

QuickTime™ and a
decompressor
are needed to see this picture.

Ventilation



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Outline

- Ventilatory Failure
- Non-invasive
- Invasive
- Practical Considerations
- Weaning
- Lung Support

Neurological dysfunction

Major surgery

Ventilation: advantages

- Gas exchange
- Work of breathing
- Lung expansion (recruitment)

Severe sepsis

pain

shock

Severe respiratory failure

Significant abdominal distension

CMHG 1.08

Cardiac failure

Ventilation: disadvantages

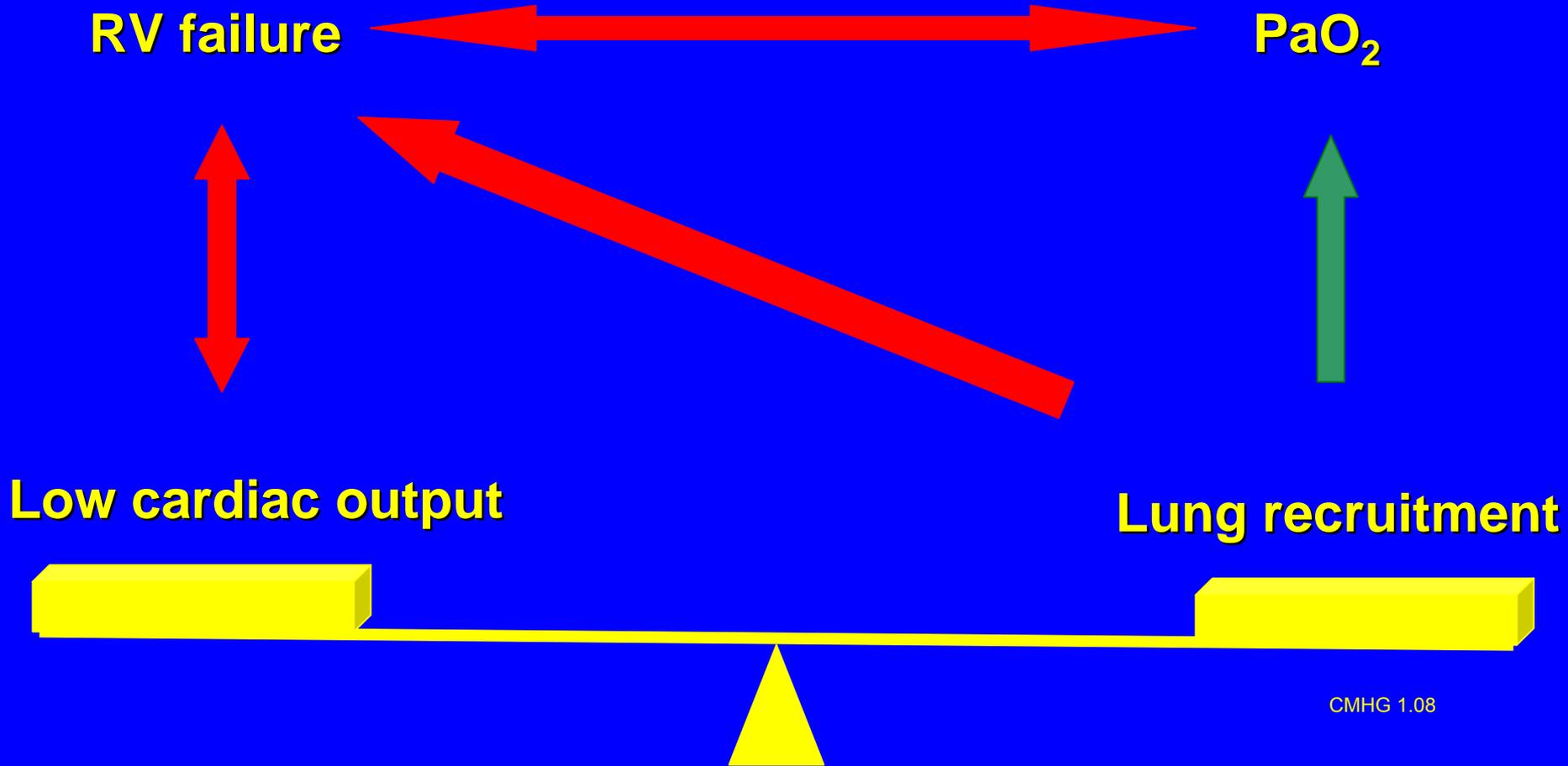
- Sedation
- Pneumonia
- Haemodynamic compromise
- Raised Intrathoracic pressure
- Right heart strain
- Impaired venous return

timing of extubation

monitoring

speed of weaning

Ventilation: a fine balance

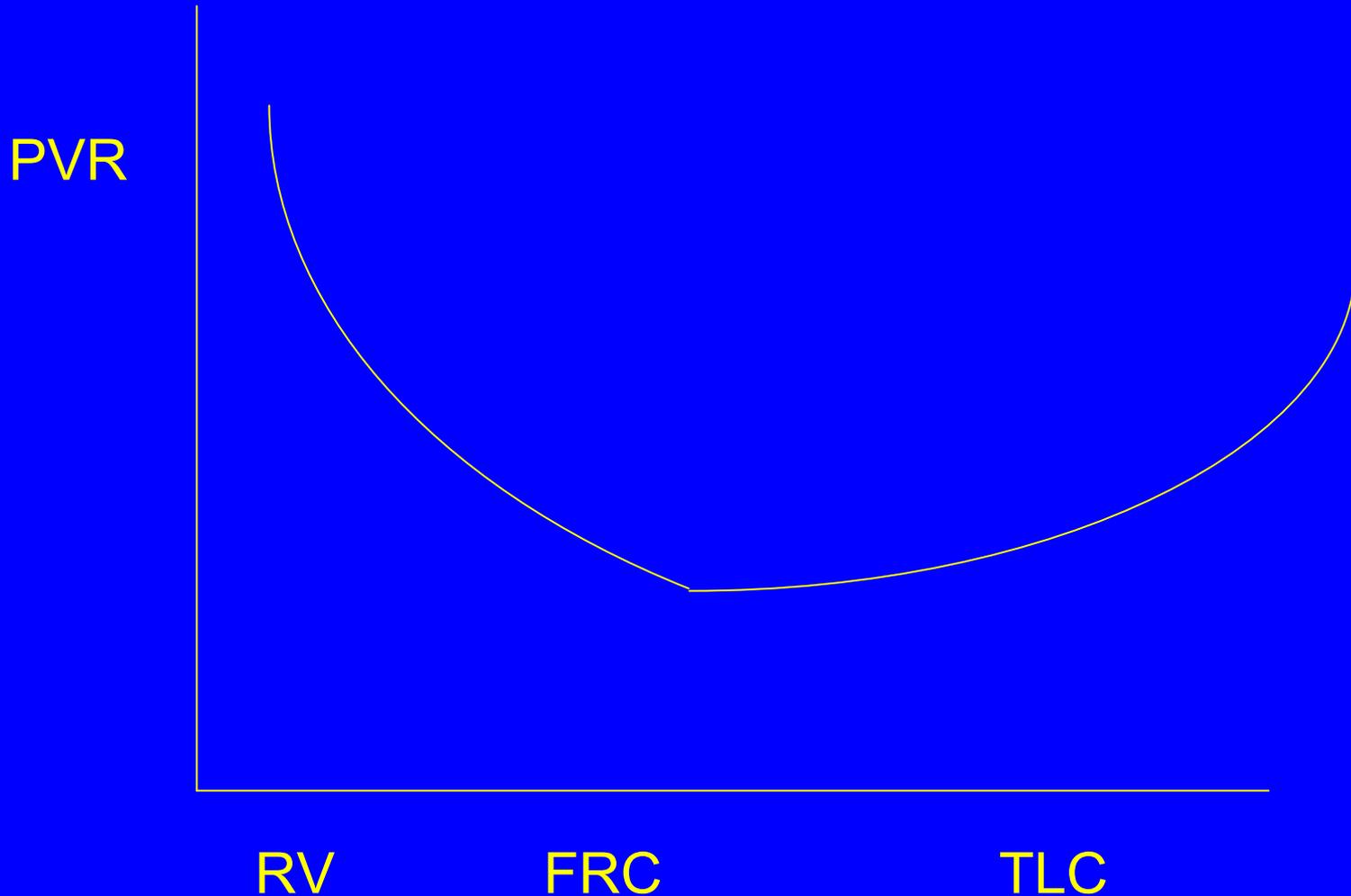


Intrathoracic pressure III

Reduces preload

Increases PVR (afterload)

