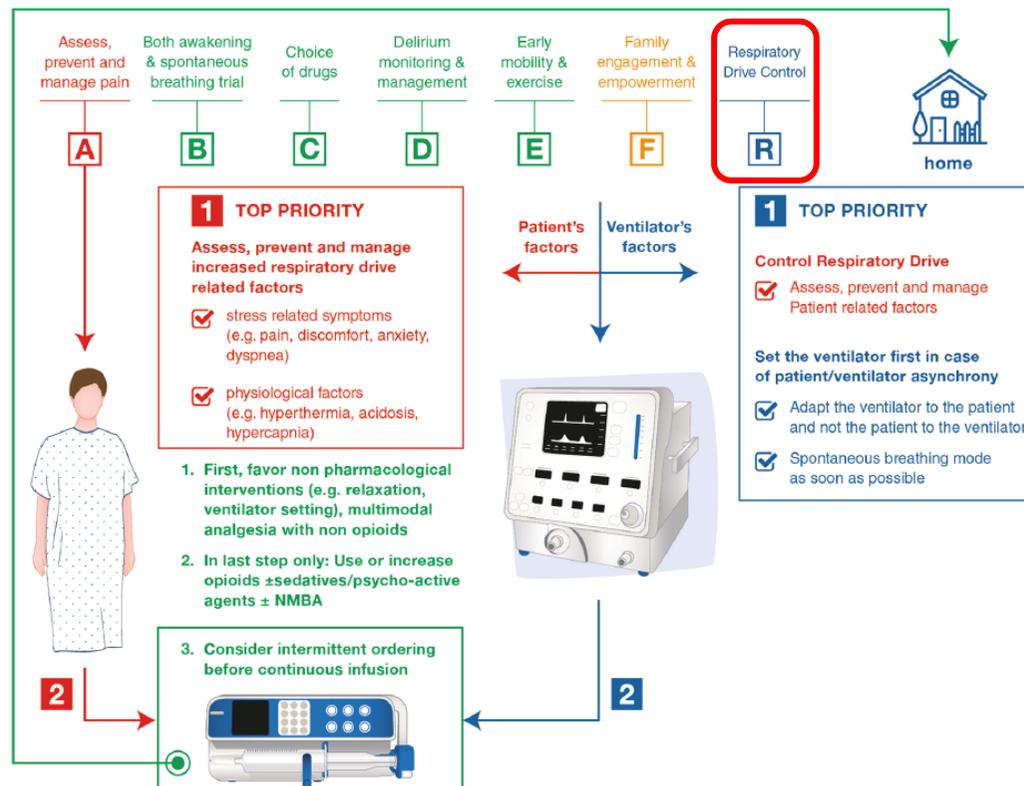




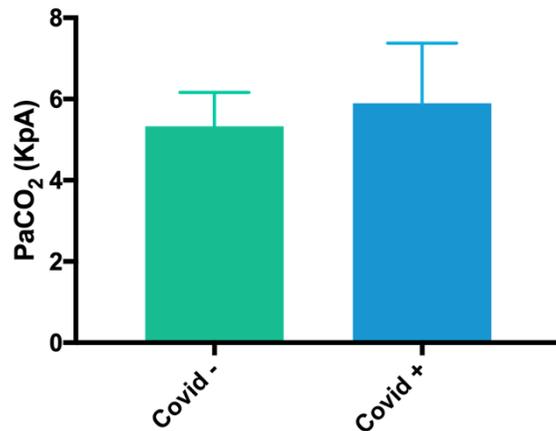
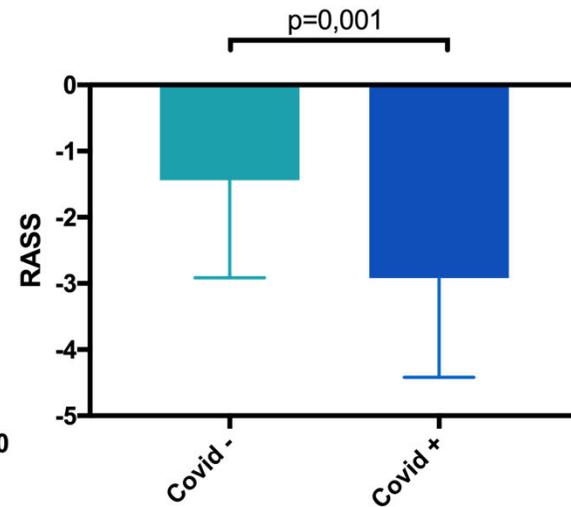
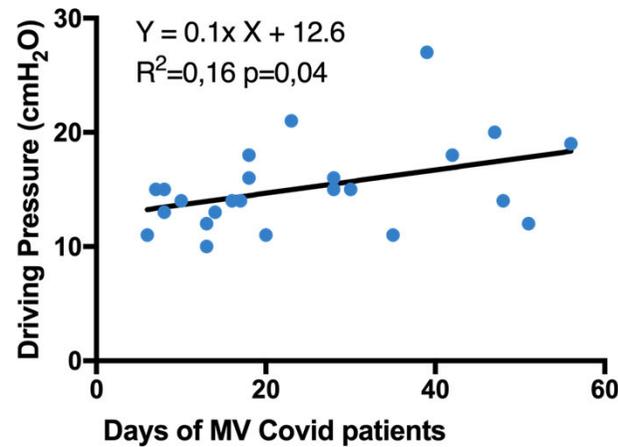
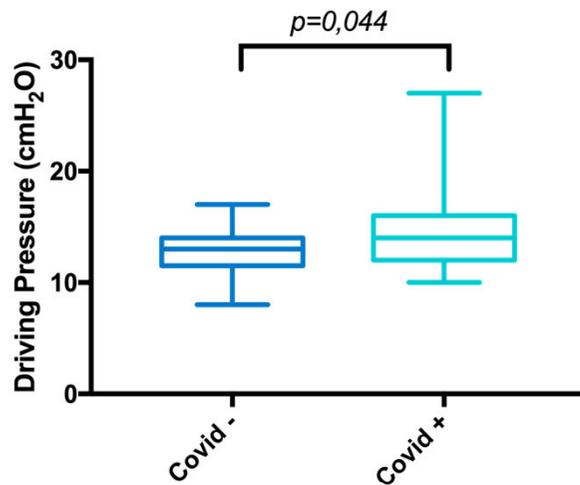


