TURIN, 20TH—21ST NOVEMBER 2008

GREAT INNOVATIONS IN CARDIOLOGY

4TH JOINT MEETING WITH MAYO CLINIC

4TH TURIN CARDIOVASCULAR NURSING CONVENTION

SESSION II:

PERSPECTIVES IN ISCHEMIC HEART DISEASE (PART II)

R. Hubmayr (Rochester—MN—USA)

Lecture

Management of the critically ill cardiac patient:
a Critical Care Specialist's perspective

Management of the Critically Ill Cardiac Patient:

An Intensivist's Perspective

Rolf D Hubmayr, MD

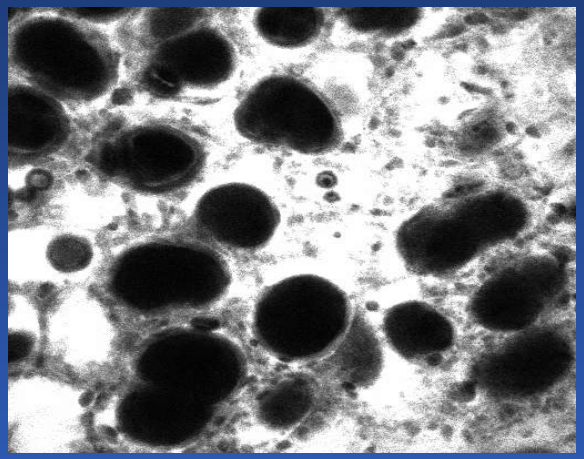
Mayo Clinic College of Medicine

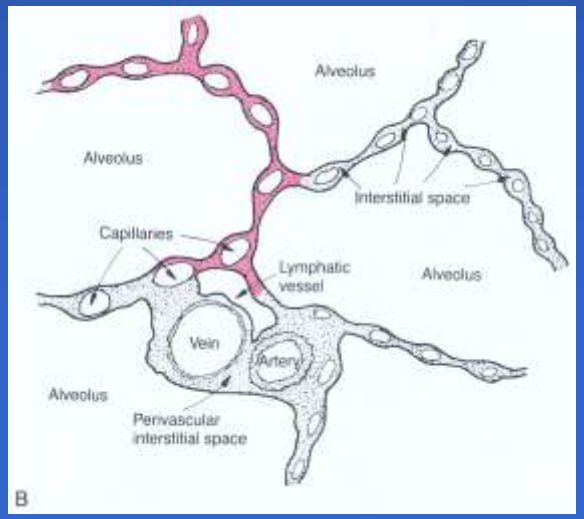
http://mayoresearch.mayo.edu/mayo/research/hubmayr/index.cfm

Ventilator-Induced Lung Injury

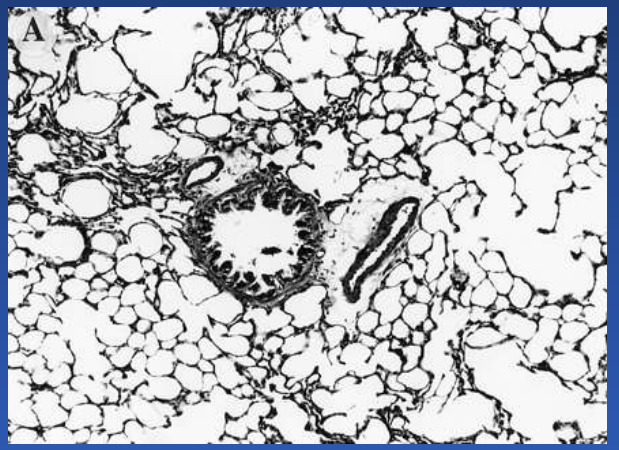
The Real Culprit ?

Effects of CPAP on the distribution of lung water

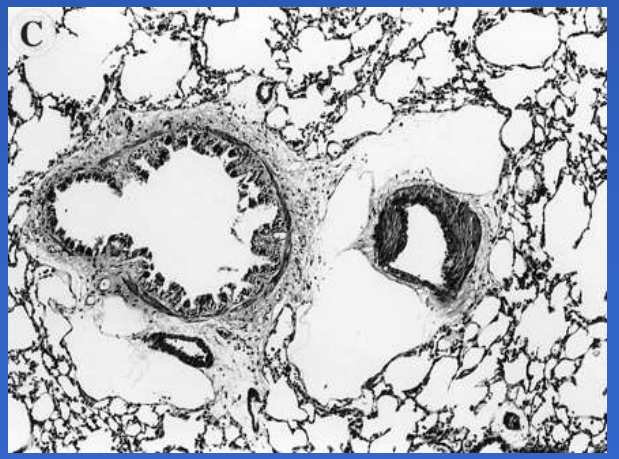




Control

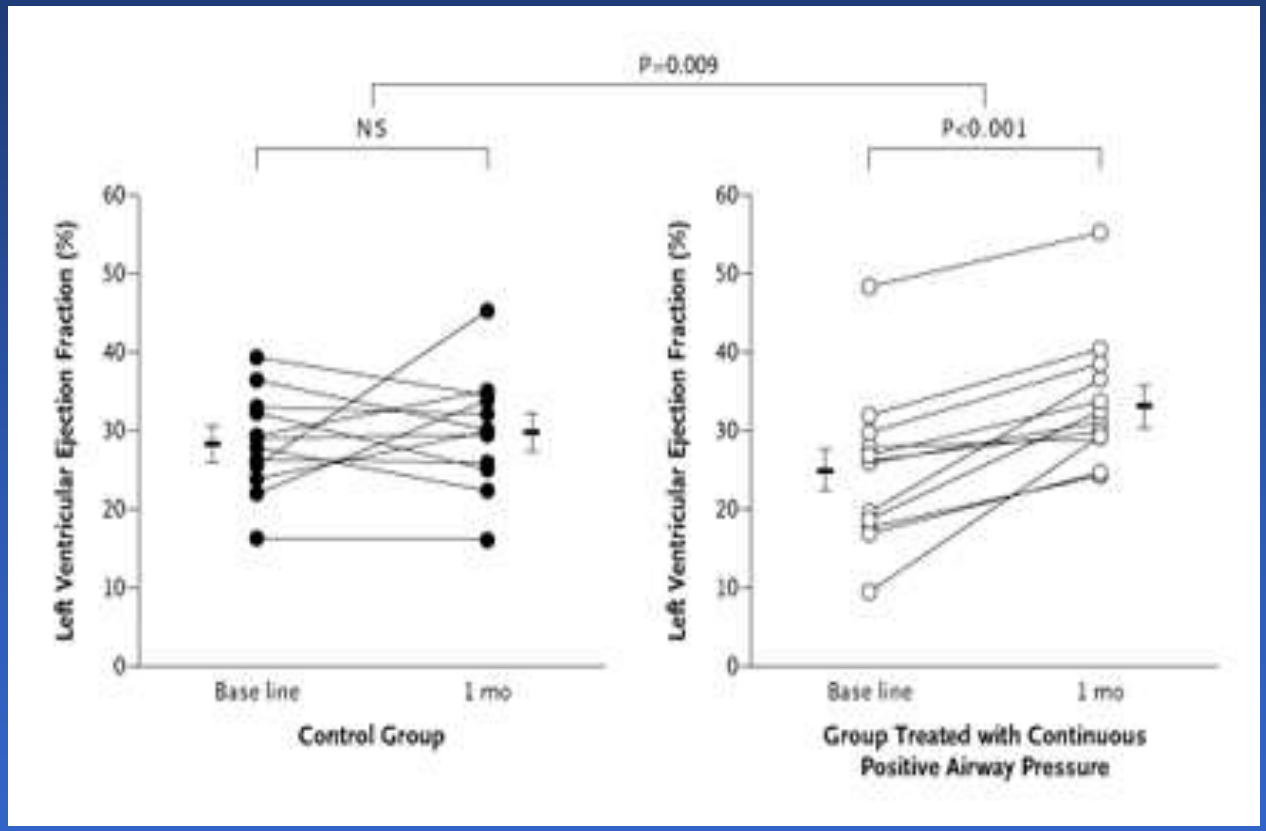


CPAP



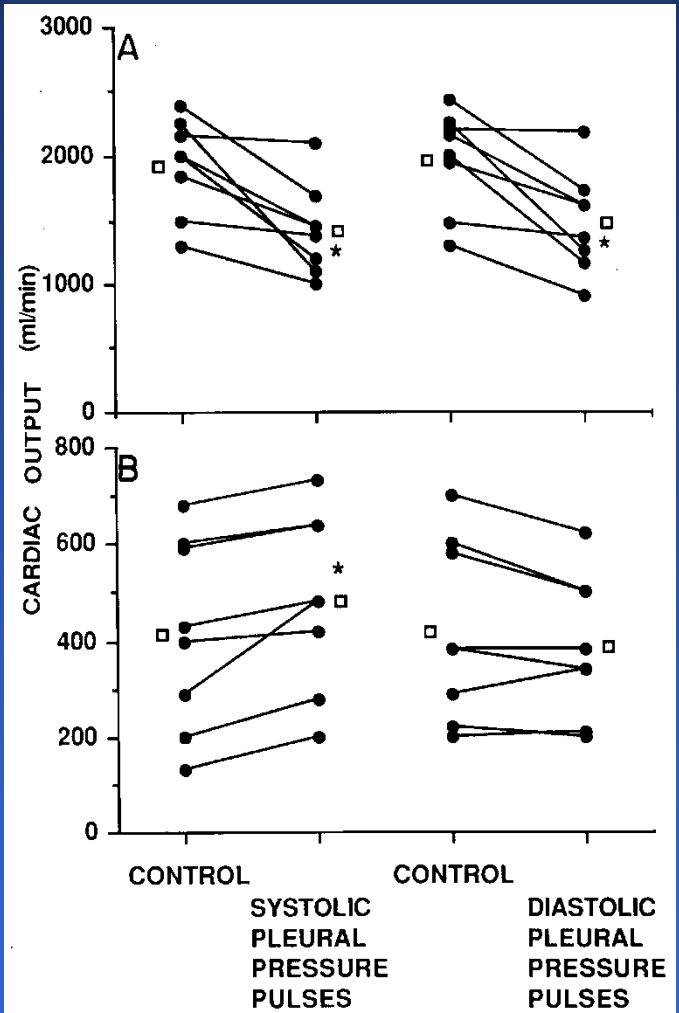
***Parker J Appl Physiol* 85: 1753-1761, 1998**

Benefits of CPAP in Heart Failure

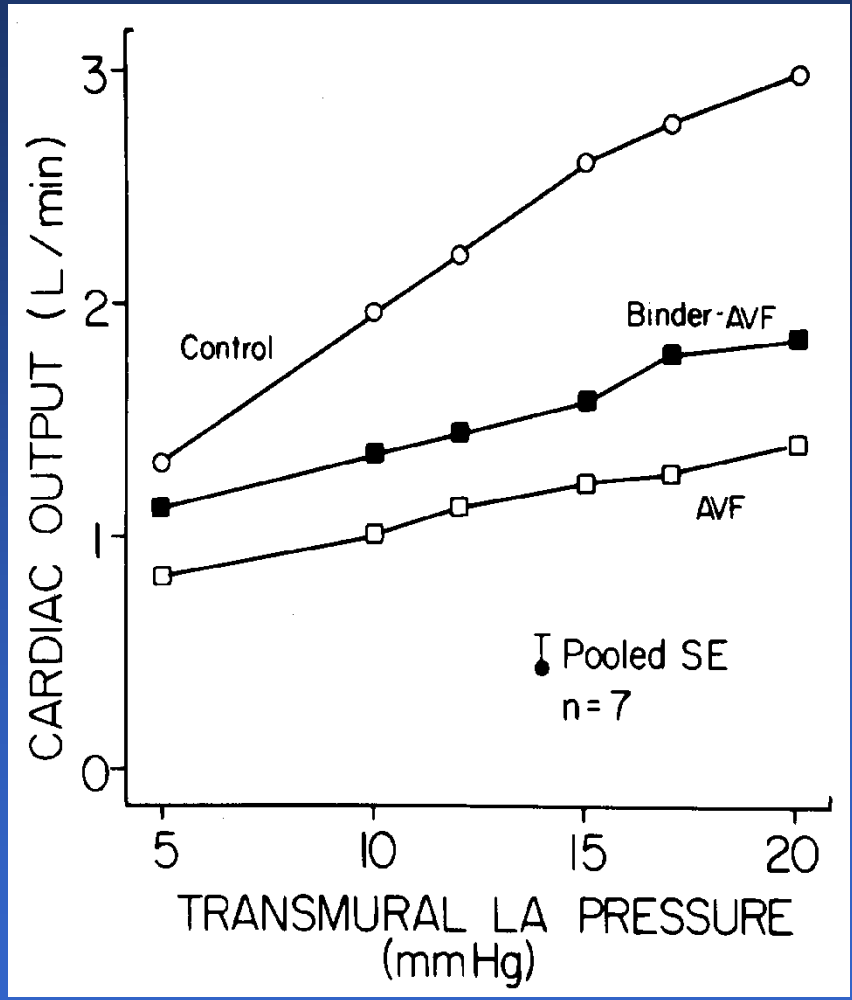


Kaneko et al. NEJM 348 (13): 1233, 2003

Under which circumstances are the lungs a Ventilatory Assist Device?