Lung volume and PVR

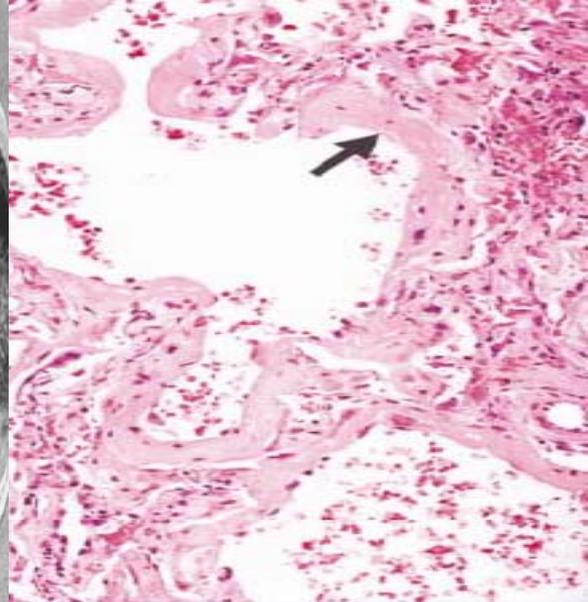


After J F Nunn and J B West

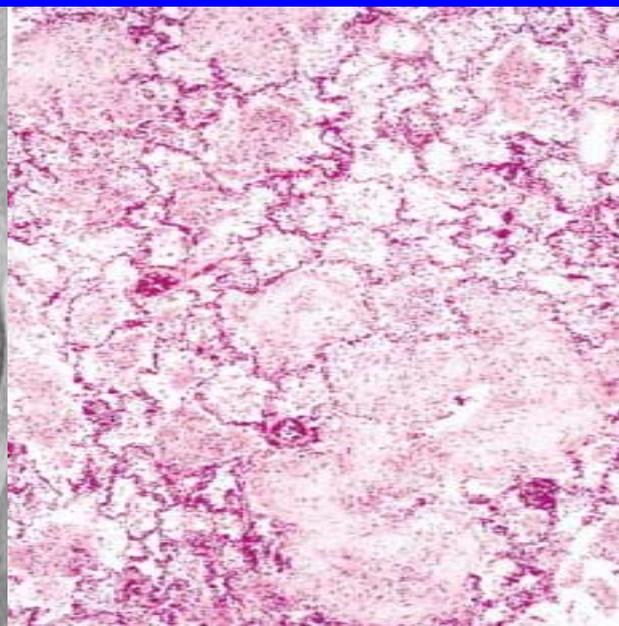
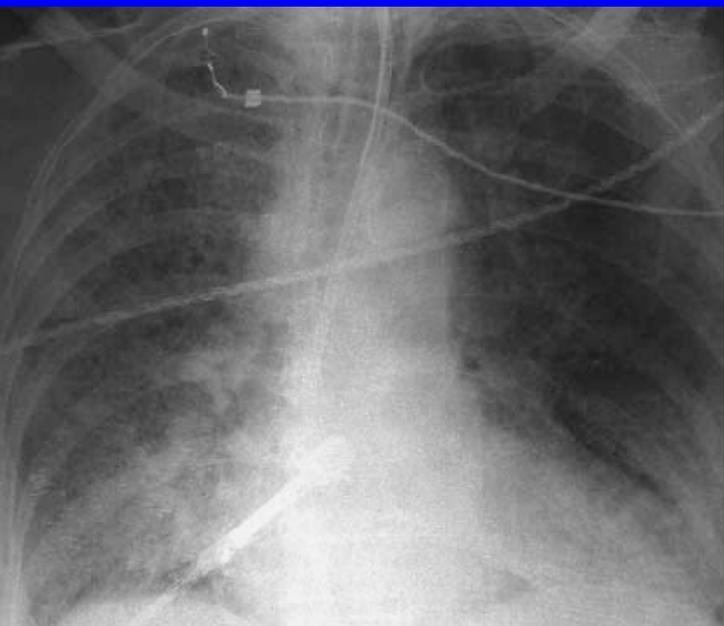
CMHG 1.08

CMHG 7.03

QuickTime™ and a
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are needed to see this picture.

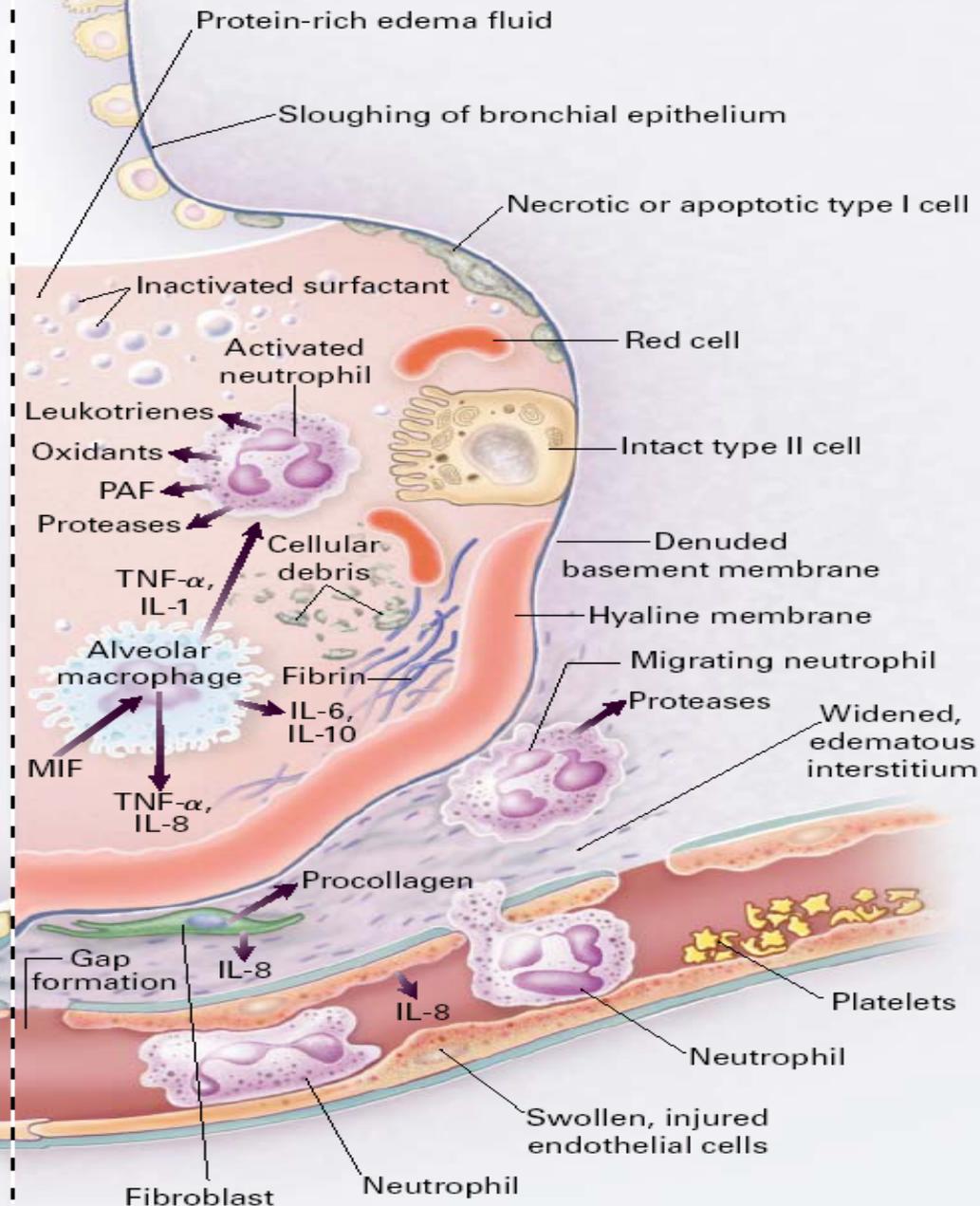
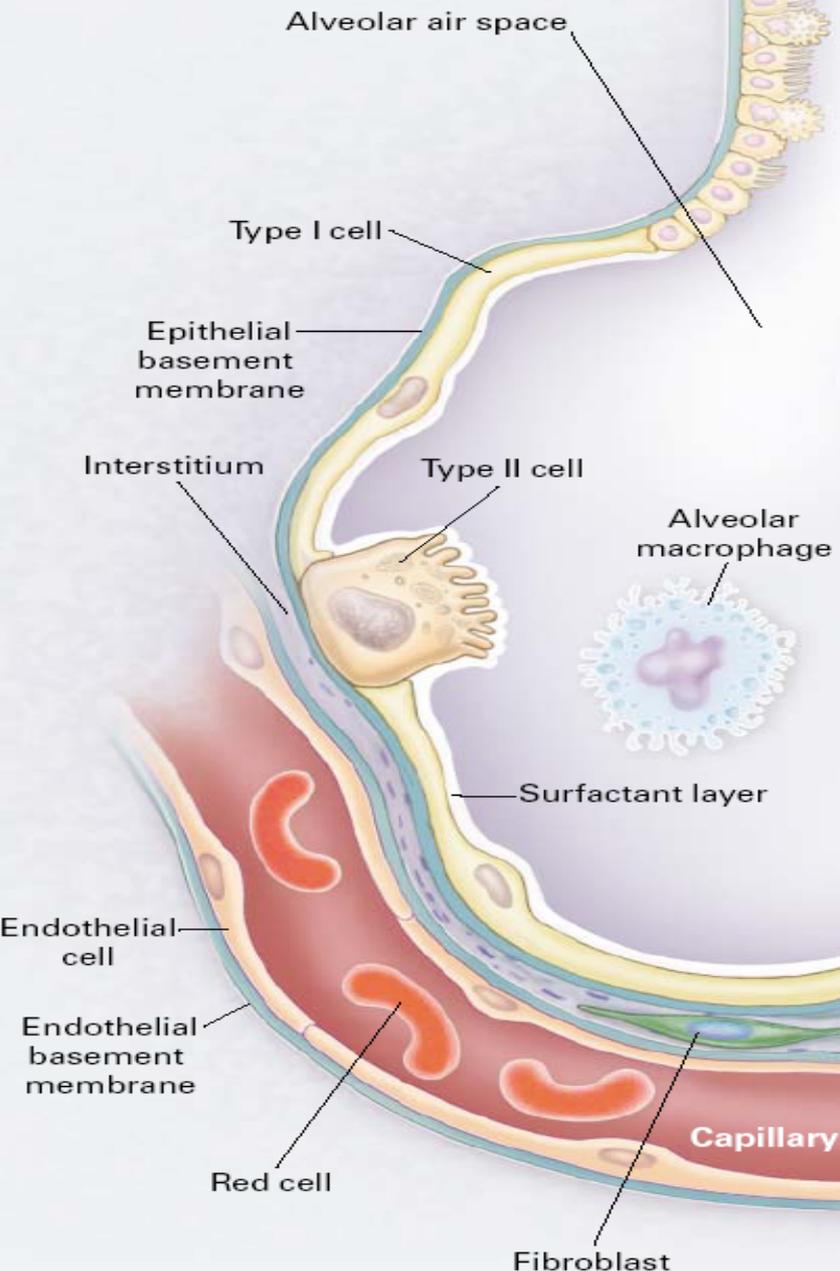


early
late

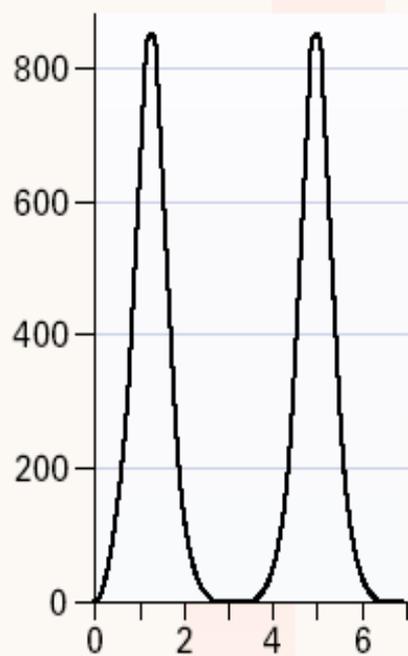
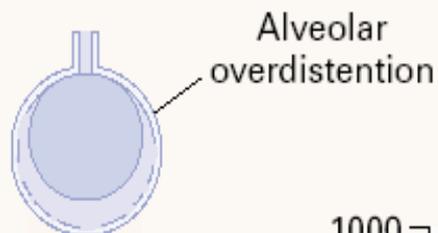