Analgesia and sedation in patients with ARDS

Gerald Chanques^{1,2*}, Jean-Michel Constantin³, John W. Devlin^{4,5}, E. Wesley Ely^{6,7,8}, Gilles L. Fraser⁹, Céline Gélinas¹⁰, Timothy D. Girard¹¹, Claude Guérin^{12,13}, Matthieu Jabaudon^{14,15}, Samir Jaber^{1,2}, Sangeeta Mehta¹⁶, Thomas Langer^{17,18}, Michael J. Murray¹⁹, Pratik Pandharipande²⁰, Bhakti Patel²¹, Jean-François Payen²², Kathleen Puntillo²³, Bram Rochweg²⁴, Yahya Shehabi^{25,26}, Thomas Strøm^{27,28}, Hanne Tanghus Olsen²⁷ and John P. Kress²¹



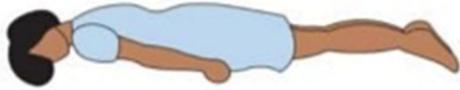
Driving Pressure en VSAI



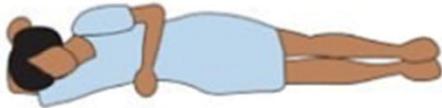
DV en VS sous HNF ou VNI



1. 30 minutes – 2 hours: laying on your belly
1. 30 minutos – 2 horas: acostado sobre su estómago (boca abajo)



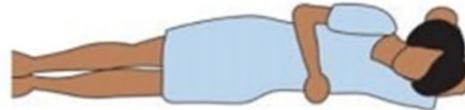
2. 30 minutes – 2 hours: laying on your right side
2. 30 minutos – 2 horas: acostado sobre su lado derecho



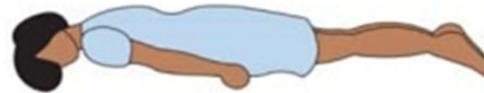
3. 30 minutes – 2 hours: sitting up
3. 30 minutos – 2 horas: sentado



4. 30 minutes – 2 hours: lying on your left side
4. 30 minutos – 2 horas: acostado sobre su lado izquierdo



Then back to Position 1. Lying on your belly!
Luego, vuelva a la posición 1. ¡Acostado sobre su estómago (boca abajo)!



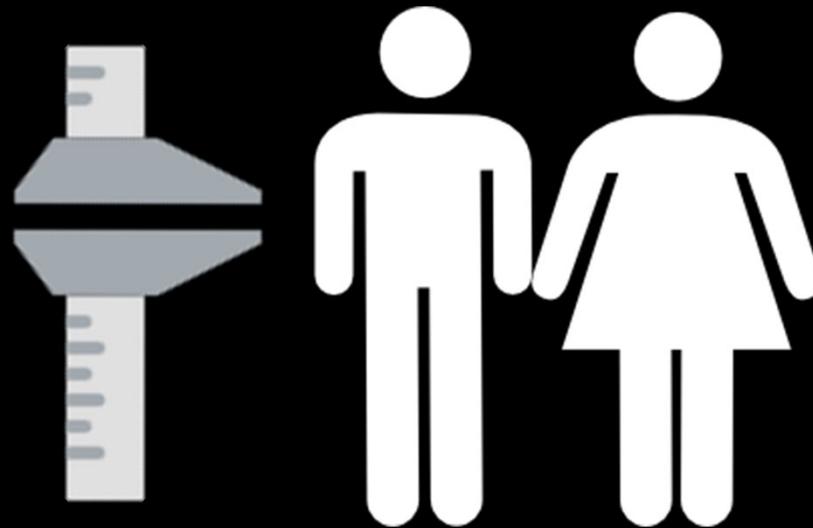




Equation du mouvement du poumon :

Le volume courant

- V_T entre 6 et 8 ml.kg⁻¹ Poids Prédit



Taille et sexe

2 morphotypes avec les mêmes poumons



2 hommes de même taille

Ventilation avec le mode VSAI

SimVA
Ventilation Artificielle Virtuelle