Fessler HE et al. J Appl Physiol 1992; 73:498

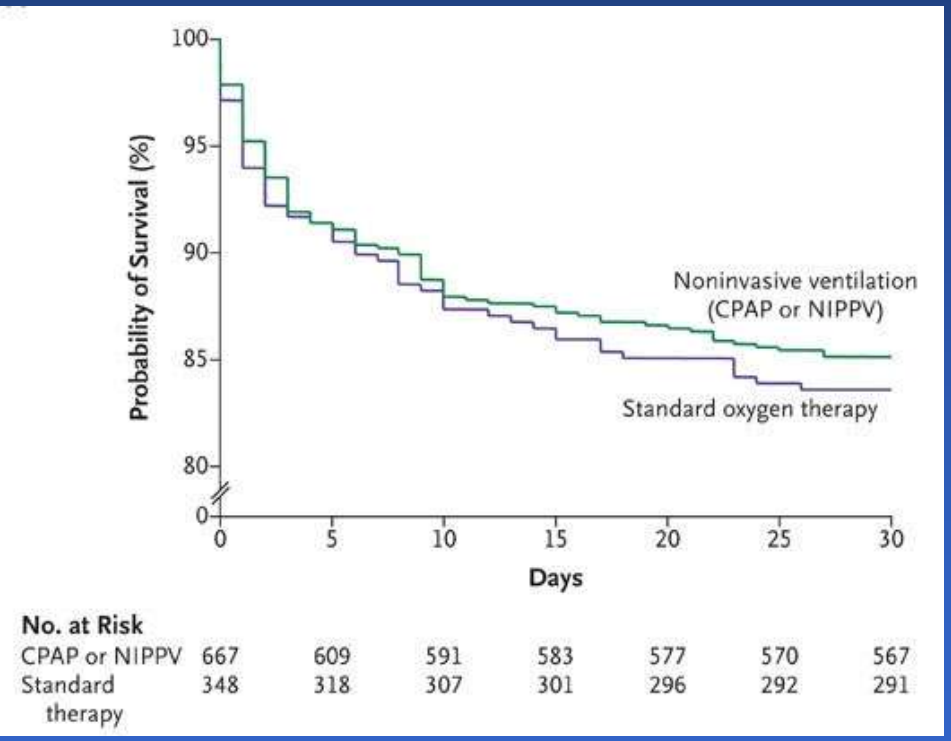


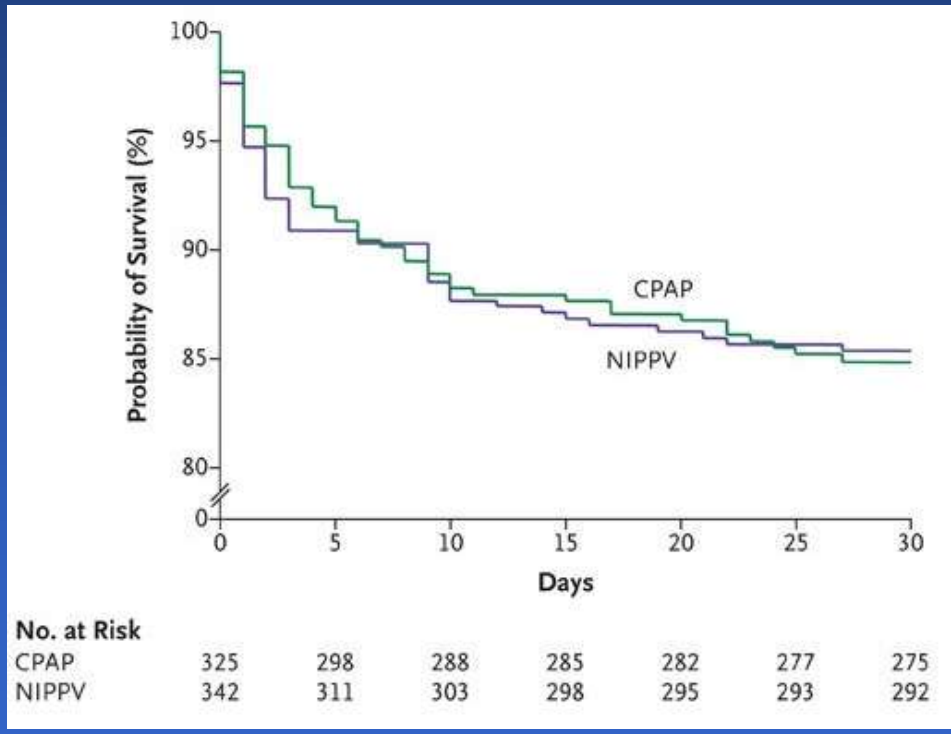
Pinsky MR et al. J Appl Physiol 1983; 54:950

Variable	Standard Oxygen Treatment (N=367)	CPAP or NIPPV (N=702)	Odds Ratio (95% CI)	P Value
Death within 7 days (% of patients)	9.8	9.5	0.97 (0.63 to 1.48)	0.87
Death within 30 days (% of patients)	16.4	15.2	0.92 (0.64 to 1.31)	0.64
Intubation within 7 days (% of patients)	2.8	2.9	1.05 (0.49 to 2.27)	0.90
Admission to critical care unit (% of patients)	40.5	45.2	1.21 (0.93 to 1.57)	0.15
Myocardial infarction (% of patients)				
WHO criteria	24.9	27.0	1.12 (0.84 to 1.49)	0.46
Universal criteria	50.5	51.9	1.06 (0.82 to 1.36)	0.66
			Difference between Means (95% CI)†	
Mean length of hospital stay (days)	10.5	11.4	0.9 (−0.2 to 2.0)	0.10
Mean change at 1 hr after start of treatment‡				
Dyspnea score§	3.9	4.6	0.7 (0.2 to 1.3)	0.008
Pulse rate (beats/min)	13	16	4 (1 to 6)	0.004
Blood pressure (mm Hg)				
Systolic	34	38	3 (−1 to 8)	0.17
Diastolic	22	22	0 (−3 to 3)	0.95
Respiratory rate (breaths/min)	7.1	7.2	0.2 (−0.8 to 1.1)	0.74
Peripheral oxygen saturation (%)	3.5	3.0	−0.4 (−1.4 to 0.6)	0.41
Arterial pH	0.08	0.11	0.03 (0.02 to 0.04)	<0.001
Arterial PaO_2 (kPa)	0.7	−0.6	−1.2 (−2.6 to 0.1)	0.07
Arterial $PaCO_2$ (kPa)	0.8	1.5	0.7 (0.4 to 0.9)	<0.001
Serum bicarbonate level (mmol/liter)	1.7	1.8	0.1 (−0.7 to 1.0)	0.77

N Engl J Med 2008;359:142-51.

Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema

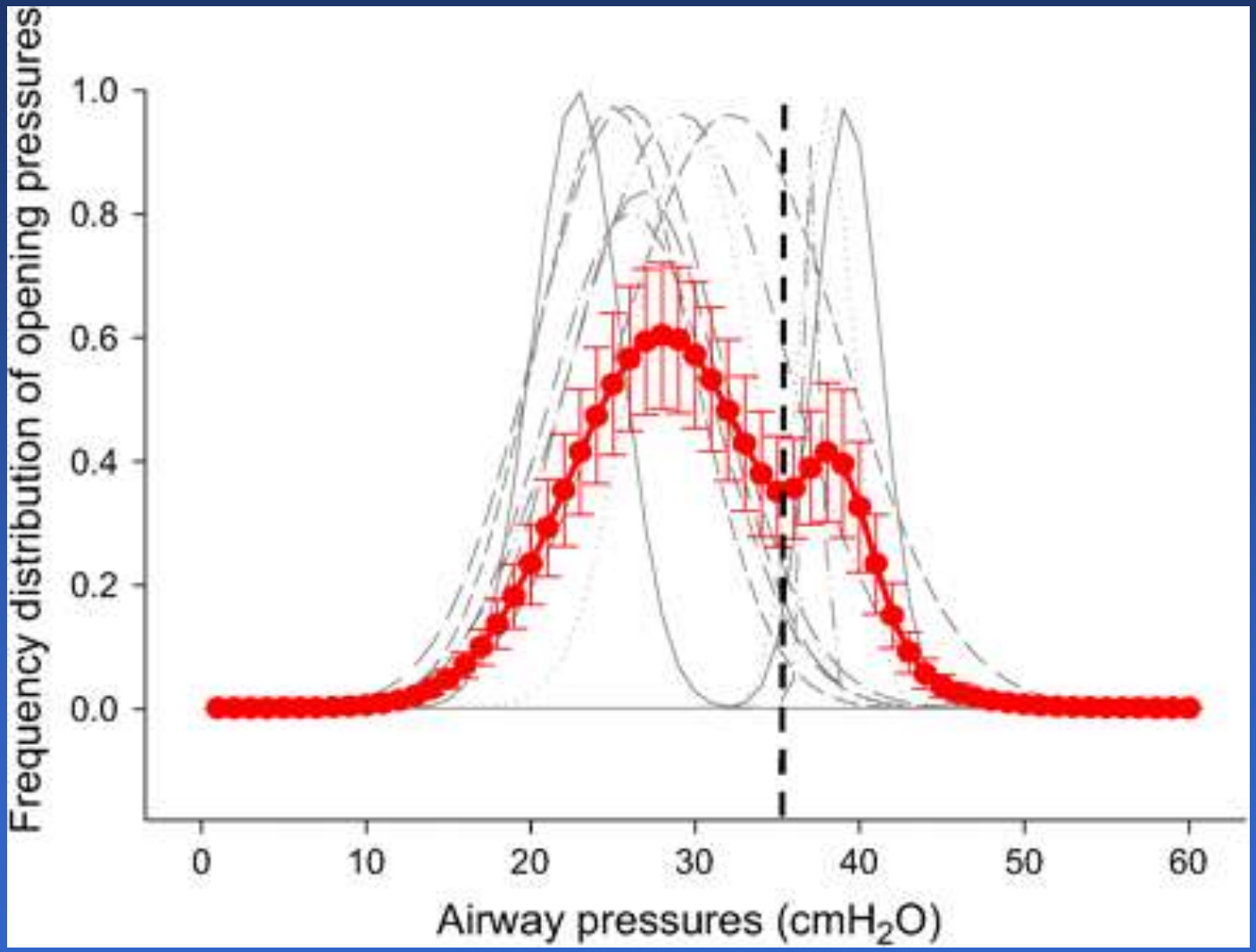




N Engl J Med 2008;359:142-51.

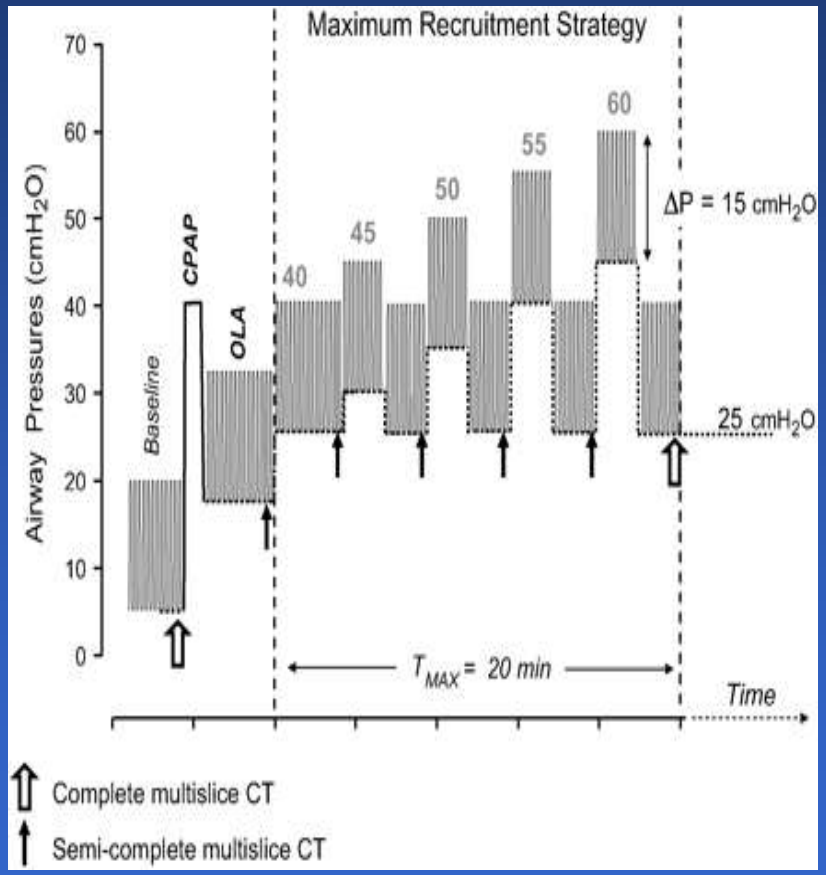
Ventilator Management:
Physical Therapy of Injured Lungs