Normal Alveolus

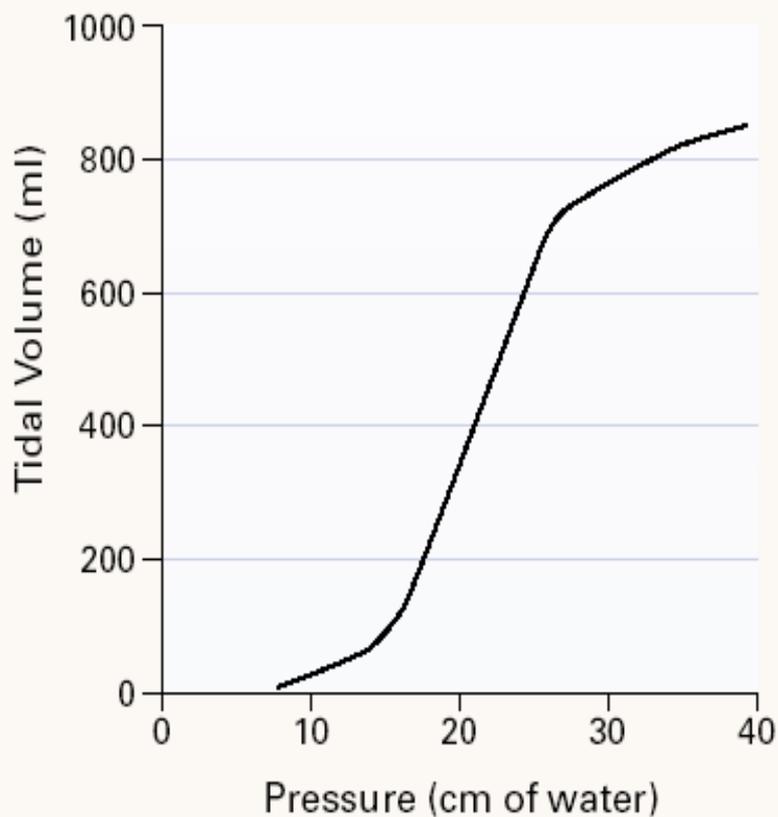
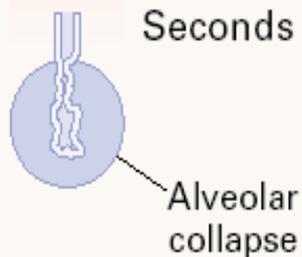
Injured Alveolus during the Acute Phase



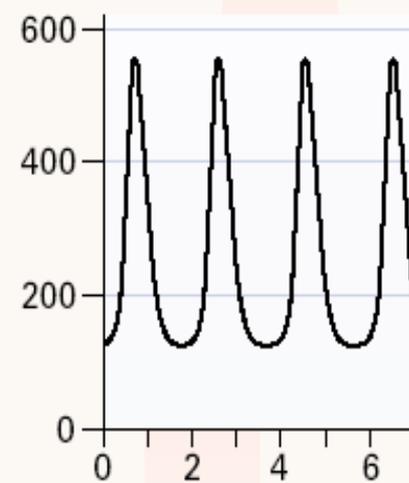
Conventional Ventilation



Seconds



Protective Ventilation



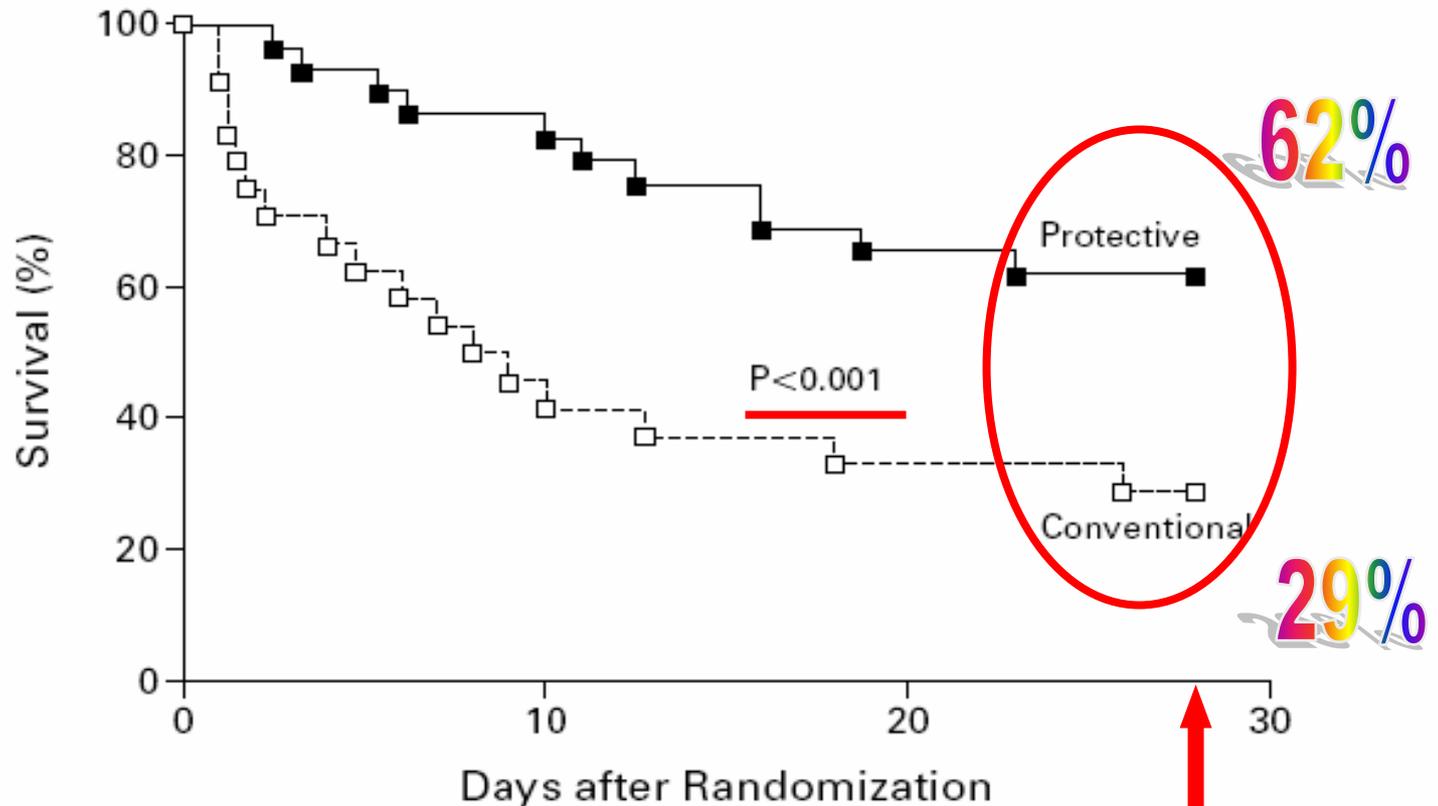
Seconds



(N Engl J Med 1998;338:347-54.)

EFFECT OF A PROTECTIVE-VENTILATION STRATEGY ON MORTALITY IN THE ACUTE RESPIRATORY DISTRESS SYNDROME

MARCELO BRITTO PASSOS AMATO, M.D., CARMEN SILVIA VALENTE BARBAS, M.D., DENISE MACHADO MEDEIROS, M.D., RICARDO BORGES MAGALDI, M.D., GUILHERME DE PAULA PINTO SCHETTINO, M.D., GERALDO LORENZI-FILHO, M.D., RONALDO ADIB KAIRALLA, M.D., DANIEL DEHEINZELIN, M.D., CARLOS MUNOZ, M.D., ROSELAINE OLIVEIRA, M.D., TERESA YAE TAKAGAKI, M.D., AND CARLOS ROBERTO RIBEIRO CARVALHO, M.D.



No. AT RISK

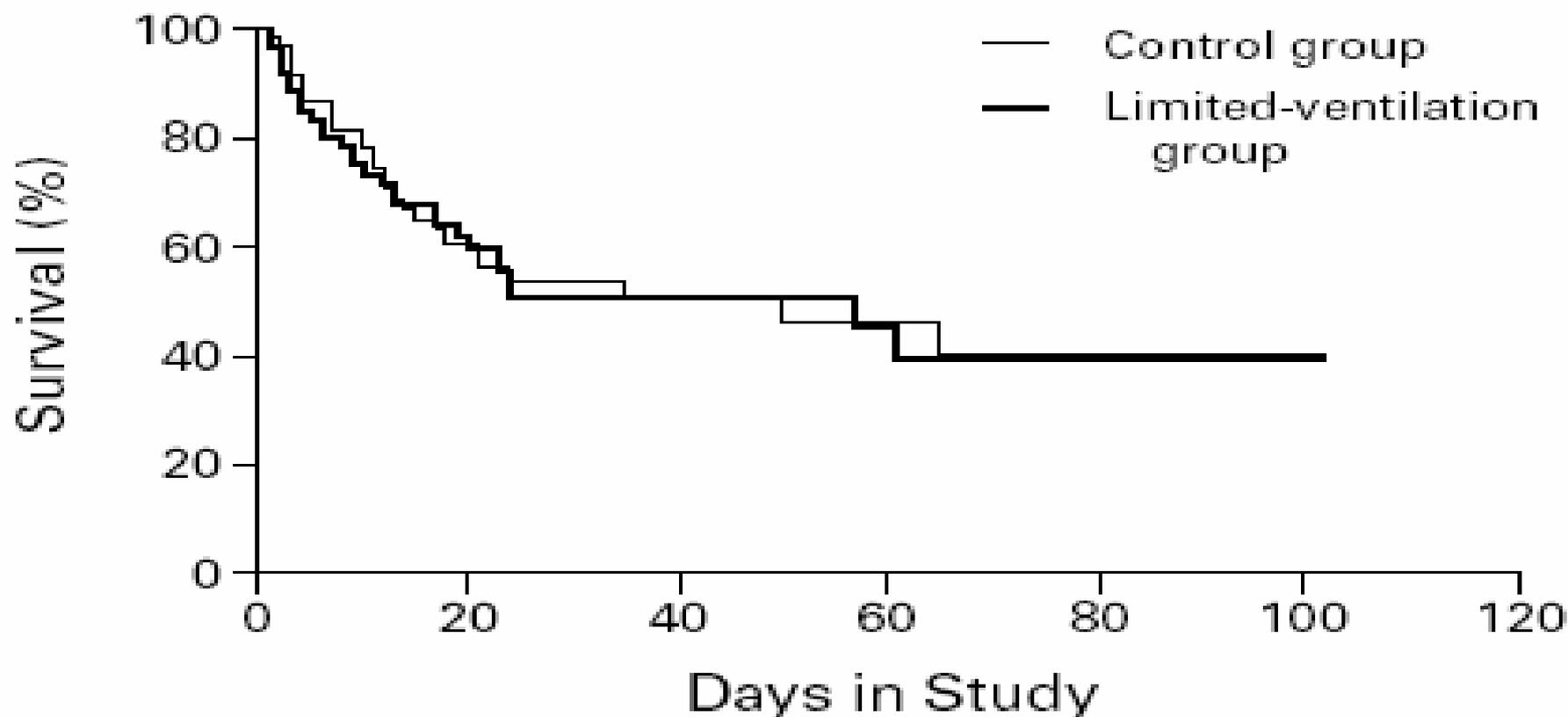
Protective	29	25	20	18
Conventional	24	11	9	7