Injury is associated with a large variability in regional impedance



Am J Respir Crit Care Med Vol 174. pp 268–278, 2006

Open the lung and keep it open

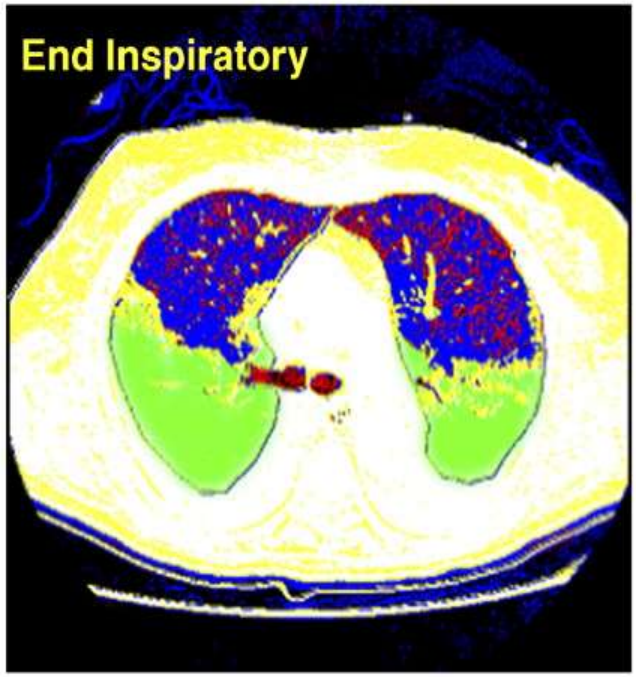


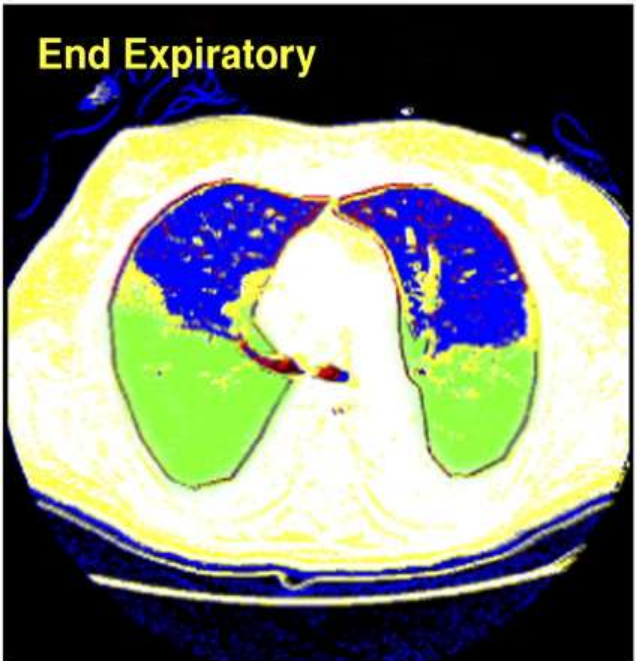
Critical Assumptions

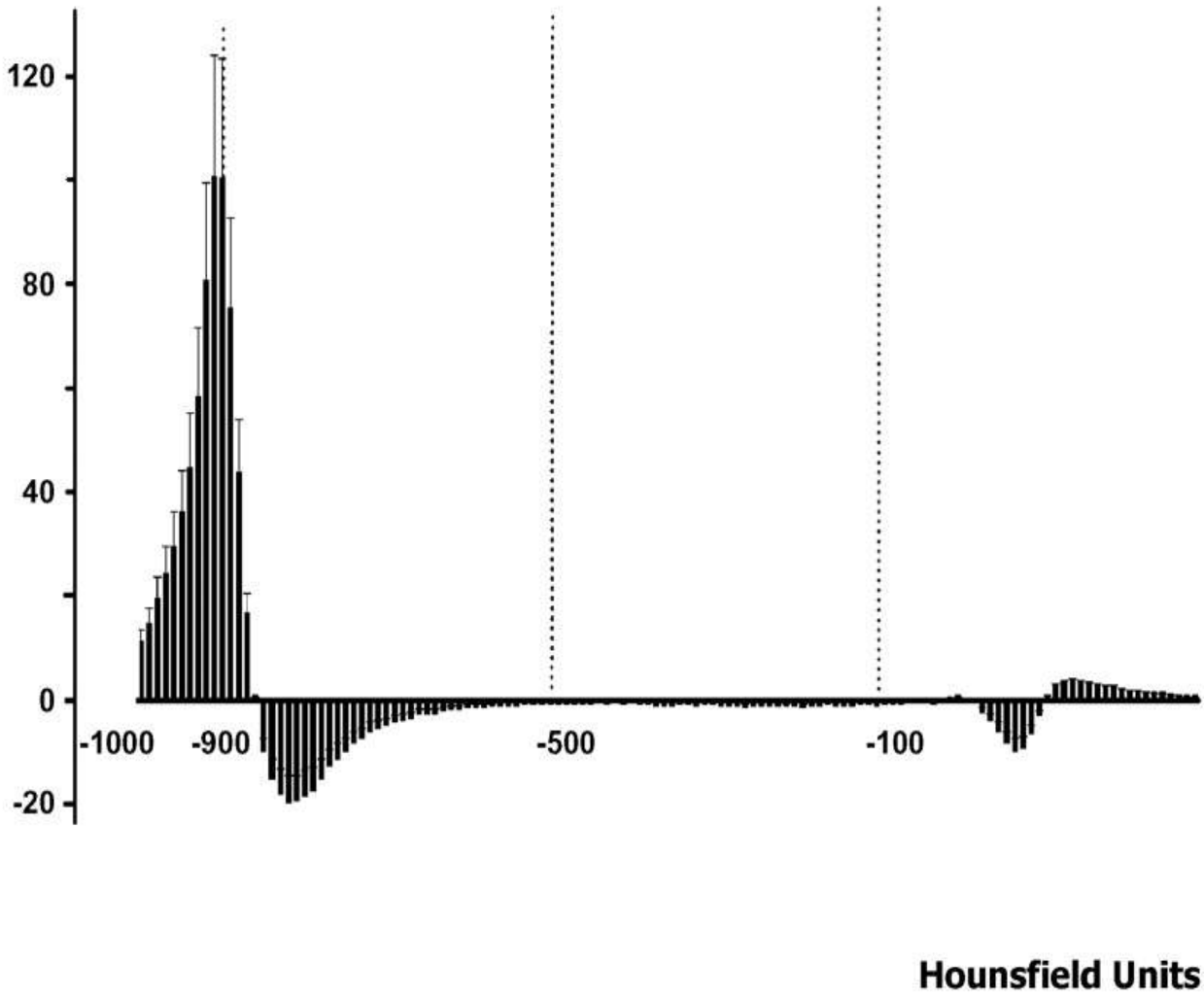
- ΔP is the critical VILI determinant
- There is no Pplat safety threshold
- Preventing opening and collapse is more important than avoiding high transpulmonary pressure
- Measures of Gas Exchange Efficiency are acceptable surrogate efficacy endpoints

Am J Respir Crit Care Med Vol 174. pp 268–278, 2006

B

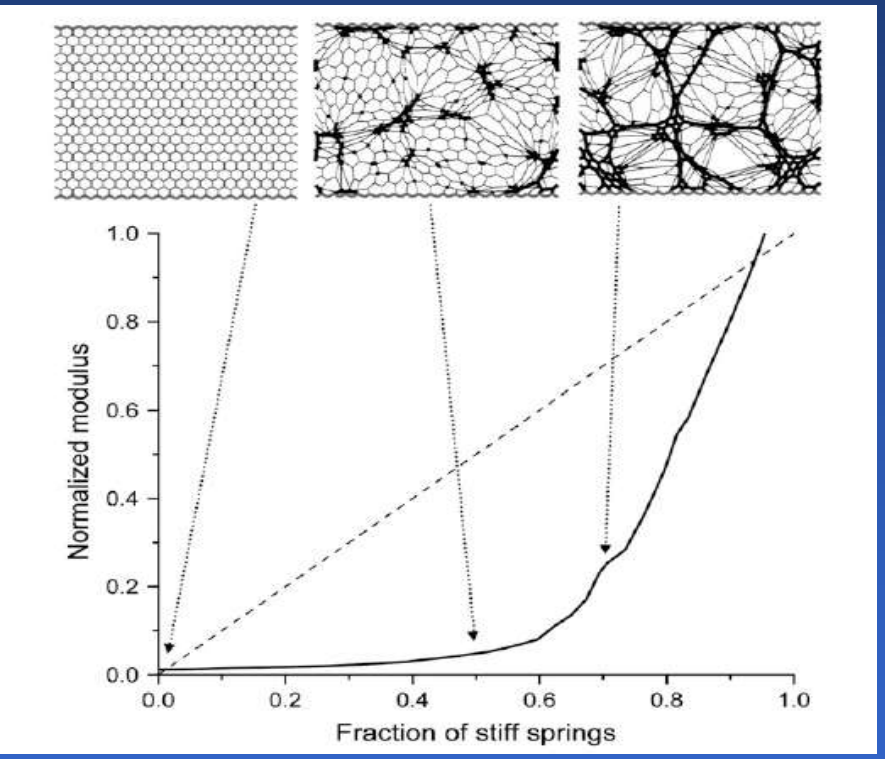


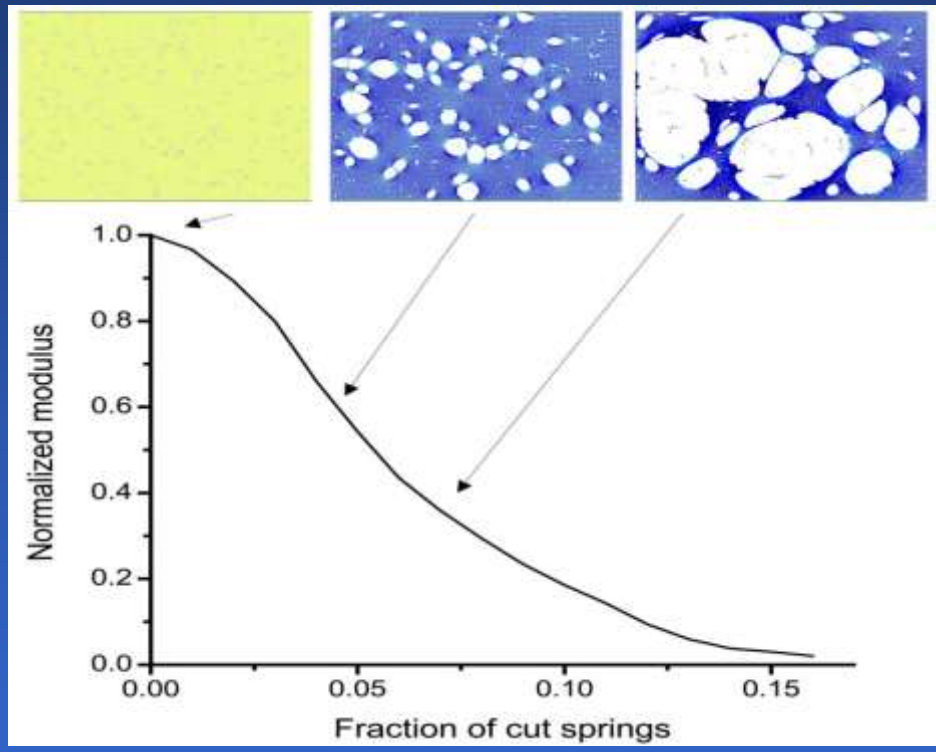




Am J Respir Crit Care Med Vol 175. pp 160–166, 2007

The Meaning of Overdistension ?



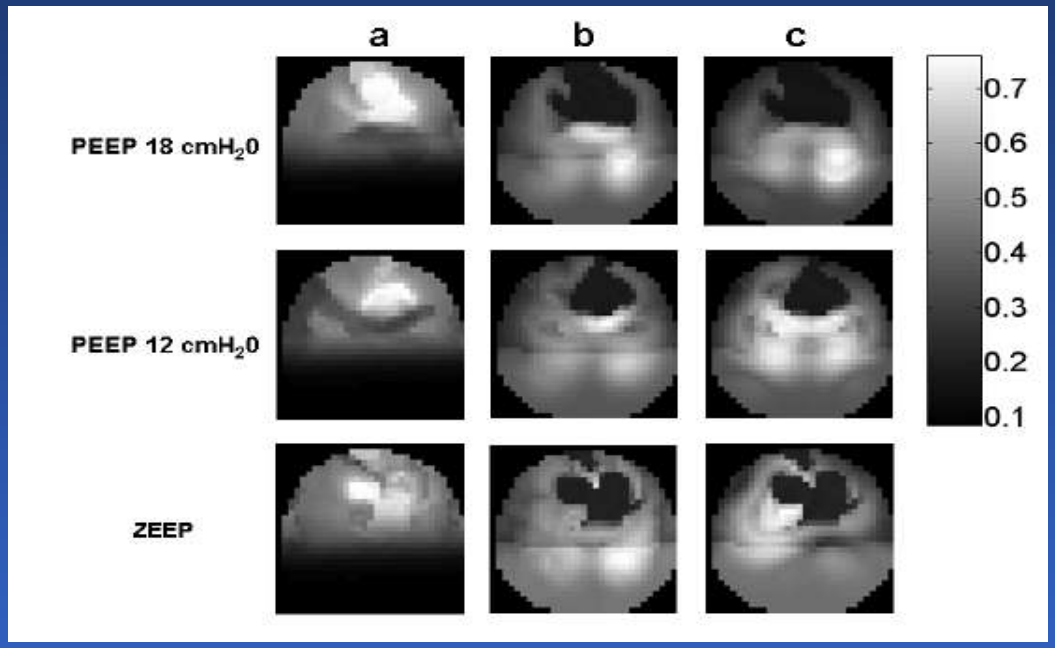


Am J Respir Crit Care Med Vol 176. pp 617–623, 2007

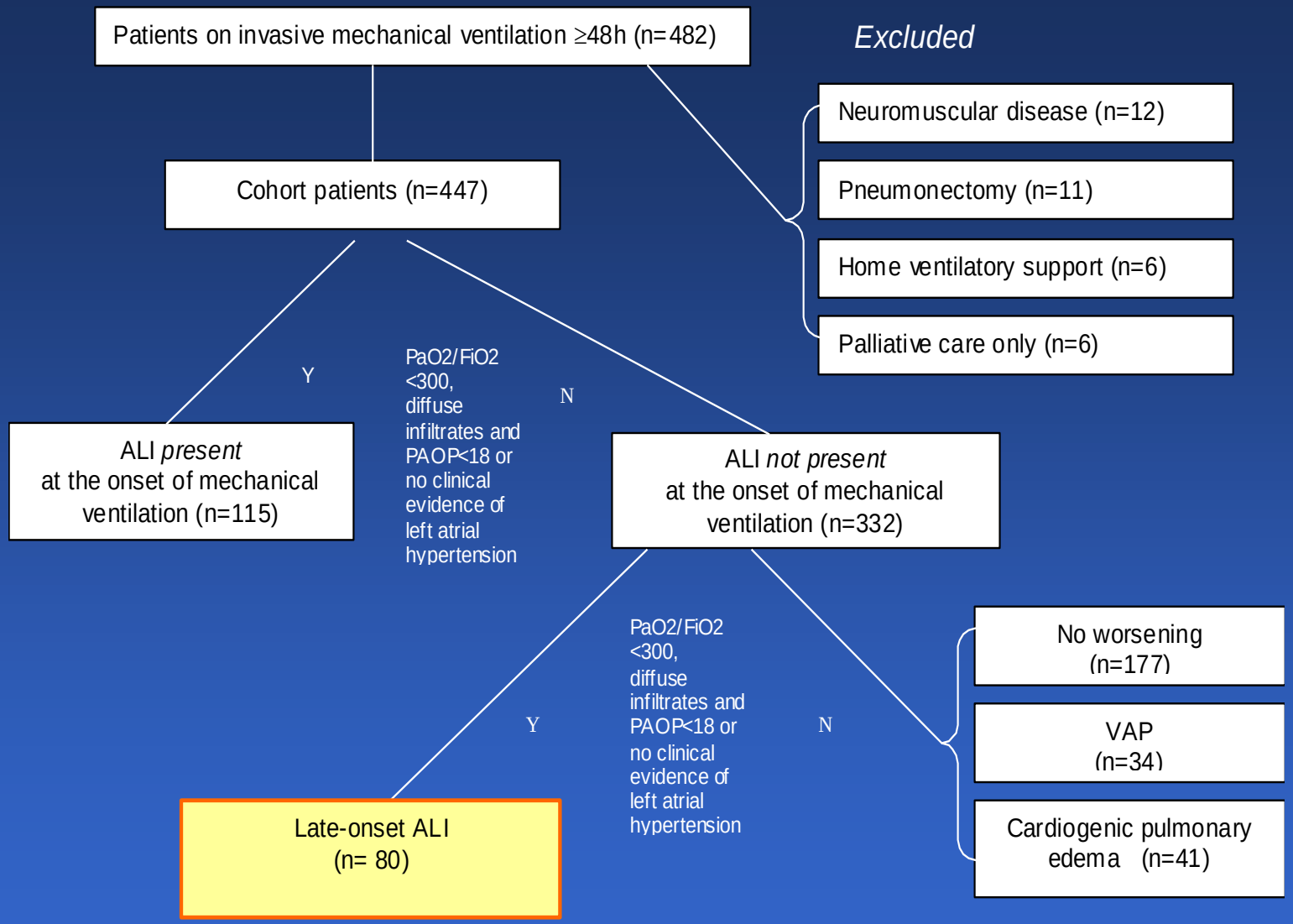
Rajiv Jesudason, Lauren Black, Arnab Majumdar, Phillip Stone and Bela Suki
J Appl Physiol 103:803-811, 2007. First published May 31, 2007; doi:10.1152/japplphysiol.00057.2007

Electrical Impedance Tomography

FUZZY MODELING OF ELECTRICAL IMPEDANCE TOMOGRAPHY IMAGES OF THE LUNGS

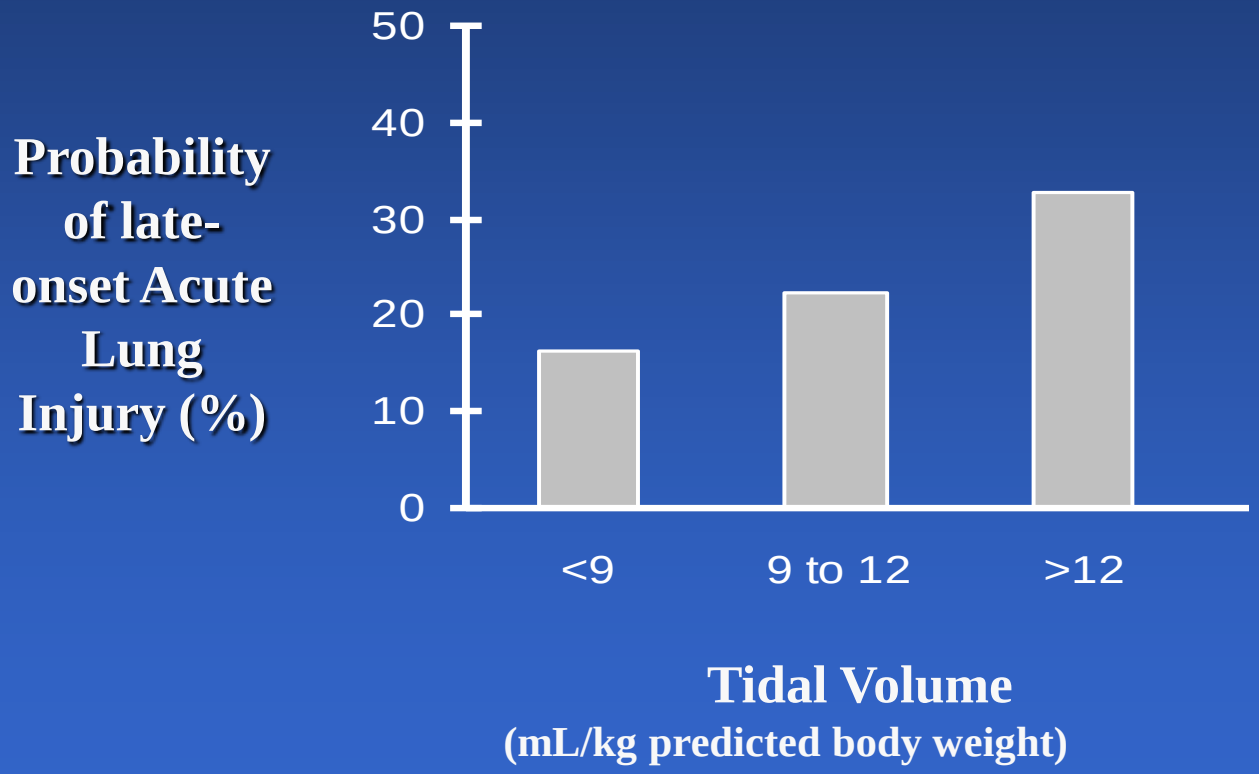


Tanaka H, Ortega NRS, Galizia MS, Borges JB, Amato MBP.
of the lungs. Clinics. 2008;63:363-70.

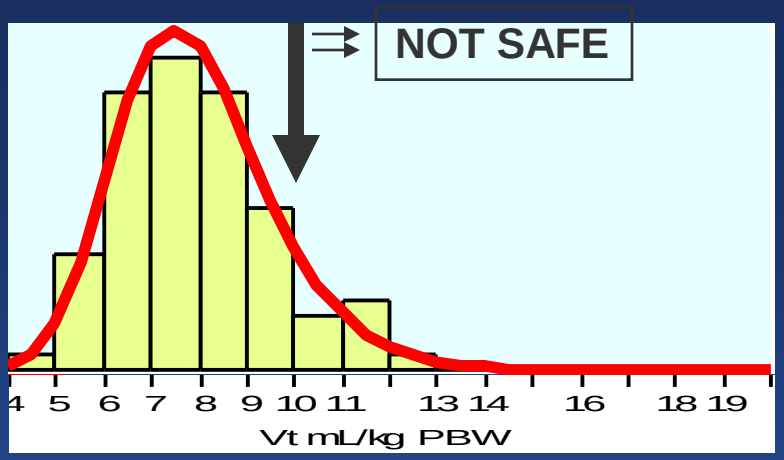


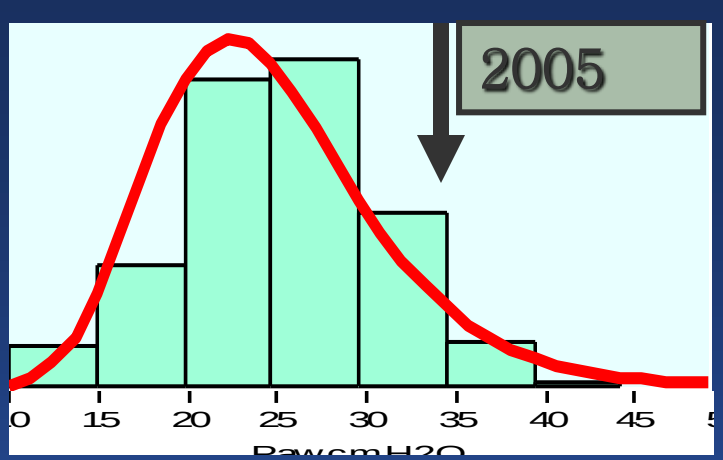
Gajic et al, Crit. Care Med. 2004; 32:1817-1824

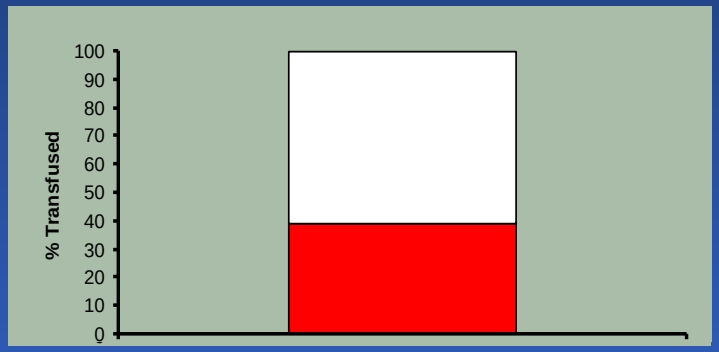
Mayo Ventilator Practice 2001

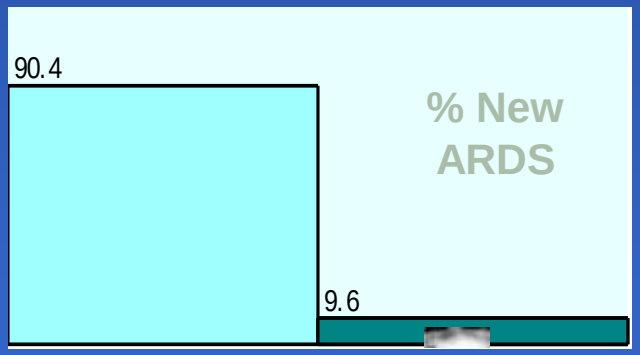


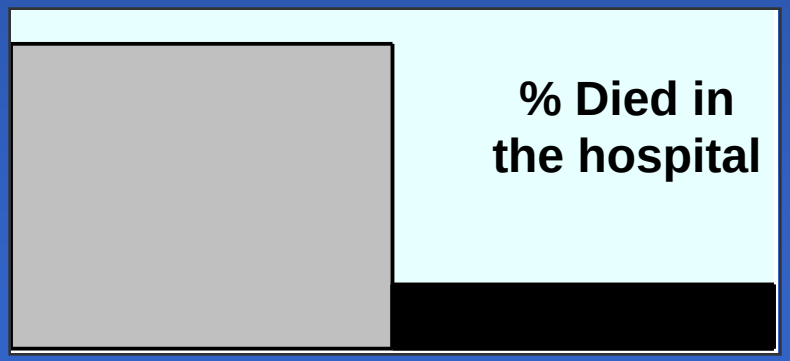
Gajic et al, Crit. Care Med. 2004; 32:1817-1824











VALI & TRALI: CAN WE PREVENT IATROGENIC ARDS?

Yilmaz et al. Towards the prevention of acute lung injury. Crit Care Med 2007

Reasons for turning unconventional?

Better Lung Protection

Noisy Ventilation

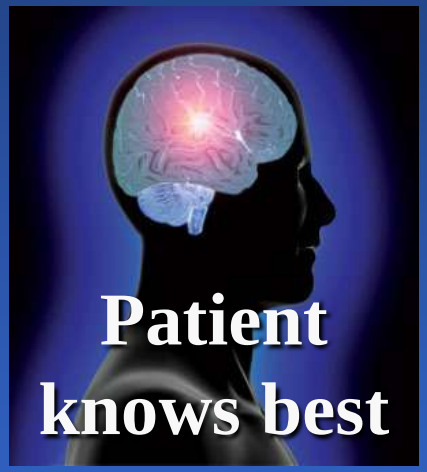
High Frequency Oscillatory Ventilation

ARDS-NET Approach

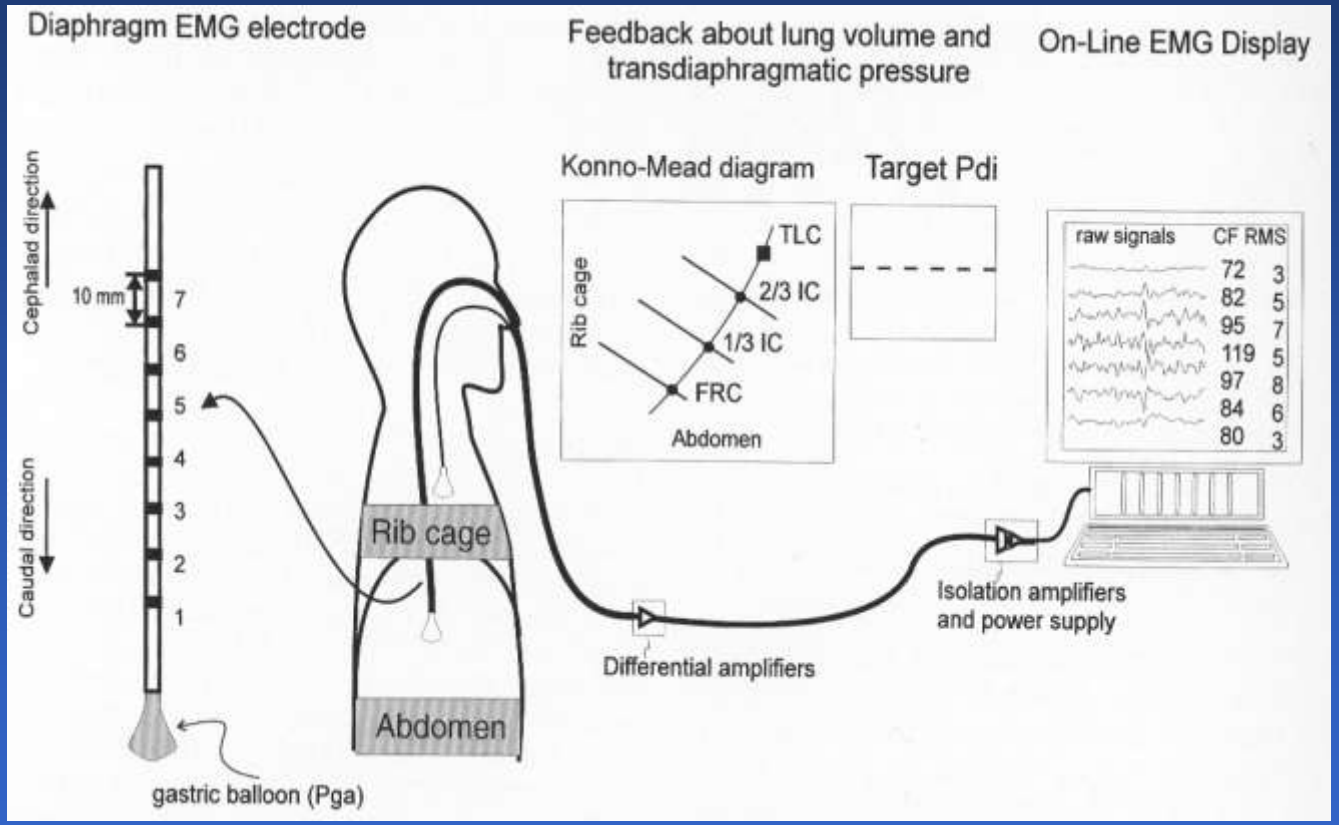
Better Synchrony

Proportional Assist Ventilation

Neurally Adjusted Ventilatory Assist



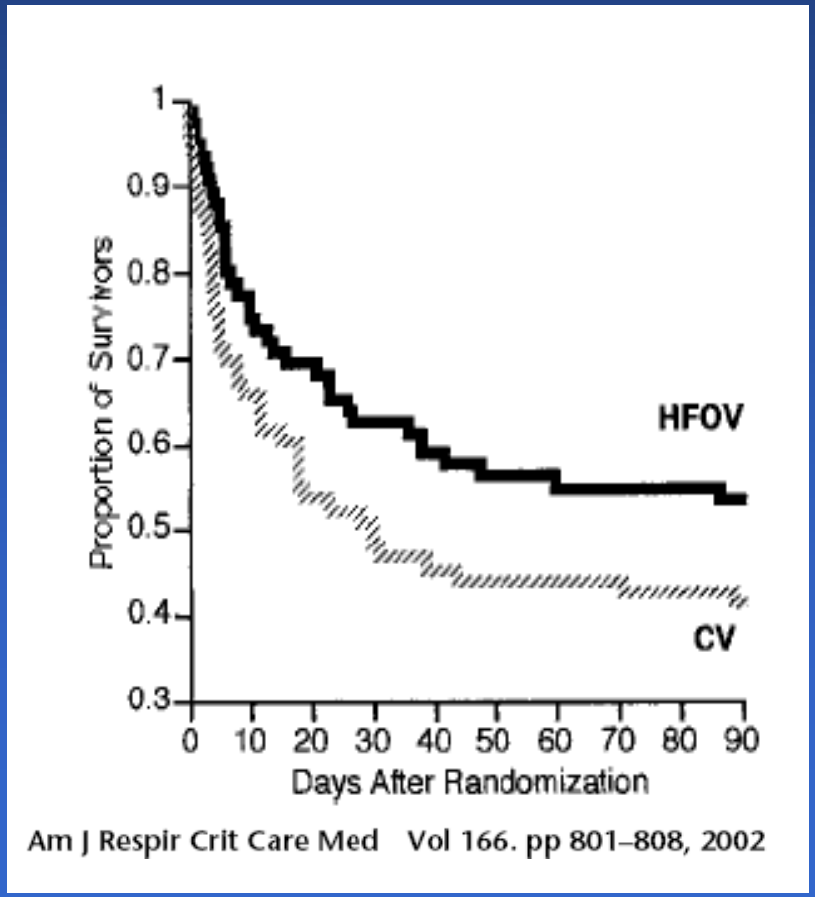
Neurally Adjusted Ventilation Assist



Beck J, et al. J Appl Physiol 1998; 85:1123-1134

Efficacy of HFO

- Adults



- Neonates

ASAIO Journal 2007

Bridge to Lung Transplantation With the Extracorporeal Membrane Ventilator Novalung in the Veno-Venous Mode: The Initial Hannover Experience