OUTCOME	PROTECTIVE	CONVENTIONAL	P VALUE	
	VENTILATION (N=29)	VENTILATION (N=24)	ISOLATED COMPARISONS	COMPARISONS CORRECTED FOR MULTIPLE TESTING*
Primary end point — no. (%)				
<u>Mortality at 28 days</u> →	11 (38)	17 (71)	<0.001†	<0.001
Secondary end points — no. (%)				
In-hospital death	13 (45)	17 (71)	0.09‡	0.37
Barotrauma	2 (7)§	10 (42)¶	0.004‡	0.02
<u>Weaning at 28 days</u> →	19 (66)	7 (29)	0.001†	0.005
PEEP (cm of water)				
Protective ventilation	6.2±0.6	16.3±0.7†	16.4±0.4†	13.2±0.4‡
Conventional ventilation	6.2±0.5	6.9±0.8	8.7±0.4	9.3±0.5
Plateau pressure (cm of water)				
Protective ventilation	32.5±1.5	31.8±1.4	30.1±0.7†	23.9±0.7†
Conventional ventilation	29.5±1.5	34.4±1.9	36.8±0.9	37.8±1.2
Peak pressure (cm of water)				
Protective ventilation	40.1±1.5	32.2±1.4†	30.5±0.7†	24.0±0.7†
Conventional ventilation	38.2±2.1	44.2±2.6	46.0±1.1	45.5±1.5
Mean airway pressure (cm of water)				
Protective ventilation	14.1±0.7	24.2±1.2†	23.5±0.6†	17.0±0.6
Conventional ventilation	13.4±0.8	15.7±1.1	17.9±0.6	18.7±0.8
Tidal volume (ml)				
Protective ventilation	661±15	362±11†	348±6†	387±7†
Conventional ventilation	646±24	763±26	768±13	728±17

N Engl J Med '98; 338: 355

EVALUATION OF A VENTILATION STRATEGY TO PREVENT BAROTRAUMA IN PATIENTS AT HIGH RISK FOR ACUTE RESPIRATORY DISTRESS SYNDROME

THOMAS E. STEWART, M.D., MAUREEN O. MEADE, M.D., DEBORAH J. COOK, M.D., JOHN T. GRANTON, M.D., RICHARD V. HODDER, M.D., STEPHEN E. LAPINSKY, M.D., C. DAVID MAZER, M.D., RICHARD F. MCLEAN, M.D., TED S. ROGOVEIN, M.D., B. DIANA SCHOUTEN, R.N., THOMAS R.J. TODD, M.D., ARTHUR S. SLUTSKY, M.D., AND THE PRESSURE- AND VOLUME-LIMITED VENTILATION STRATEGY GROUP*



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VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

THE ACUTE RESPIRATORY DISTRESS SYNDROME NETWORK*

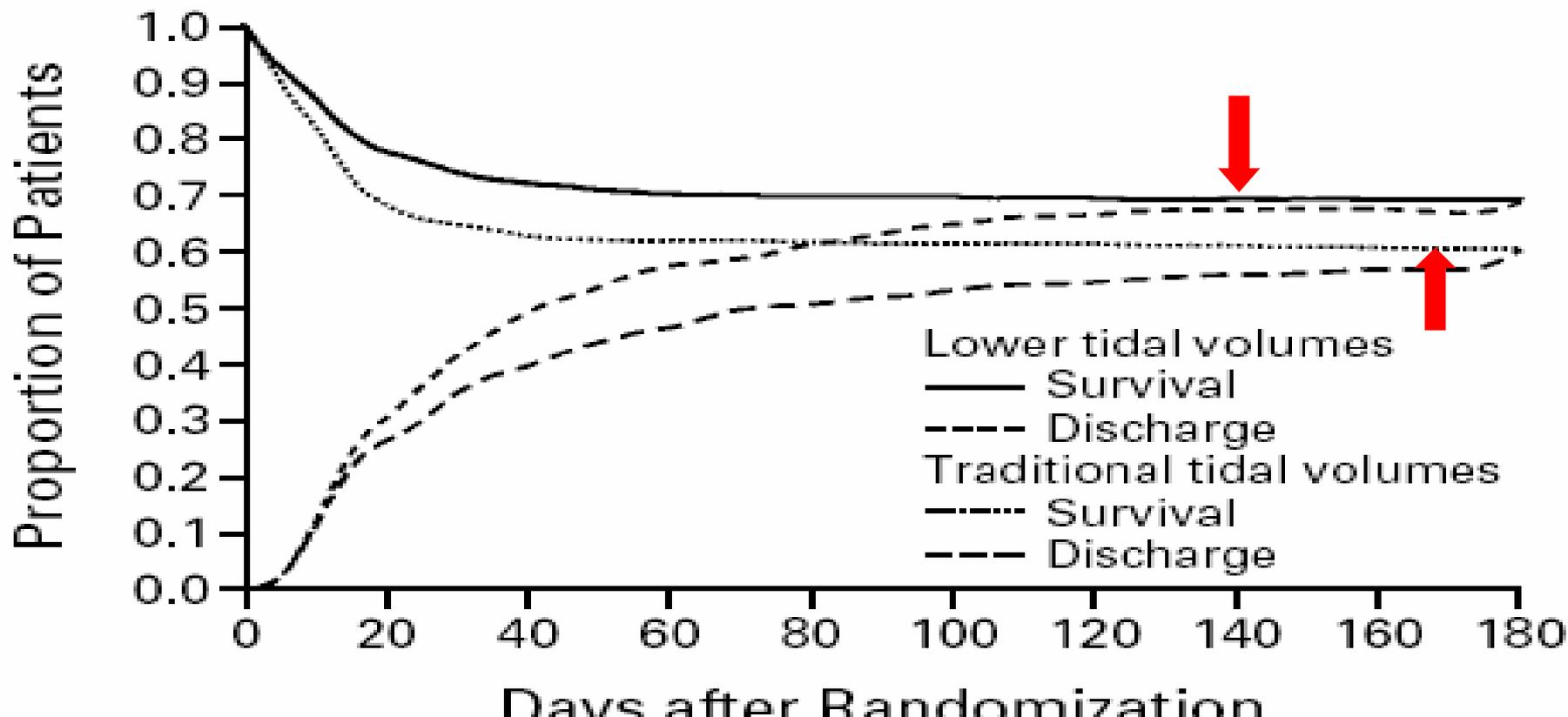


TABLE 4. MAIN OUTCOME VARIABLES.*

VARIABLE	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	P VALUE
Death before discharge home and breathing without assistance (%)	31.0	39.8	0.007
Breathing without assistance by day 28 (%)	65.7	55.0	<0.001
No. of ventilator-free days, days 1 to 28	12±11	10±11	0.007
Barotrauma, days 1 to 28 (%)	10	11	0.43
No. of days without failure of nonpulmonary organs or systems, days 1 to 28	15±11	12±11	0.006

VARIABLE	DAY 1		DAY 3		DAY 7	
	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES
Tidal volume (ml/kg of predicted body weight)	6.2±0.9	11.8±0.8	6.2±1.1	11.8±0.8	6.5±1.4	11.4±1.4
No. of patients	387	405	294	307	181	179
Plateau pressure (cm of water)	25±7	33±9	26±7	34±9	26±7	37±9
No. of patients	384	399	294	307	168	173
Peak inspiratory pressure (cm of water)	32±8	39±10	33±9	40±10	33±9	44±10
No. of patients	382	401	295	308	178	177
Mean airway pressure (cm of water)	17±13	17±12	17±14	19±17	17±14	20±10
No. of patients	369	385	288	301	176	173
Respiratory rate (breaths/min)	29±7	16±6	30±7	17±7	30±7	20±7
No. of patients	389	406	296	308	185	181
Minute ventilation (liters/min)	12.9±3.6	12.6±4.5	13.4±3.5	13.4±4.8	13.7±3.8	14.9±5.3
No. of patients	387	401	296	307	182	177

ARDS net continued

VARIABLE	DAY 1		DAY 3		DAY 7	
	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES
PaCO ₂ (mm Hg)	40±10	35±8	43±12	36±9	44±12	40±10
No. of patients	351	369	285	297	147	160
Arterial pH	7.38±0.08	7.41±0.07	7.38±0.08	7.41±0.07	7.40±0.07	7.41±0.08
No. of patients	351	369	285	297	148	160

Normal PaCO₂!

Interpreting results

Characteristics of control group

Differences in PEEP

Recruitment manouvres

Fan E. JAMA '07; 294:2889

Side effects (lung protective ventilation)

Hypercapnia

Sedation

Possibly worsened oxygenation

Recruitment manouvres

Brief sustained pressures 35-40 cm H₂O

No evidence of benefit

ARDSnet. N Engl J Med '04; 351:327-36

Some enthusiasts; not many in UK

Haemodynamic and respiratory problems in practice

Prone ventilation

Improvement in oxygenation

Gattinoni. N Engl J Med '01; 345:568-73

No hospital survival benefit

Positional side effects

Mancebo. Intensive Care Med '03; 29: 564
Guelin. JAMA '04; 292:2379-87

Prone ventilation. Physiology

More uniform distribution of V and Q

Better matching

Mure. J Appl Physiol '00; 88:1076-1083

Drainage of secretions

Improved fit of the lung

Albert. Am J Respir Crit Care Med 2000; 161:1660-1665

Better chest mechanics

Pelosi. Am J Respir Crit Care Med 1998; 157:387-393



What about PEEP

P_{Flex}

Tricky at the bedside in practice

Ware. N Engl J Med '00; 342:1334

Thoracic P_{flex} \neq alveolar P_{flex}

Hickling. Am J R Crit Care Med '98; 158:194

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Higher versus Lower Positive End-Expiratory Pressures in Patients with the Acute Respiratory Distress Syndrome