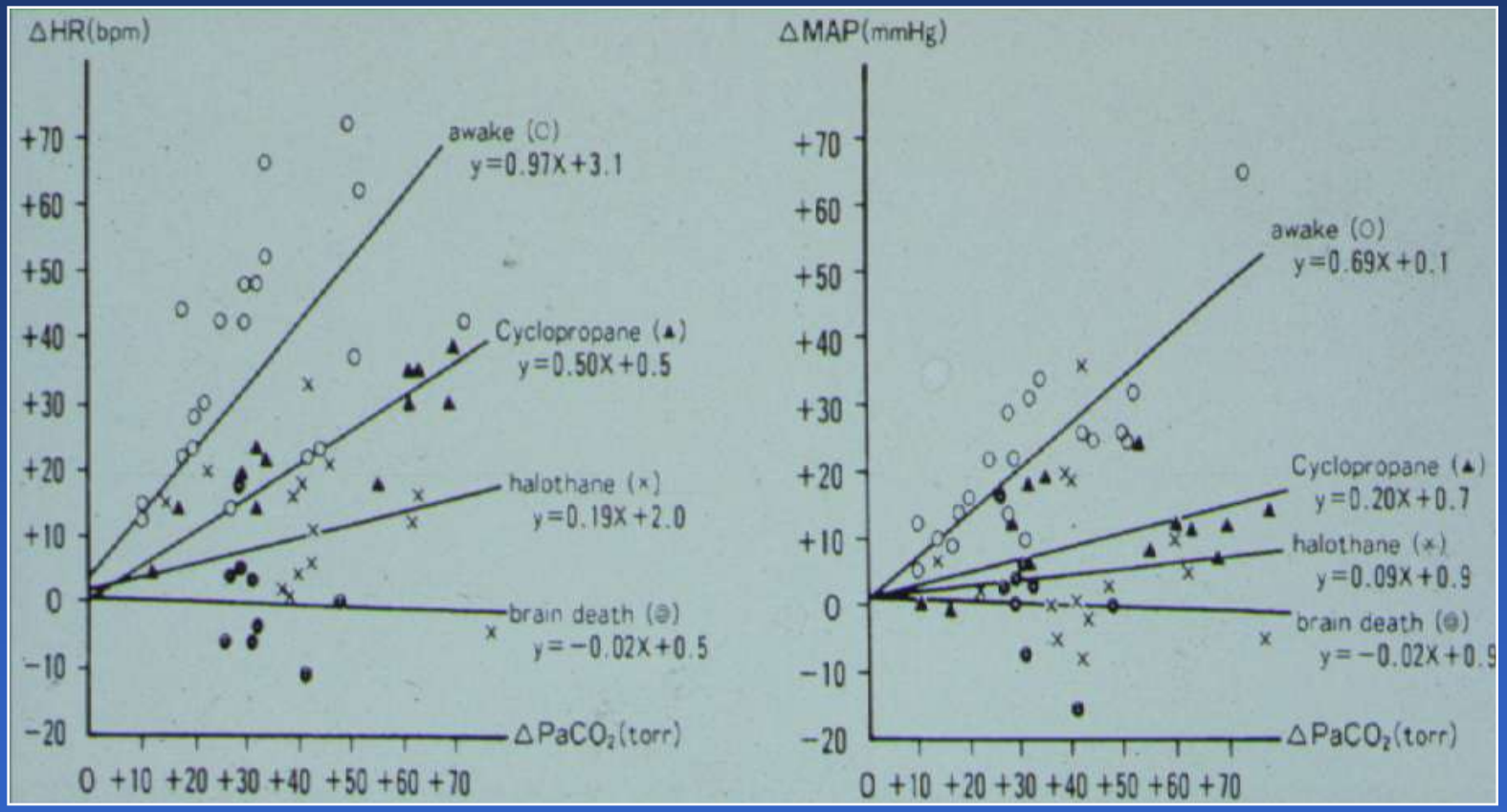
Stefan Fischer,* Marius M. Hoeper,† Sandra Tomaszek,* Andre Simon,* Jens Gottlieb,† Tobias Welte,† Axel Haverich,* and Martin Strueber*

Table 1. Patient Characteristics Before Novalung Implantation

	Patient 1	Patient 2
Age (years)	35	38
Gender (m/f)	F	F
Indication for LTx	Alveolitis	CF
Pre v-v Novalung ventilation		
FiO_2	1.0	1.0
Peak inspiratory pressure (mm Hg)	45	51
PEEP (mm Hg)	15	6
Tidal volume (ml)	214	185
PaO_2 at Novalung insertion (mm Hg)	38	37
$PaCO_2$ at Novalung insertion (mm Hg)	89	173
pH in arterial blood	7.22	6.95
Time of pre-Novalung ventilation (days)	10	4
Secondary organ failure (yes/no)	No	No
Hemodynamics		
Mean arterial pressure (mm Hg)	67	75
Central venous pressure (mm Hg)	15	10
Mean pulmonary artery pressure (mm Hg)	32	n/a
Inotropic support (yes/no)	Yes	Yes
Infection status		
Sepsis (yes/no)	No	No
Positive blood cultures (yes/no)	No	No
Test results	Neg.	Neg.
Other positive cultures (yes/no)	No	Yes
Test results	Neg.	Pseud aer in lung

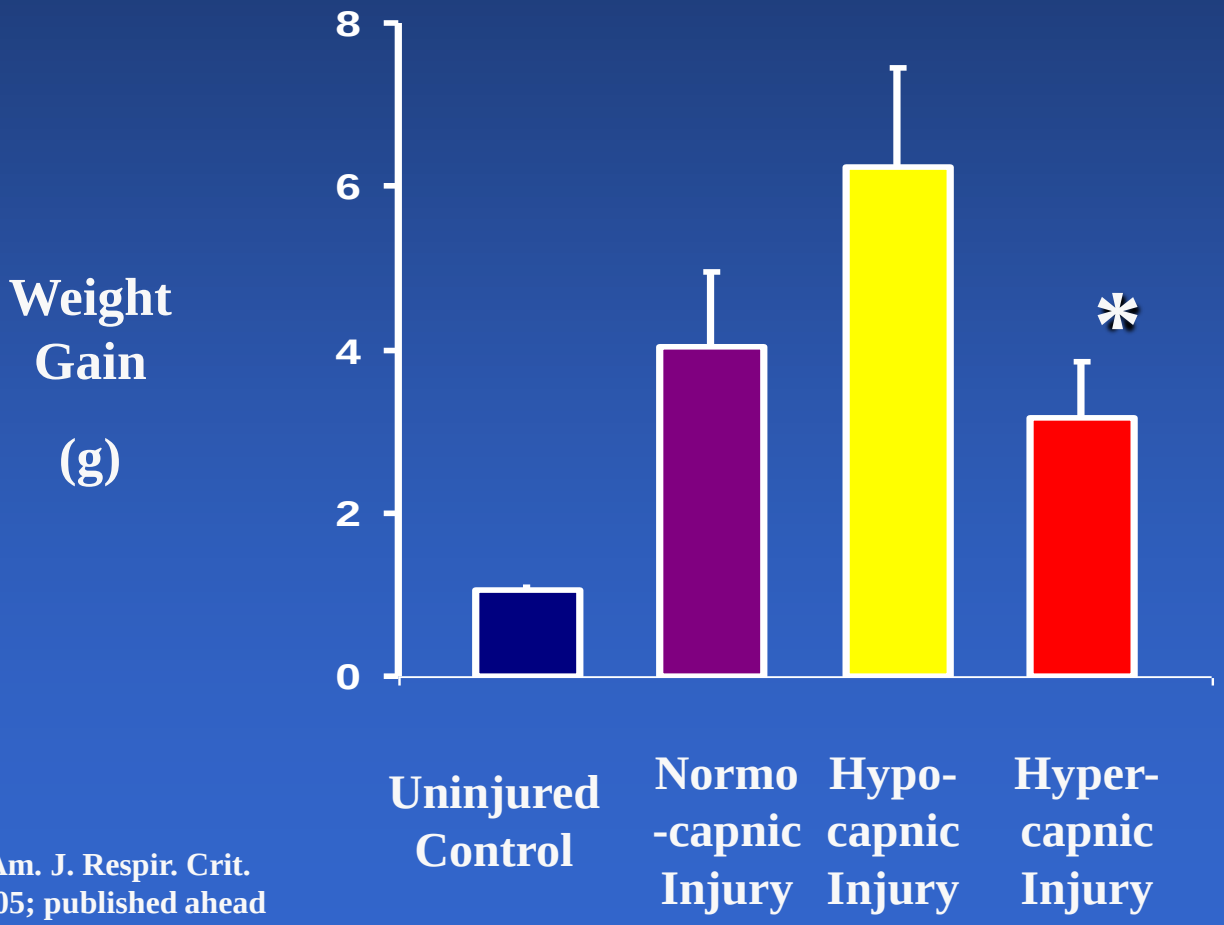
CF, cystic fibrosis; Pseud aer, Pseudomonas aeroginosa; n/a, not assessed.

Hypercapnic Acidosis



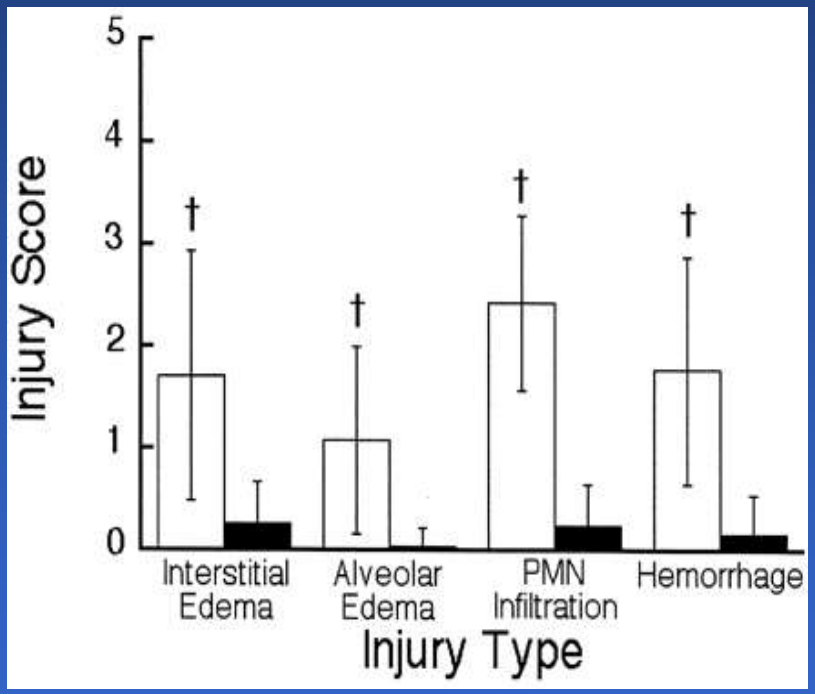
Ebata et al. Can J Anesth 1991; 38:436-440

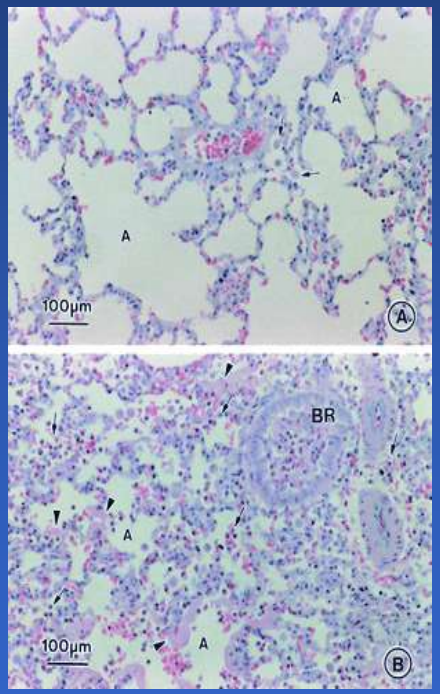
Effects of CO_2 on Pulmonary Vascular Barrier Properties



Doerr et al, Am. J. Respir. Crit. Care Med. 2005; published ahead of print on February 1, 2005

Permissive Hypercapnia and VILI





Hypercapnia

Normocapnia

Scott E. Sinclair, Am. J. Respir. Crit. Care Med. 166: 403-408

Bicarbonate buffers generate CO_2

NaHCO3

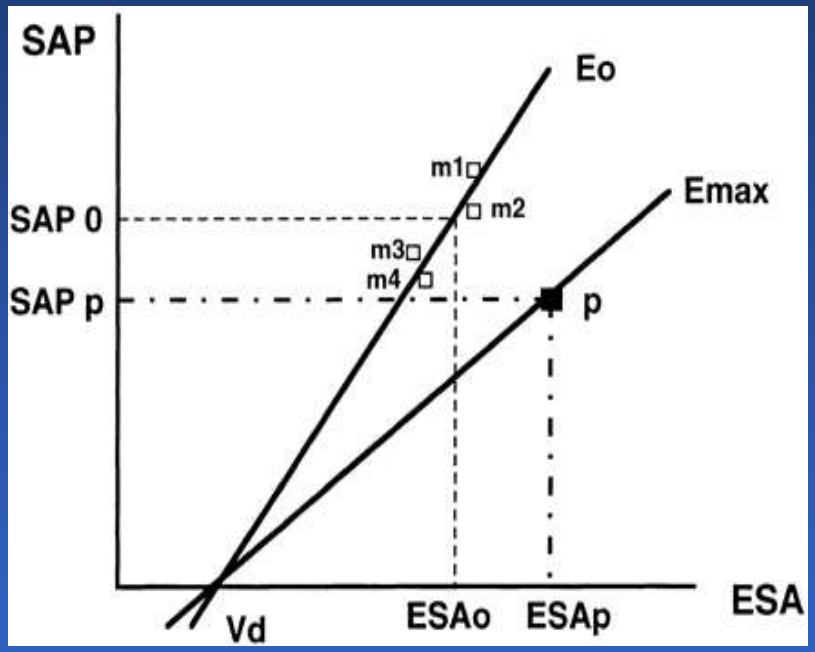
Case	pHa Pre-$NaHCO_3$	pHa Post-$NaHCO_3$	Pa_{CO_2} Pre-$NaHCO_3$ (*mm Hg*)	Pa_{CO_2} Post-$NaHCO_3$ (*mm Hg*)	Base Deficit Pre-$NaHCO_3$ (*mEq/L*)	Base Deficit Post-$NaHCO_3$ (*mEq/L*)	$NaHCO_3$ Dose (*mEq*)
Mean ± SD	7.21 ± 0.06	7.10 ± 0.04*	53 ± 19	62 ± 24*	−6.4 ± 9.5	−9.7 ± 11.3	82.5 ± 64.5

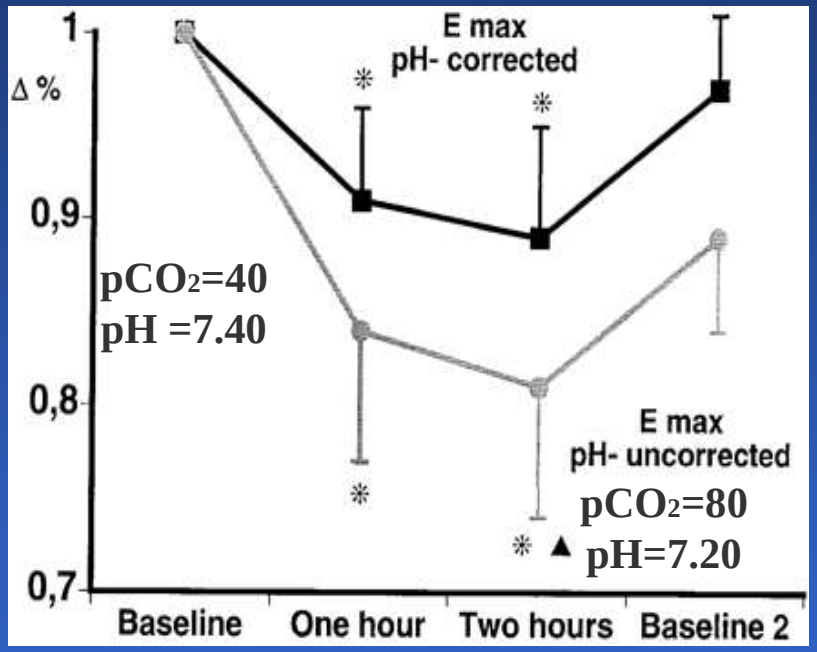
THAM

Case	pHa Pre-THAM	pHa Post-THAM	Pa_{CO_2} Pre-THAM (*mm Hg*)	Pa_{CO_2} Post-THAM (*mm Hg*)	Base Deficit Pre-THAM (*mEq/L*)	Base Deficit Post-THAM (*mEq/L*)	THAM dose (*mmol/kg/h*)
Mean ± SD	7.14 ± 0.05	7.26 ± 0.08‡	63 ± 19	50 ± 16‡	−8.1 ± 8.0	−4.4 ± 7.6‡	1.07 ± 1.23

Kallet et al. AJRCCM 161: 1149, 2000

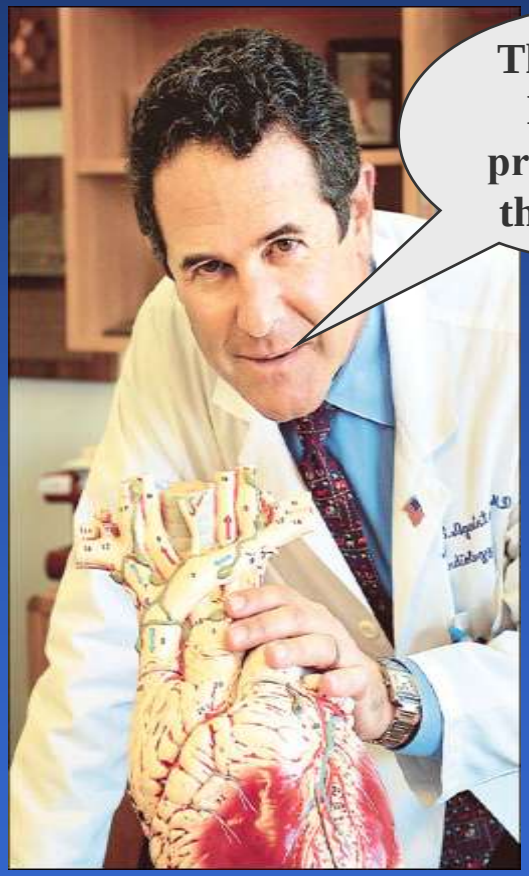
Effects of Hypercapnic Acidosis on Myocardial Contractility