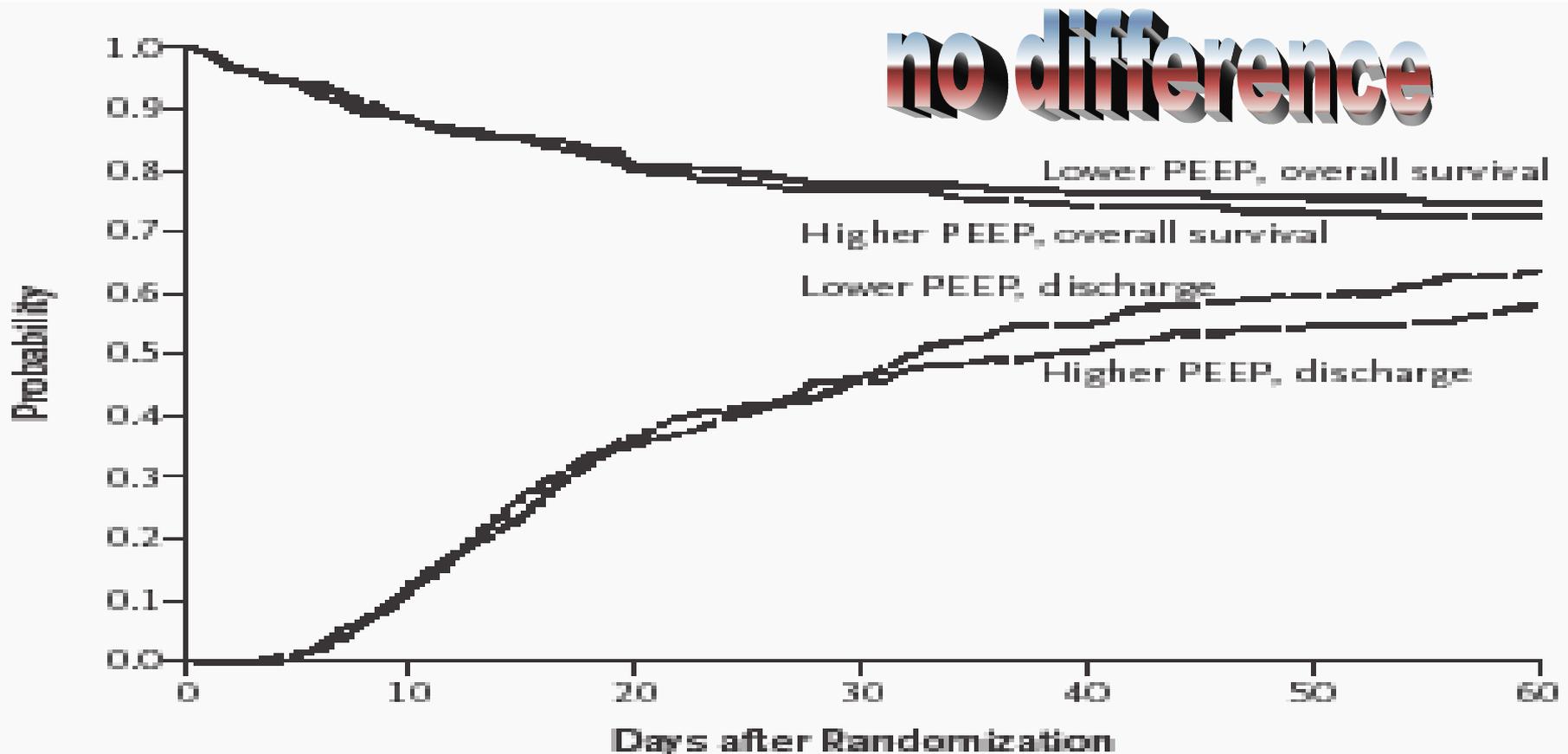


Table 4. Main Outcome Variables.*

Outcome	Lower-PEEP Group	Higher-PEEP Group	P Value
Death before discharge home (%) †			
Unadjusted	24.9	27.5	0.48
Adjusted for differences in baseline covariates	27.5	25.1	0.47
Breathing without assistance by day 28 (%)	72.8	72.3	0.89
No. of ventilator-free days from day 1 to day 28 †	14.5±10.4	13.8±10.6	0.50
No. of days not spent in intensive care unit from day 1 to day 28	12.2±10.4	12.3±10.3	0.83

Allowable combinations of PEEP and FiO₂ †

Lower-PEEP group

FiO ₂	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18–24

Higher-PEEP group (before protocol changed to use higher levels of PEEP)

FiO ₂	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22–24

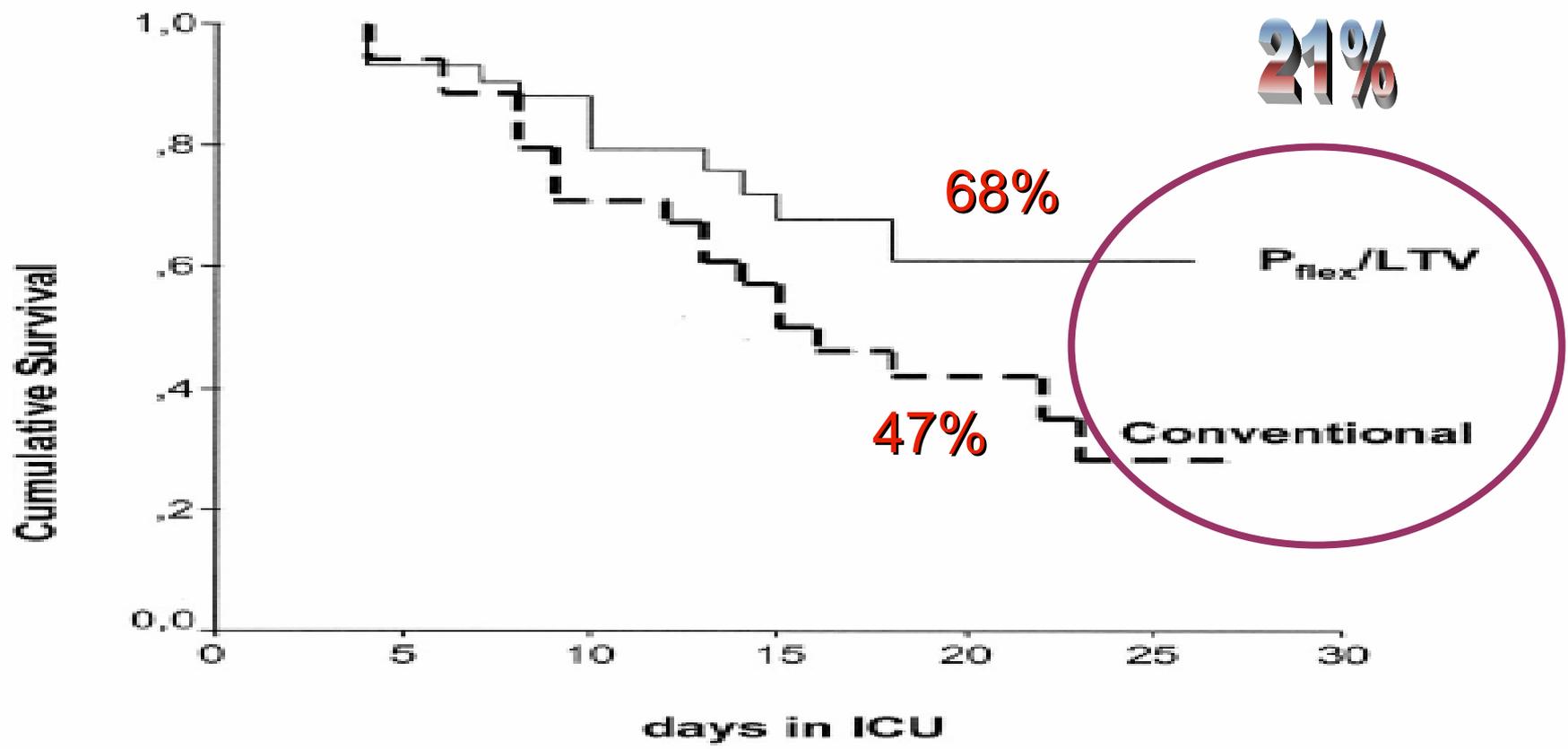
Higher-PEEP group (after protocol changed to use higher levels of PEEP)

FiO ₂	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0
PEEP	12	14	14	16	16	18	20	22	22	22–24

A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: A randomized, controlled trial*

Jesús Villar, MD, PhD, FCCM; Robert M. Kacmarek, PhD, FCCM; Lina Pérez-Méndez, MD, PhD; Armando Aguirre-Jaime, PhD; for the ARIES Network

(Crit Care Med 2006; 34:1311-1318)



P _{flex} /LTV	50	46	33	20	12	8	7
Control	45	43	32	23	17	13	10

A high positive end-expiratory pressure, low tidal volume ventilatory strategy improves outcome in persistent acute respiratory distress syndrome: A randomized, controlled trial*

Jesús Villar, MD, PhD, FCCM; Robert M. Kacmarek, PhD, FCCM; Lina Pérez-Méndez, MD, PhD; Armando Aguirre-Jaime, PhD; for the ARIES Network. (Crit Care Med 2006; 34:1311-1318)

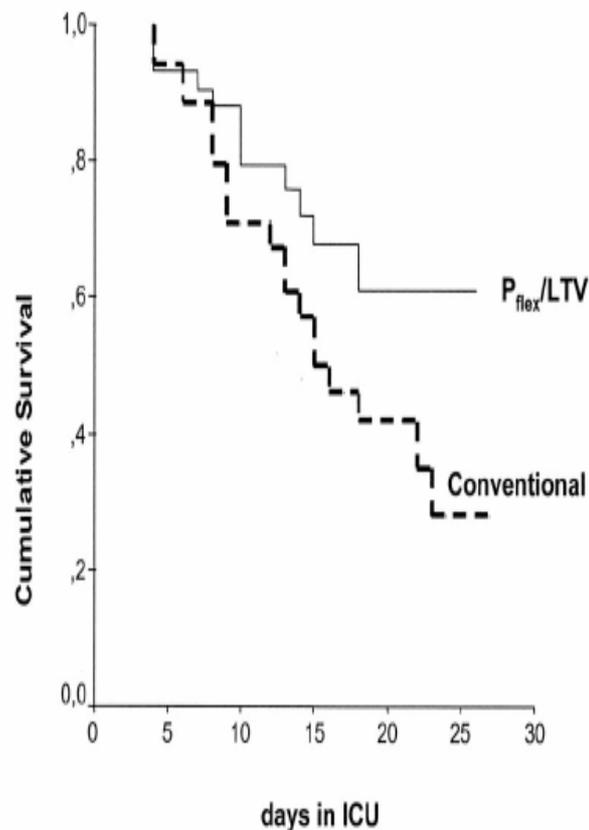


Table 2. Main outcome variables

	Control	P _{flex} /LTV	p Value
Ventilator-free days	6.0 ± 7.9	10.9 ± 9.4	.008
Barotrauma, n (%)	4 (8.4)	2 (4)	.418
No. of organ failures: post-pre randomization	1.2 (0.7-1.6)	0.3 (0-0.7)	<.001
ICU mortality rate, %	53.3	32.0	.040