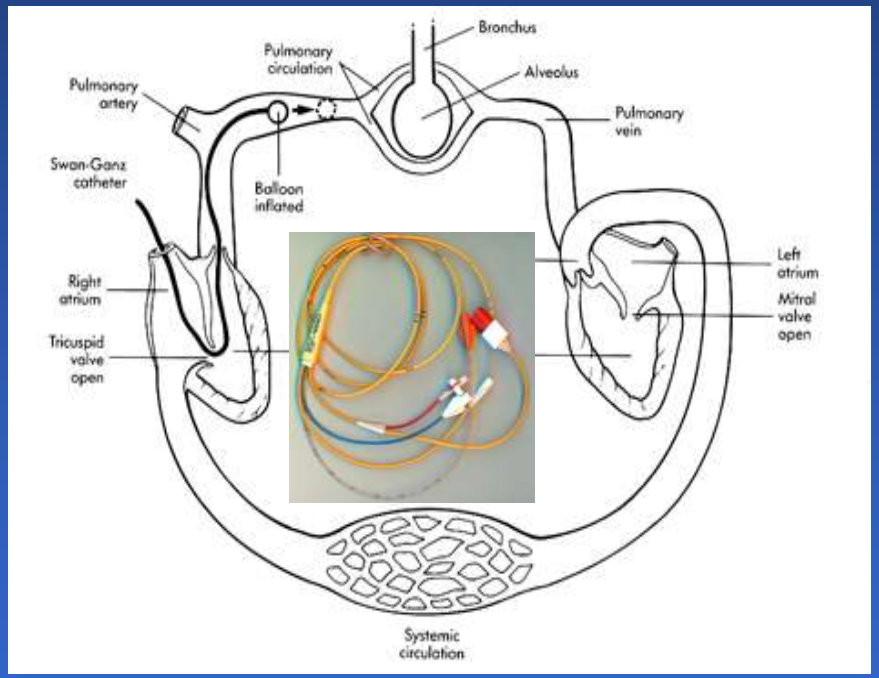


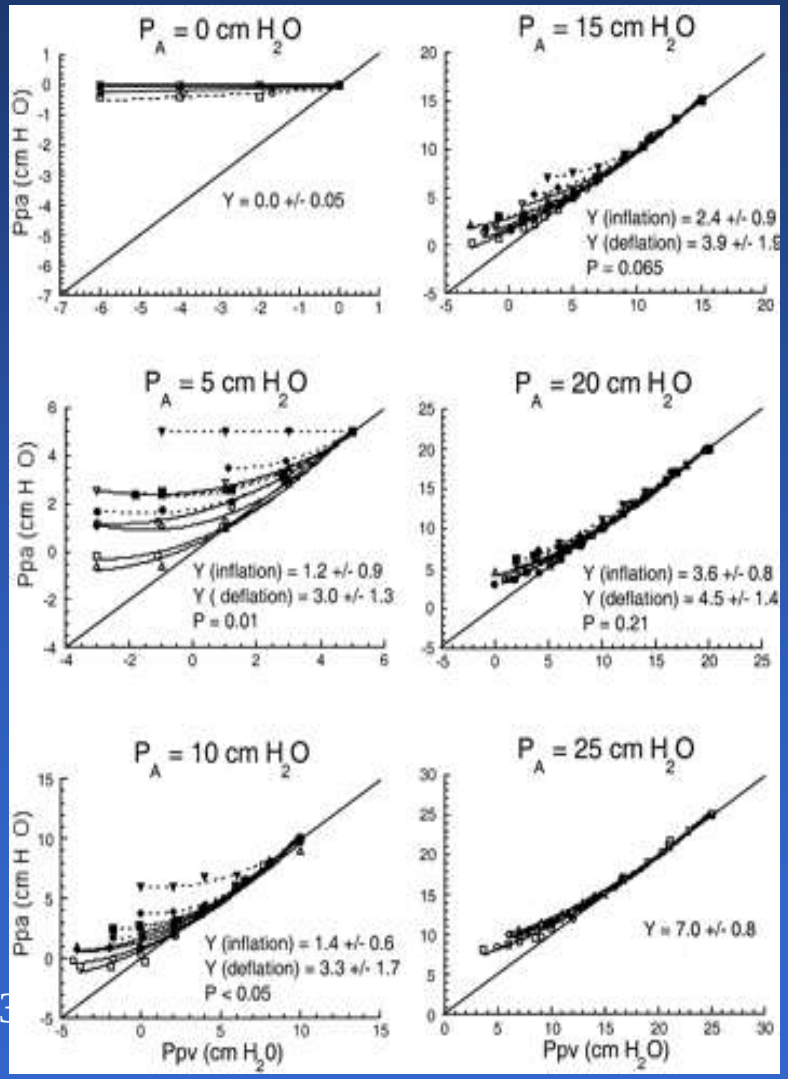
Weber et al. AJRCCM 162: 1361; 2000

Cardiogenic or Non-Cardiogenic Edema

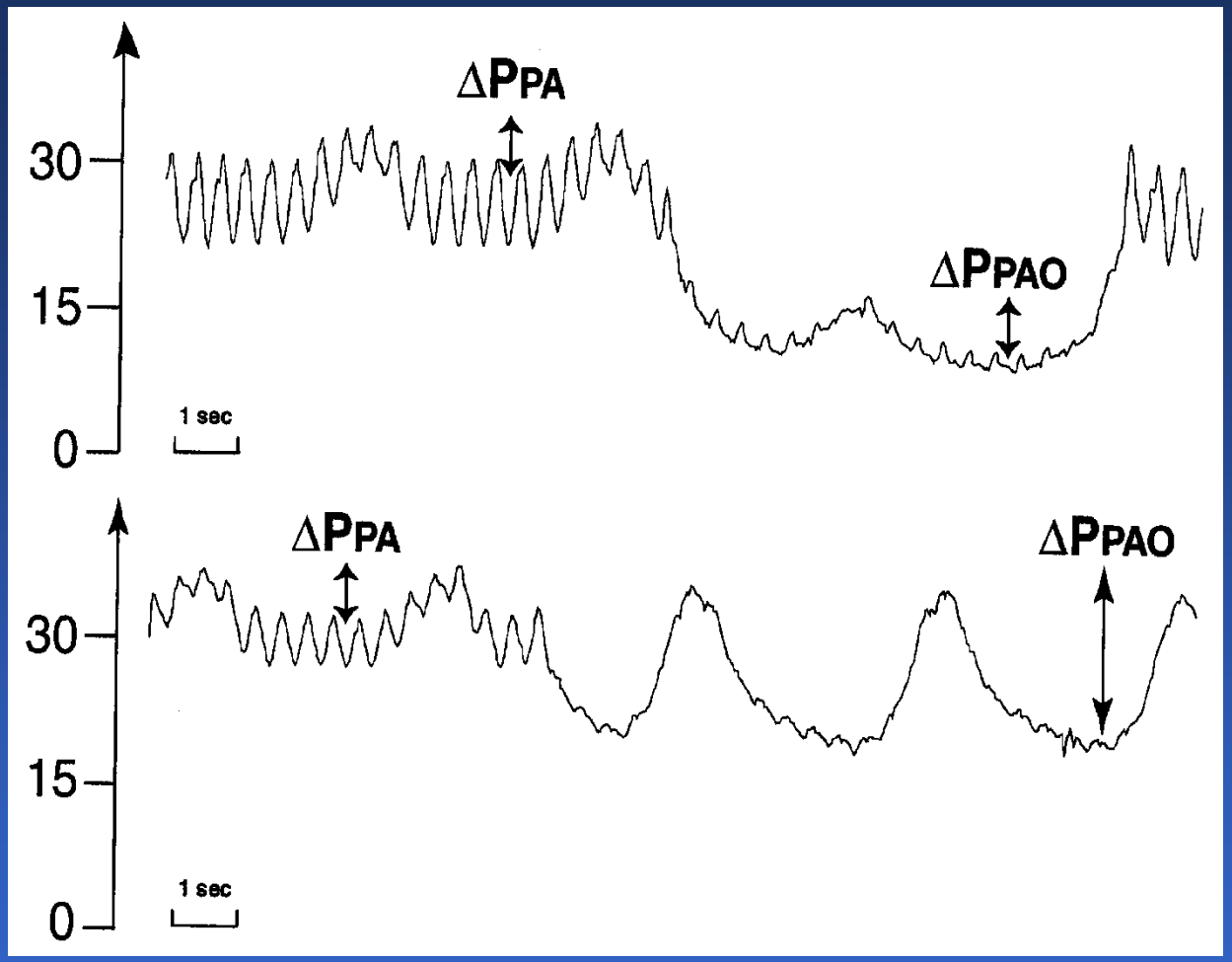


The Swan and the Zone 1 Misconception



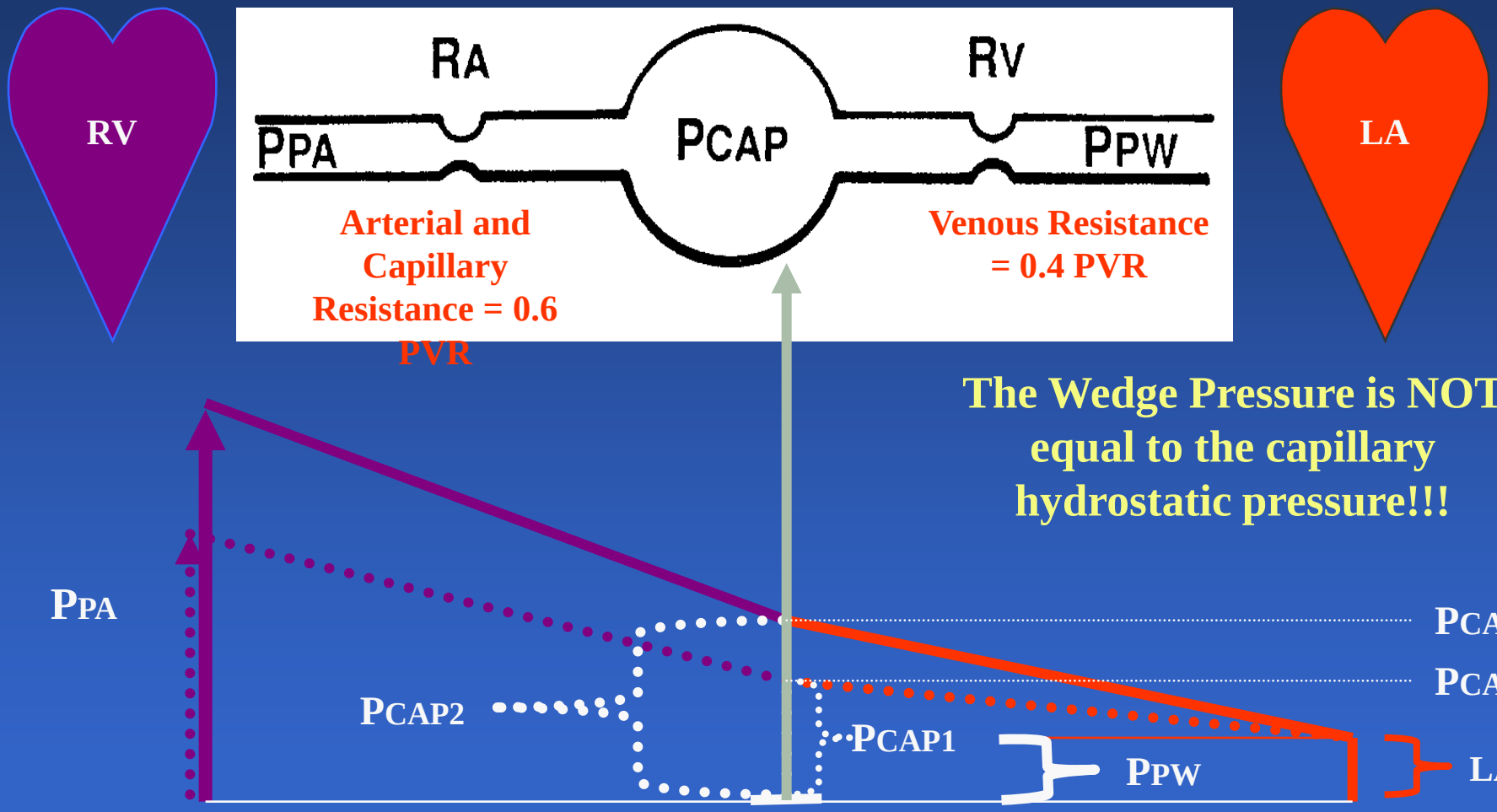


Albert et al. AJRCCM Vol 167. pp. 1016-1020, (2003

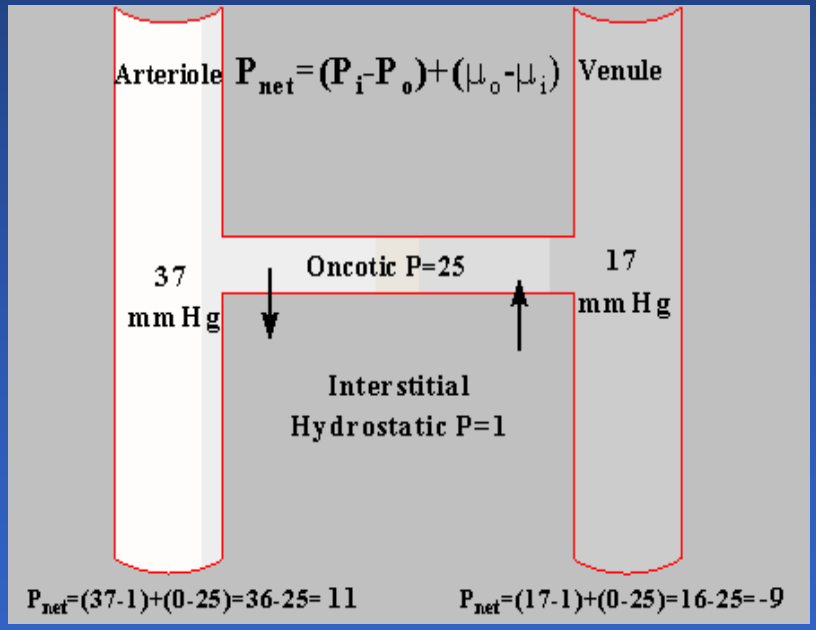


Leatherman JW, Marini JJ. Pulmonary artery catheterization: Interpretation of pressure recordings. In: Tobin MJ. Principles and Practice of Intensive Care Monitoring. New York: McGraw-Hill 1998; 821-837

There is Nothing Magical about a Wedge of 18

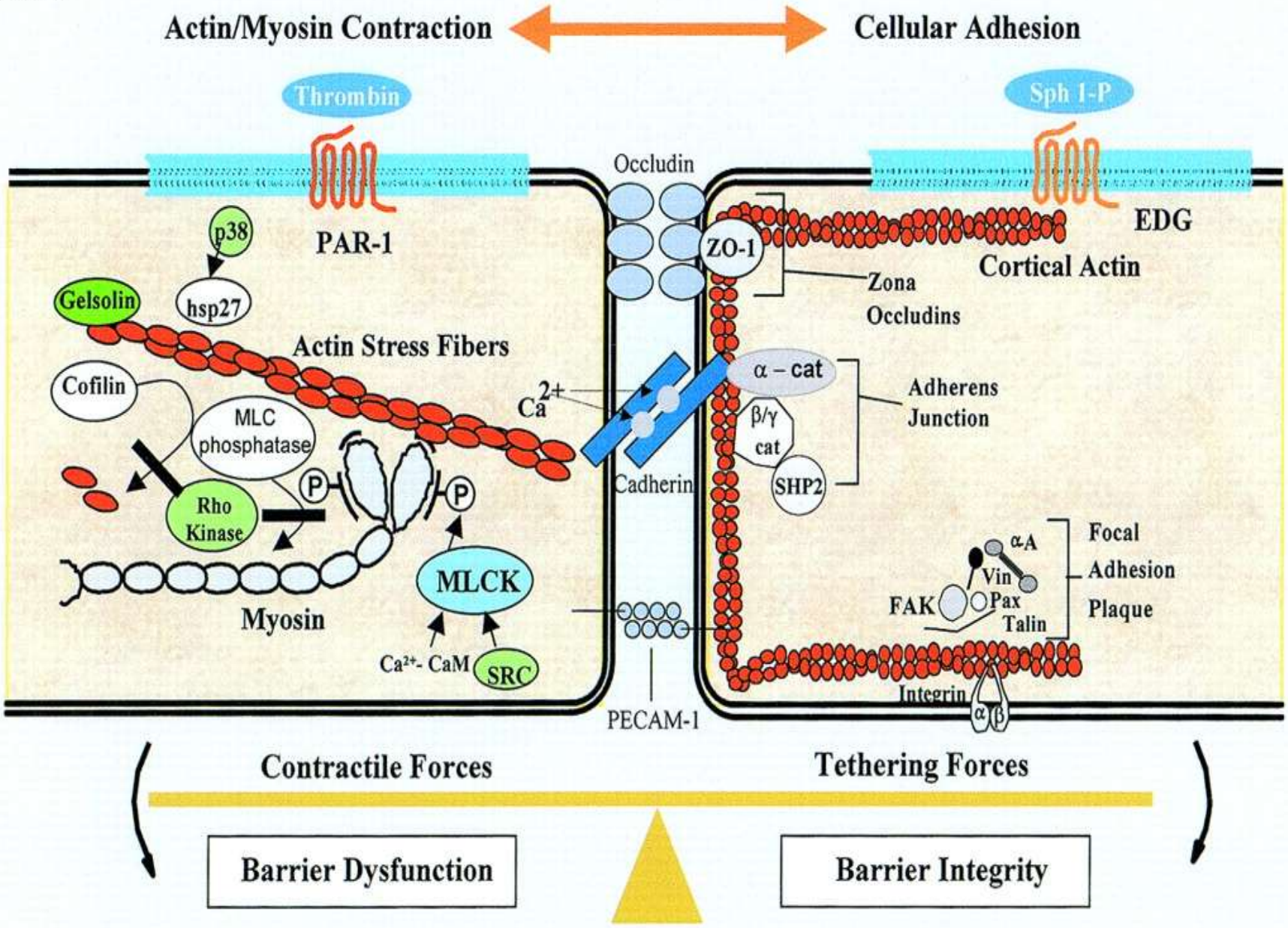


The Starling Equation does NOT tell the Whole Story



- Endothelial and Epithelial Barrier Properties are actively controlled
- Compliance and Hydration of the Lung Interstitium is regulated by matrix metallo-proteinases
- Edema Clearance from the Alveolar Space is accomplished by active Ion Transport

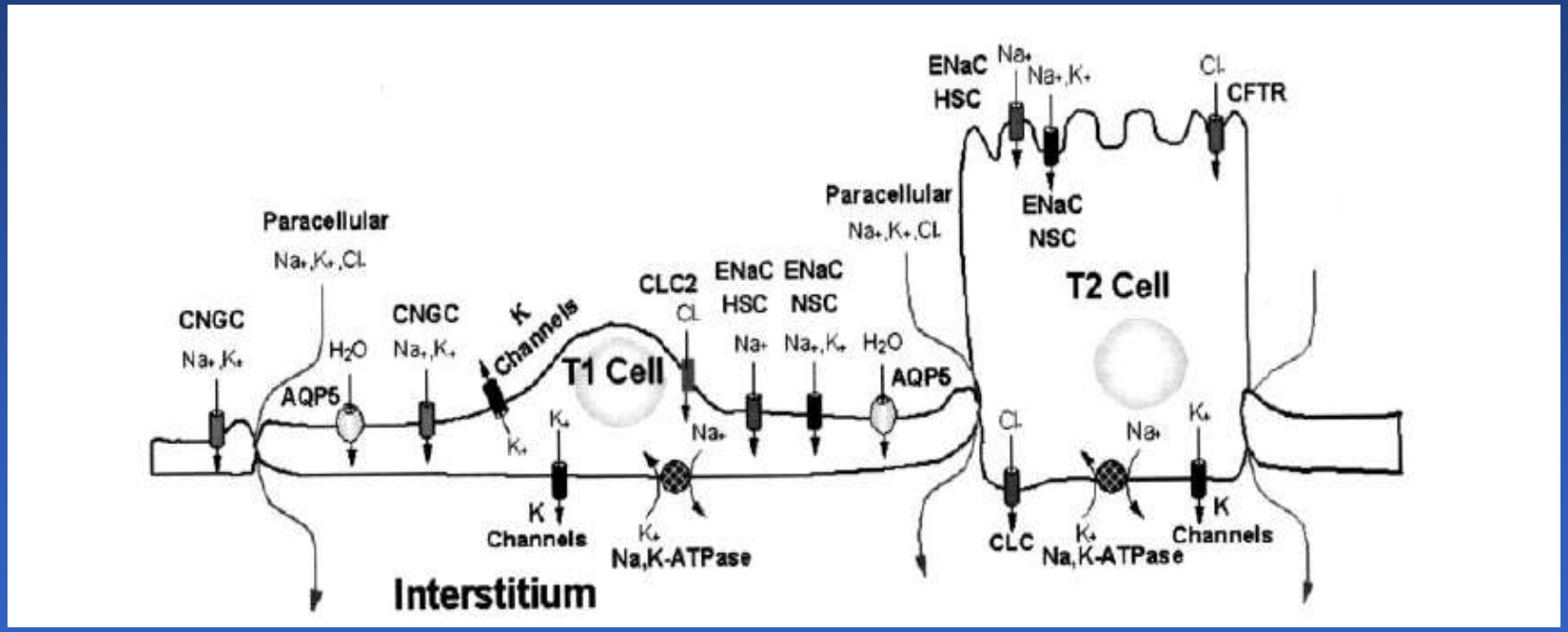
Figure 2



Dudek & Garcia JAP. 91(4):1487-1500, 2001

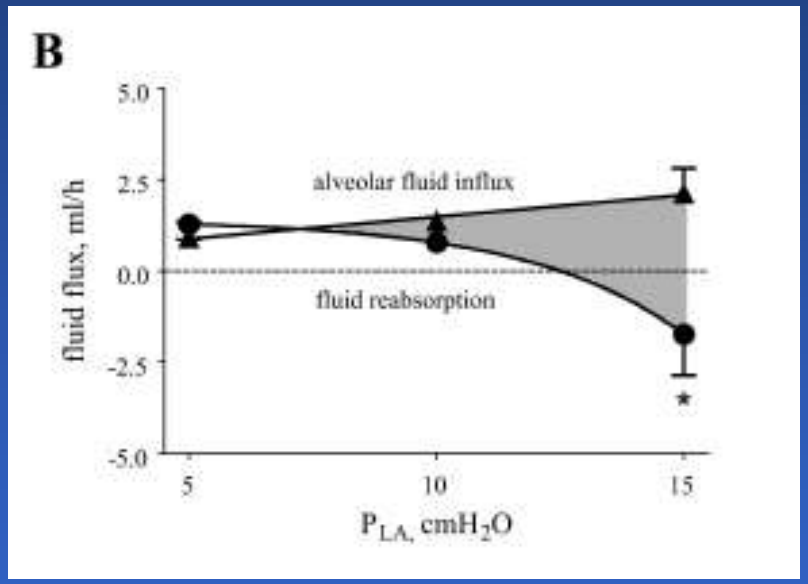
Integrating acute lung injury and regulation of alveolar fluid clearance

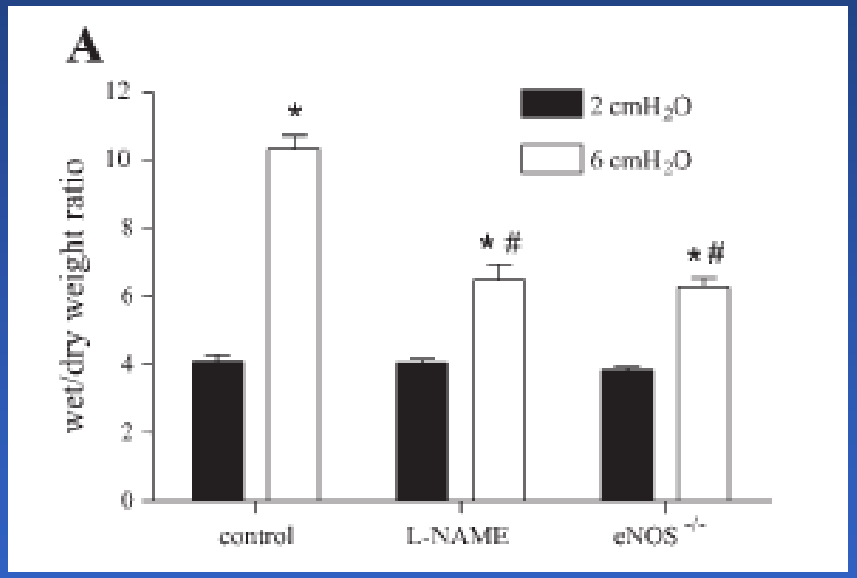
David M. Guidot,[1] Hans G. Folkesson,[2] Lucky Jain,[1]
Jacob I. Sznajder,[3] Jean-François Pittet,[4] and Michael A. Matthay[4]



Am J Physiol Lung Cell Mol Physiol 291: L301–L306, 2006.
First published May 12, 2006; doi:10.1152/ajplung.00153.2006.