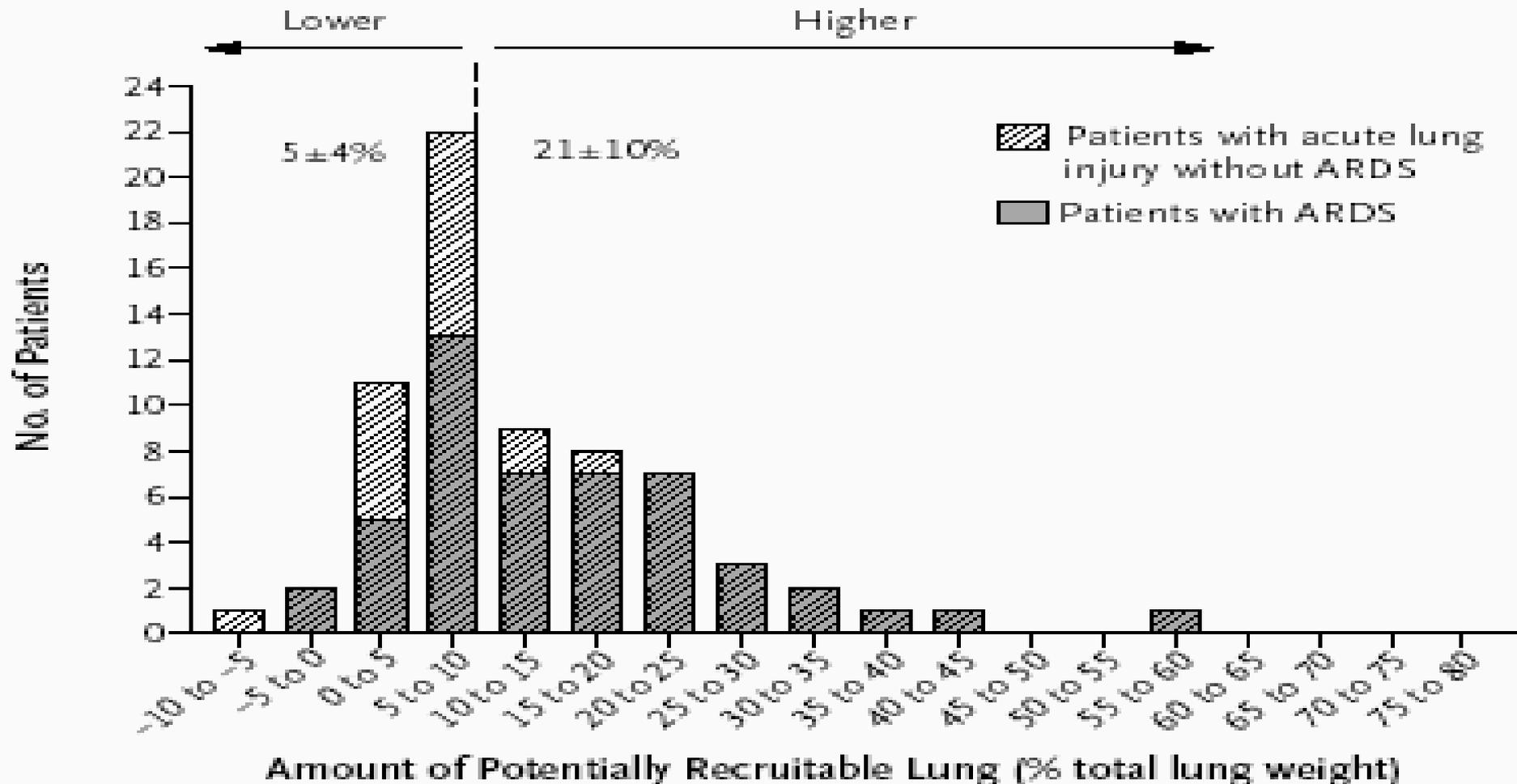
P_{flex}, lower inflection point of the pressure volume curve of the respiratory system; LTV, low tidal volume; ICU, intensive care unit.

Jesús Villar, MD, PhD, FCCM; Robert M. Kacmarek, PhD, FCCM; Lina Pérez-Méndez, MD, PhD; Armando Aguirre-Jaime, PhD; for the ARIES Network (continued)

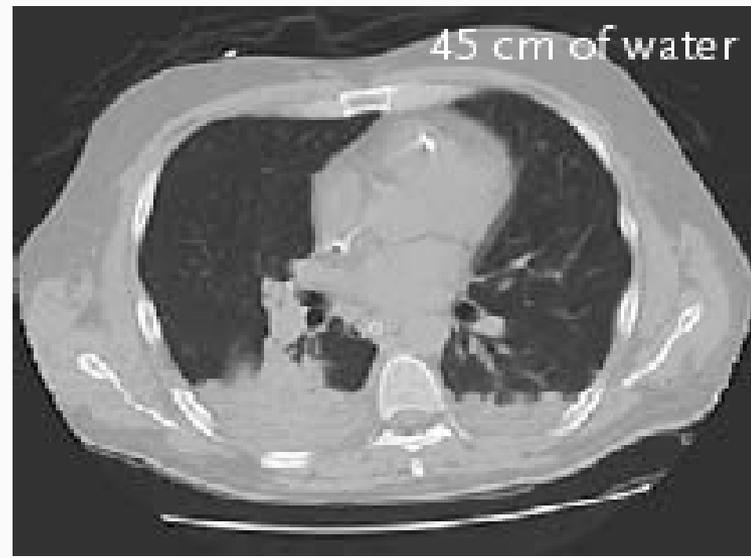
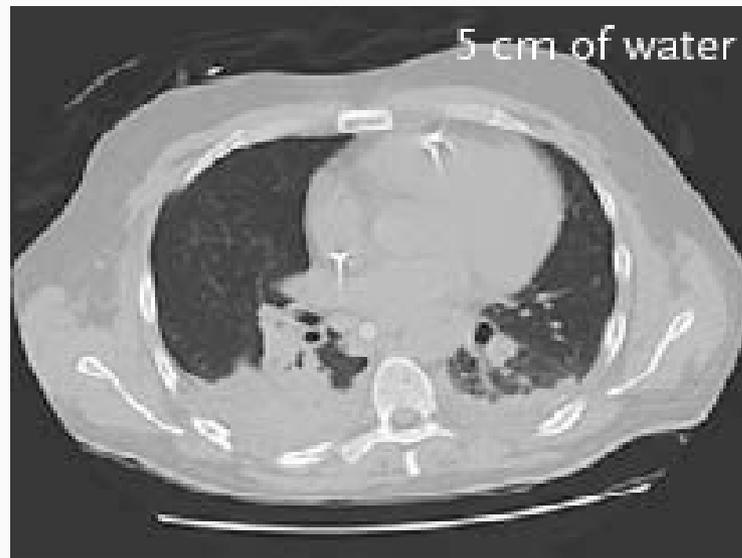
Variable, Units	Day 1		Day 3		Day 6	
	Control n = 45	P _{flex} /LTV n = 50	Control n = 45	P _{flex} /LTV n = 50	Control n = 42	P _{flex} /LTV n = 41
Tidal volume, mL/kg PBW	10.2 ± 1.2	7.3 ± 0.9 ^a	10.0 ± 1.0	7.1 ± 0.9 ^a	9.9 ± 1.2	7.1 ± 0.9 ^a
PEEP, cm H ₂ O	9.0 ± 2.7	14.1 ± 2.8 ^a	8.7 ± 2.8	11.2 ± 3.1 ^b	8.3 ± 3.7	8.2 ± 3.5
Respiratory rate, breaths/min	15.0 ± 3.0	20.6 ± 4.0 ^b	15.9 ± 2.9	19.8 ± 3.0 ^b	16.1 ± 5	18 ± 4.0 ^c
Peak inspiratory pressure, cm H ₂ O	37.1 ± 7.7	36.3 ± 5.9	38.0 ± 8.1	32.5 ± 6.6 ^b	36.7 ± 8.6	29.2 ± 7.6 ^a
Plateau pressure, cm H ₂ O	32.6 ± 6.2	30.6 ± 6.0	32.5 ± 7.5	28.4 ± 5.4 ^c	32.4 ± 8.0	25.7 ± 7.2 ^a

**Lung Recruitment in Patients
with the Acute Respiratory Distress Syndrome**

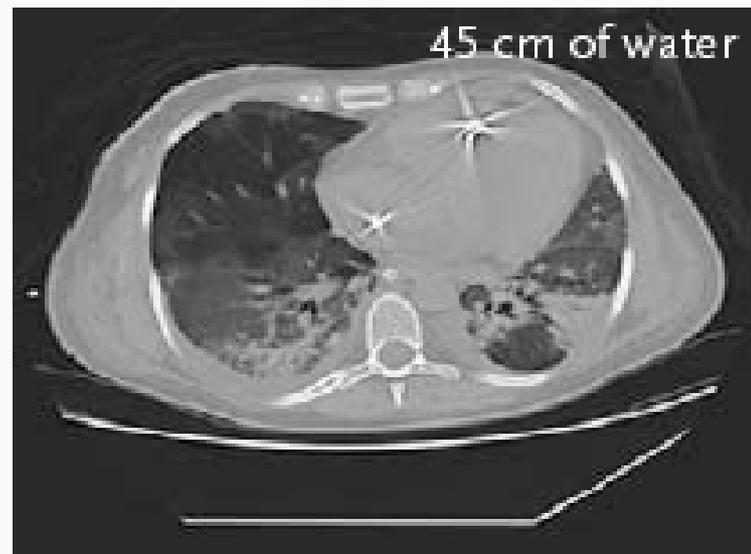
Luciano Gattinoni, M.D., F.R.C.P., Pietro Caironi, M.D., Massimo Cressoni, M.D., Davide Chiumello, M.D.,
V. Marco Ranieri, M.D., Michael Quintel, M.D., Ph.D., Sebastiano Russo, M.D., Nicolò Patroniti, M.D.,
Rodrigo Cornejo, M.D., and Guillermo Bugedo, M.D.



B Lower Percentage of Potentially Recrutable Lung



C Higher Percentage of Potentially Recrutable Lung



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**Lung Recruitment in Patients
with the Acute Respiratory Distress Syndrome**

Luciano Gattinoni, M.D., F.R.C.P., Pietro Caironi, M.D., Massimo Cressoni, M.D., Davide Chiumello, M.D.,
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Rodrigo Cornejo, M.D., and Guillermo Bugedo, M.D.

Variation in lung recruitability

Recruitable lungs more responsive to PEEP

Limit PEEP in non-recruitable lungs

Ventilation Strategy Using Low Tidal Volumes, Recruitment Maneuvers, and High Positive End-Expiratory Pressure for Acute Lung Injury and Acute Respiratory Distress Syndrome: A Randomized Controlled Trial

Maureen O. Meade; Deborah J. Cook; Gordon H. Guyatt; et al.

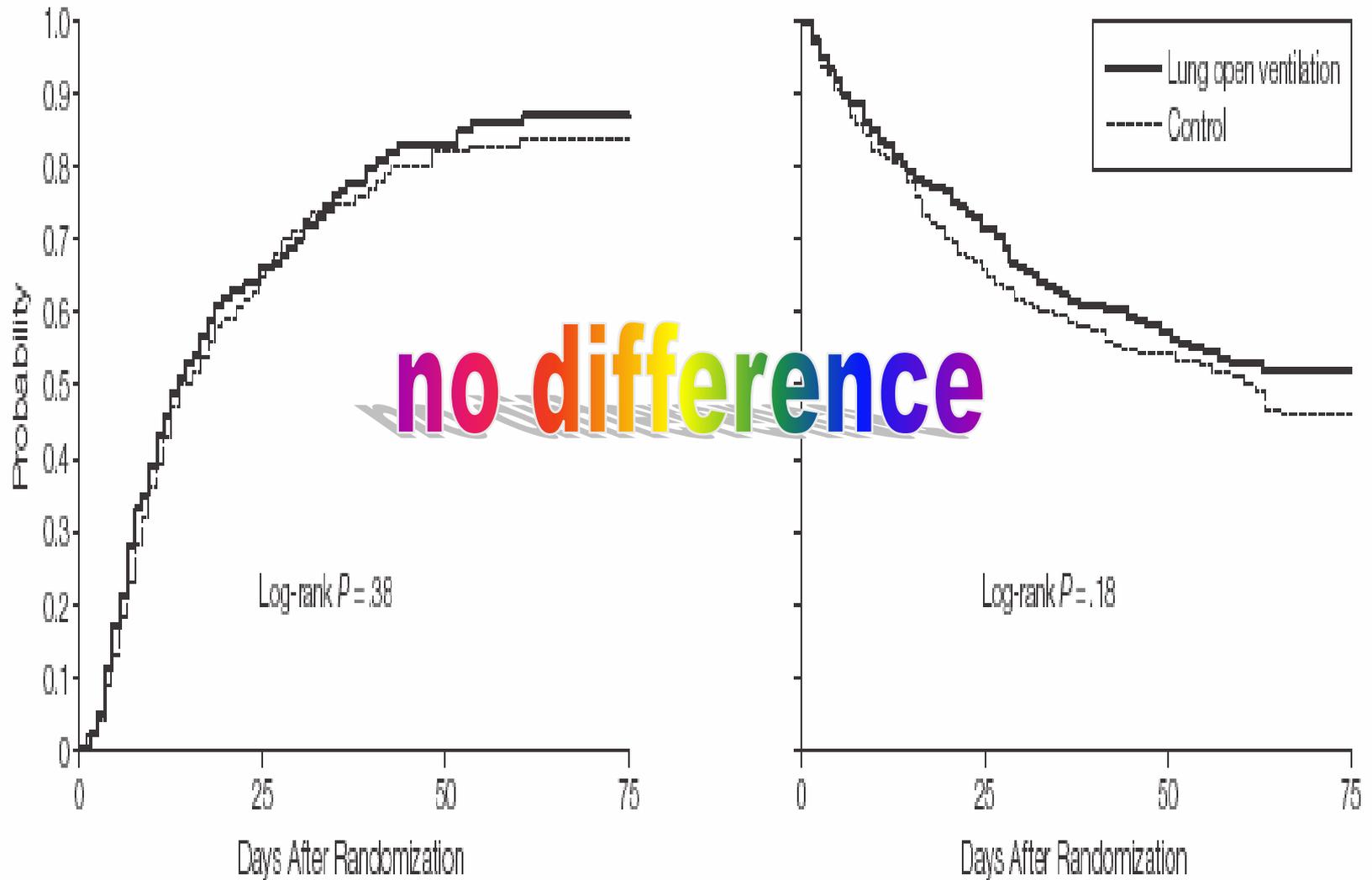
JAMA. 2008;299(6):637-645 (doi:10.1001/jama.299.6.637)

<http://jama.ama-assn.org/cgi/content/full/299/6/637>

Variables	Lung Open Ventilation	Control	P Value
Tidal volume, mean (SD), mL/kg predicted body weight	6.8 (1.4)	6.8 (1.3)	.76
No. of patients	436	469	
Total respiratory rate, mean (SD), /min	25.2 (6.6)	26.0 (6.5)	.08
No. of patients	471	507	
Plateau pressure, mean (SD), cm H ₂ O	30.2 (6.3)	24.9 (5.1)	<.001
Set PEEP, mean (SD), cm H ₂ O	15.6 (3.9)	10.1 (3.0)	<.001
All patients			
No. of patients	471	507	
Pao ₂ /Fio ₂ , mean (SD)	187.4 (68.8)	149.1 (60.6)	<.001
No. of patients	464	498	
Pao ₂ , mean (SD), mm Hg	88.1 (32.0)	80.1 (25.2)	<.001

Breathing independently

All-cause mortality



No. at Risk

Lung open ventilation	475	99	23	11	475	223	91	43
Control ventilation	508	95	26	1	508	220	97	47

Ventilation Strategy Using Low Tidal Volumes, Recruitment Maneuvers, and High Positive End-Expiratory Pressure for Acute Lung Injury and Acute Respiratory Distress Syndrome: A Randomized Controlled Trial

Maureen O. Meade; Deborah J. Cook; Gordon H. Guyatt; et al.

JAMA. 2008;299(6):637-645 (doi:10.1001/jama.299.6.637)

<http://jama.ama-assn.org/cgi/content/full/299/6/637>

Outcomes	Ventilation (n = 475)	Ventilation (n = 508)
Death in hospital	173 (36.4)	205 (40.4)
Refractory hypoxemia	22 (4.6)	52 (10.2)
Death with refractory hypoxemia	20 (4.2)	45 (8.9)
Refractory barotrauma	14 (3.0)	12 (2.4)
Death with refractory barotrauma	8 (1.7)	8 (1.6)
Eligible use of rescue therapies ^c	24 (5.1)	47 (9.3)

Some important differences!

Positive End-Expiratory Pressure Setting in Adults With Acute Lung Injury and Acute Respiratory Distress Syndrome: A Randomized Controlled Trial

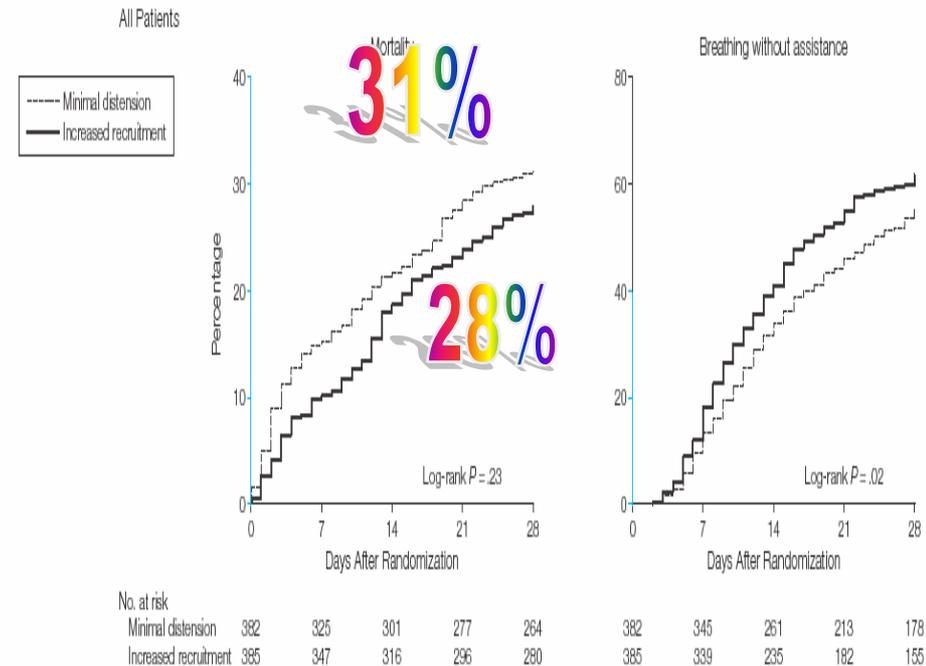
Online article and related content current as of September 22, 2008.

Alain Mercat; Jean-Christophe M. Richard; Bruno Vielle; et al.

JAMA. 2008;299(6):646-655 (doi:10.1001/jama.299.6.646)

<http://jama.ama-assn.org/cgi/content/full/299/6/646>

Variable	Day 1		P Value
	Minimal Distension	Increased Recruitment	
Tidal volume, mL/kg of predicted body weight	6.1 (0.4)	6.1 (0.3)	.57
No. of patients	372	379	
Plateau pressure, cm H ₂ O	21.1 (4.7)	27.5 (2.4)	<.001
No. of patients	365	378	
Total PEEP, cm H ₂ O ^b	8.4 (1.9)	15.8 (2.9)	<.001
No. of patients	336	343	
PaO ₂ /FiO ₂	150 (69)	218 (97)	<.001
No. of patients	371	378	



Similar PEEP achieved
Comparable results

PEEP: conclusions

Safe (10 - 14 cm H₂O)

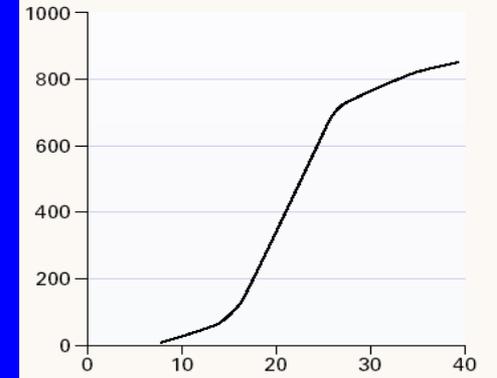
Based on individual lung physiology

Assess recruitability (PEEP trial)

Table 1. Settings for Positive End-Expiratory Pressure (PEEP), According to the Required Fraction of Inspired Oxygen (FiO₂).^{a*}

FiO ₂	PEEP
0.3	5
0.4	5–8
0.5	8–10
0.6	10
0.7	10–14
0.8	14
0.9	14–18
1.0	18–24

Best PEEP



Somewhere above lower inflection

Pre set values depending on PaO₂/FiO₂ or P_{Plat}

ARDSnet. N Engl J Med '00; 342:1301

PEEP trial

Malhotra. N Engl J Med '07; 357:1113

As long as P_{plat}
NOT rising

Target SaO₂ ~ 90%

CMHG 1.08



“Non-invasive” ventilation

Avoid intubation

Accelerate extubation

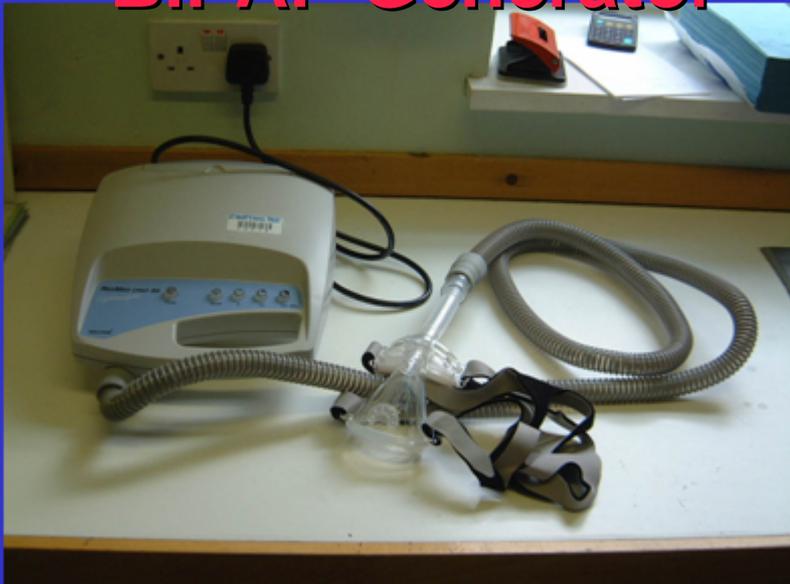
General weaning



Respironics BiPAP ST30



BiPAP Generator



Respironics Vision



Efficacy and safety of non-invasive ventilation in the treatment of acute cardiogenic pulmonary edema – a systematic review and meta-analysis