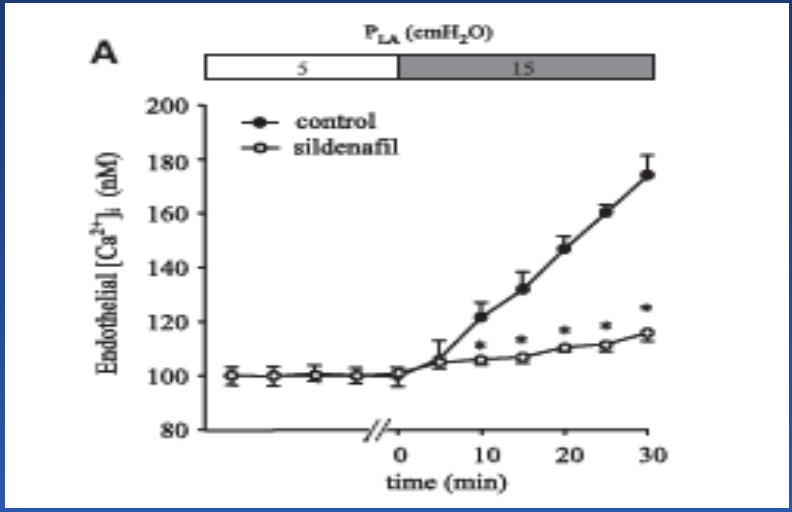
Nitric oxide-dependent inhibition of alveolar fluid clearance in hydrostatic lung edema

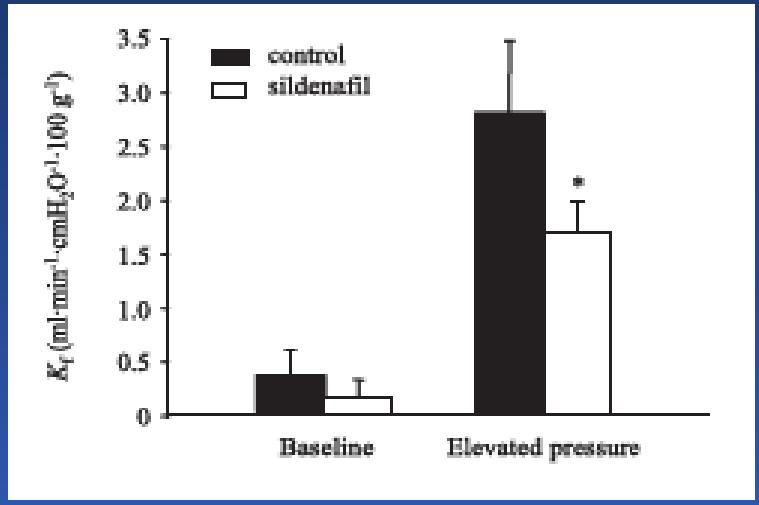


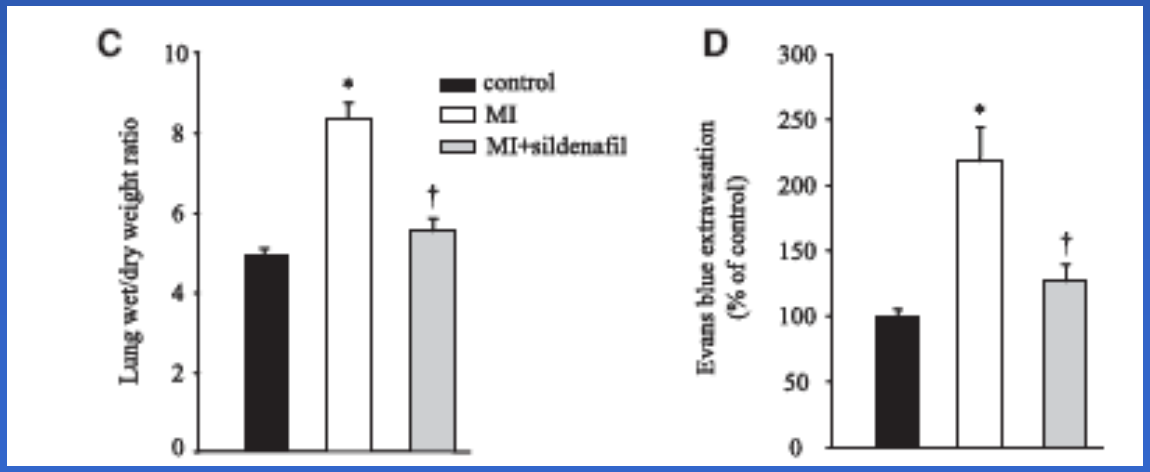


Am J Physiol Lung Cell Mol Physiol 293: L859–L869, 2007.
First published July 6, 2007; doi:10.1152/ajplung.00008.2007.

Negative-Feedback Loop Attenuates Hydrostatic Lung Edema via a cGMP-Dependent Regulation of Transient Receptor Potential Vanilloid 4







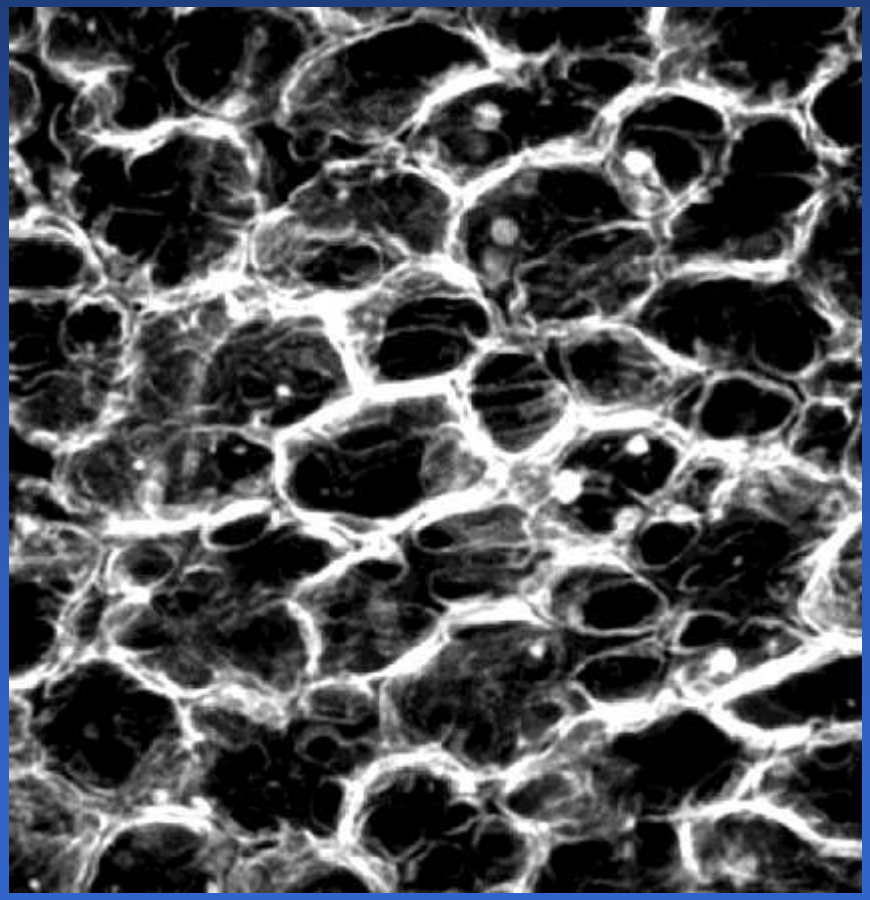
(*Circ Res*. 2008;102:966-974.)

Stimuli of Na Transport

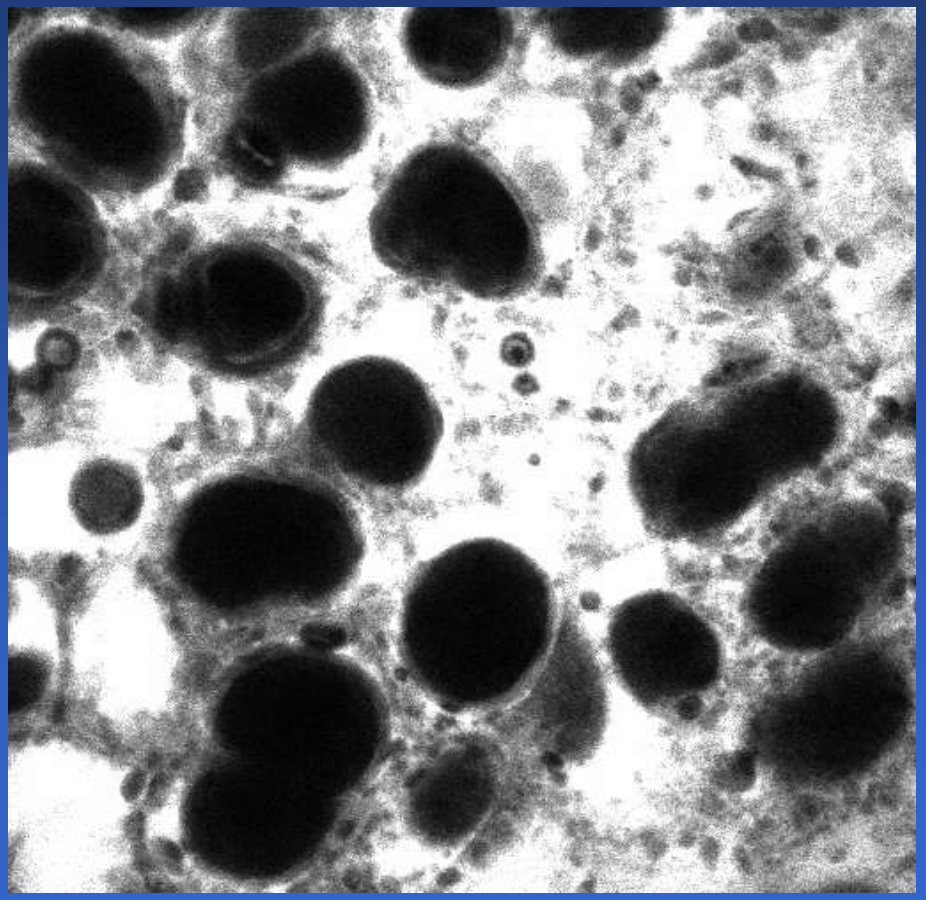
- Dopamine
- Catecholamines
- Glucocorticoids
- Aldosterone
- Thyroid Hormone
- Cytokines and Growth Factors (HGF, KGF, TNFα)

NHLBI Workshop Summary: Alveolar Epithelial Transport. AJRCCM Vol 162 pp 1021, 2001

Normal Lung

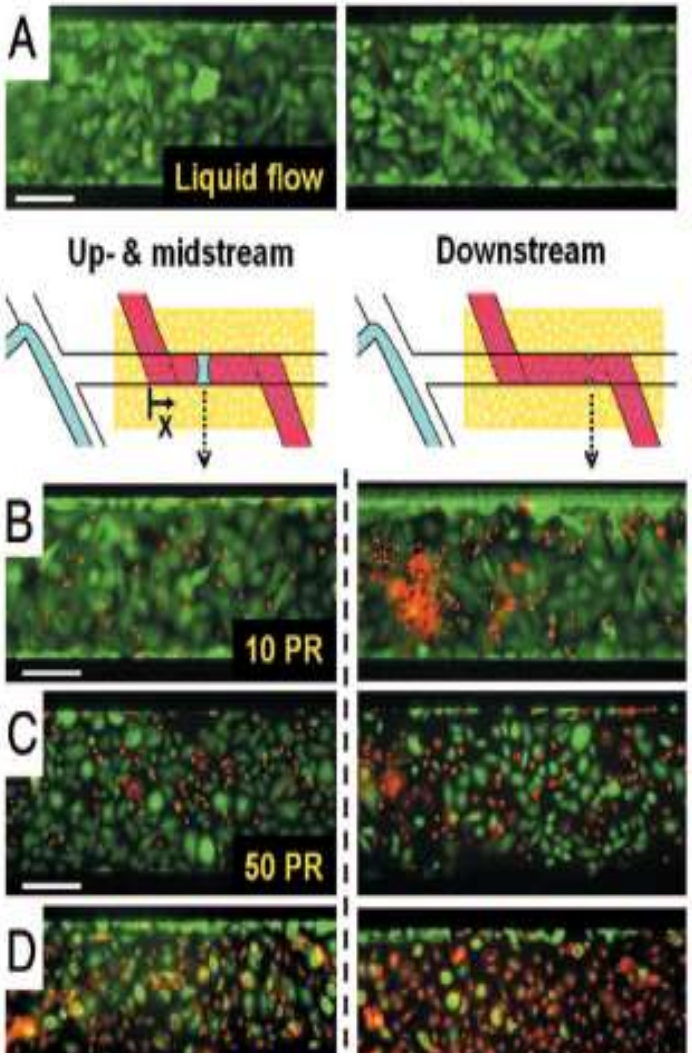


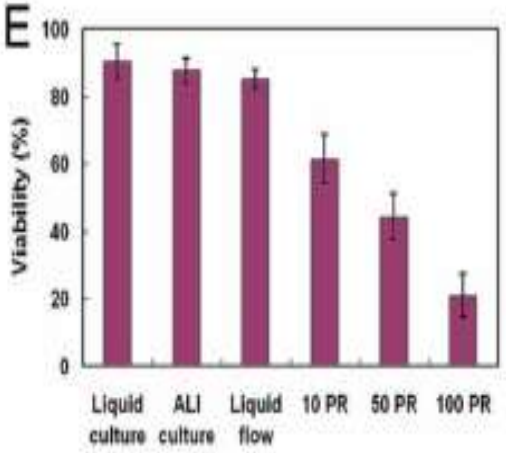
Edematous Lung

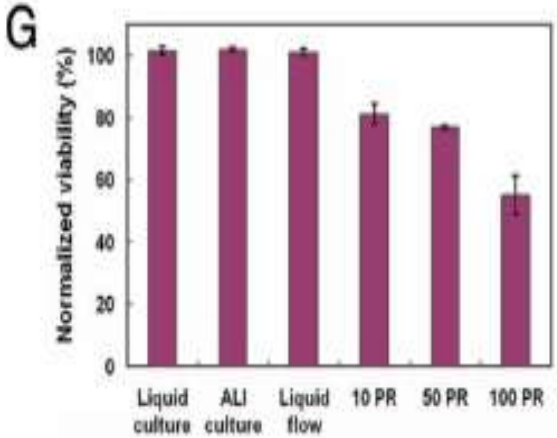


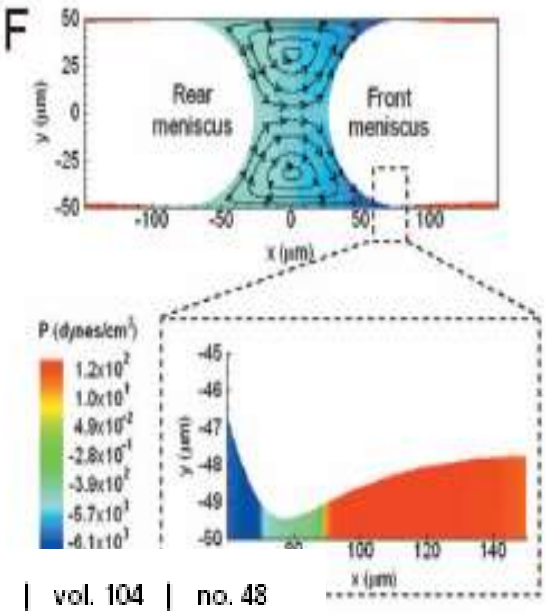
Hubmayr; Am J Respir Crit Care Med, 2002; 165:1647-1653

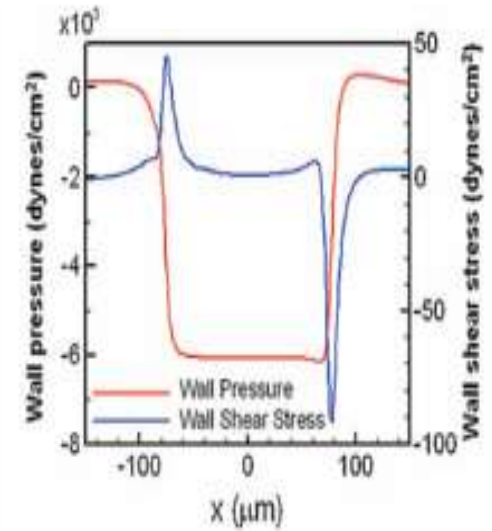
Crackles and the Sounds of VILI











Hue et al.
18886–18891 | PNAS | November 27, 2007 | vol. 104 | no. 48

Patient on Ventilator