João C Winck¹, Luís F Azevedo^{2,3}, Altamiro Costa-Pereira^{2,3}, Massimo Antonelli⁴ and Jeremy C Wyatt⁵

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⁴Unita Operativa di Rianimazione e Terapia Intensiva, Istituto di Anestesia e Rianimazione, Policlinico Universitario A Gemelli, Università Cattolica del Sacro Cuore, Rome, Italy

⁵Health Informatics Centre, University of Dundee, Dundee, Scotland, UK

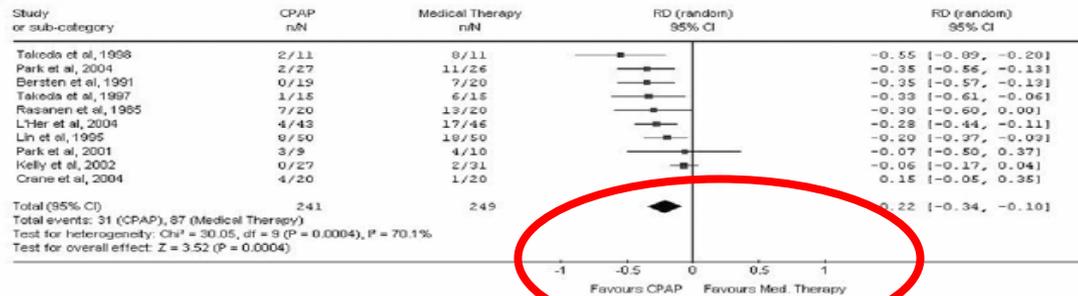
Corresponding author: Luis F Azevedo, lazevedo@med.up.pt

Received: 9 Mar 2006 Accepted: 24 Mar 2006 Published: 28 Apr 2006

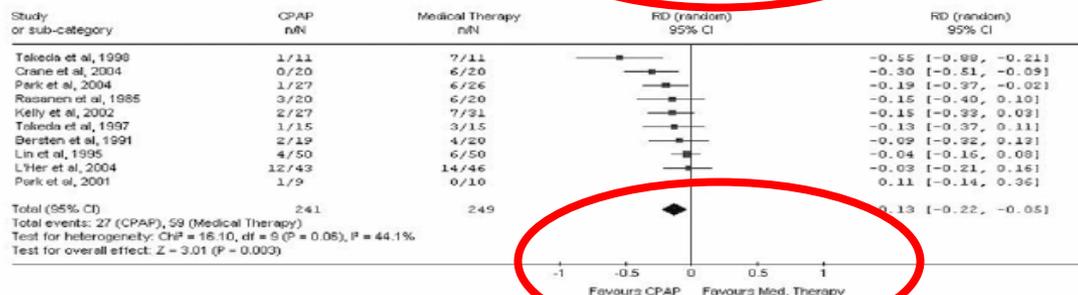
Critical Care 2006, 10:R69 (doi:10.1186/cc4905)

Figure 2

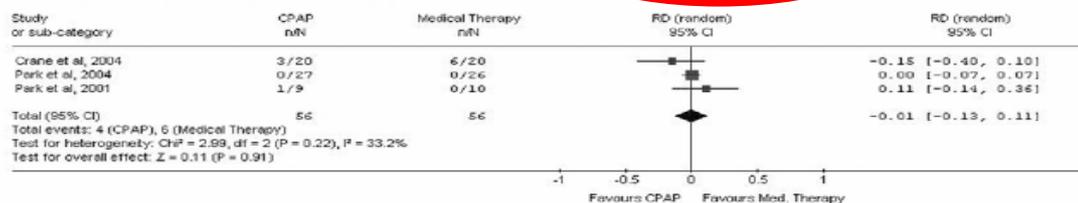
a) Need for endotracheal intubation



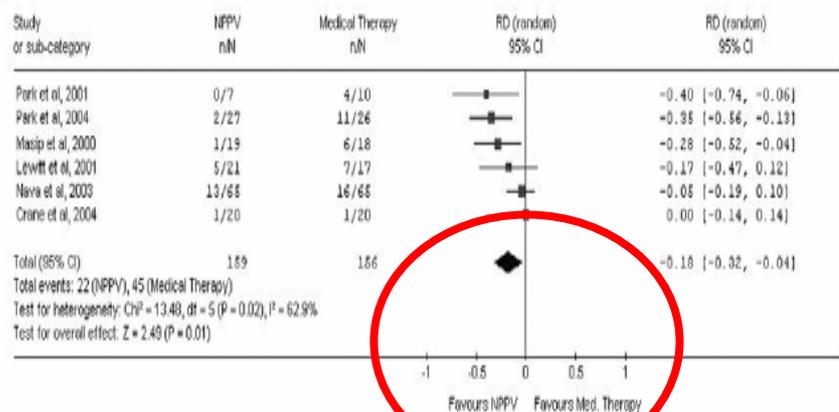
b) Mortality



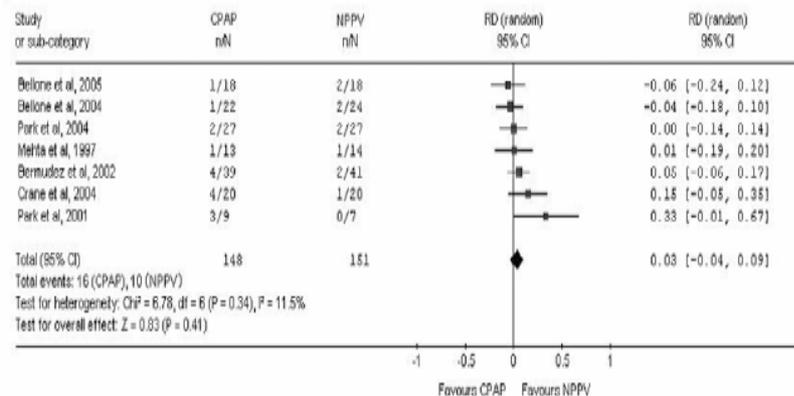
c) Acute myocardial infarction



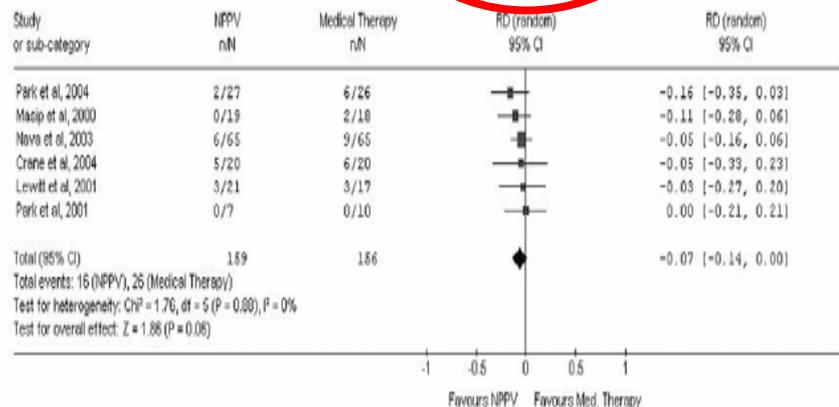
a) Need for endotracheal intubation



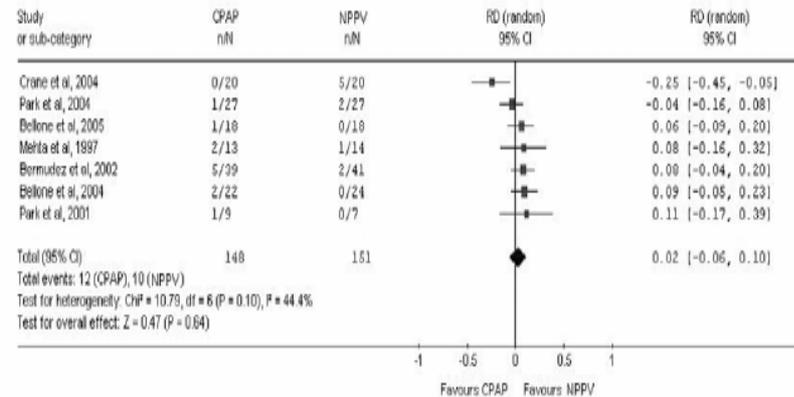
a) Need for endotracheal intubation



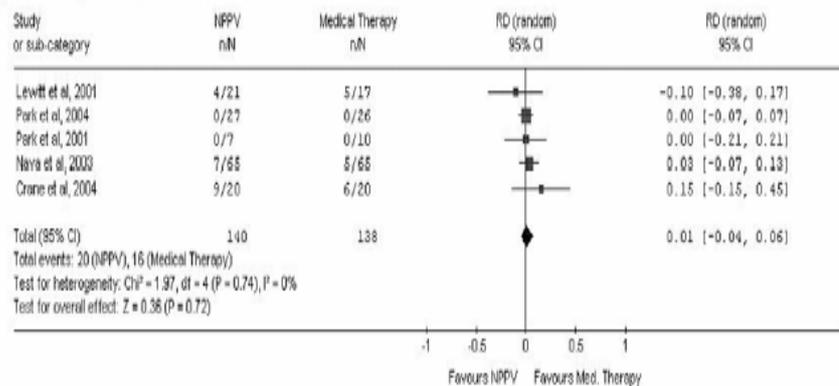
b) Mortality



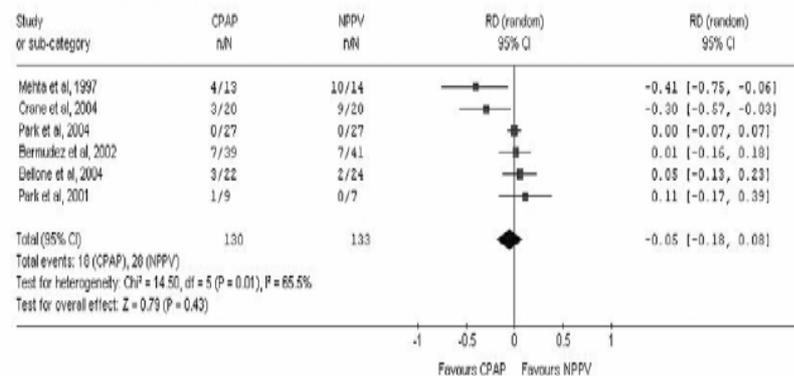
b) Mortality



c) Acute myocardial infarction



c) Acute myocardial infarction



Noninvasive Ventilation during Persistent Weaning Failure

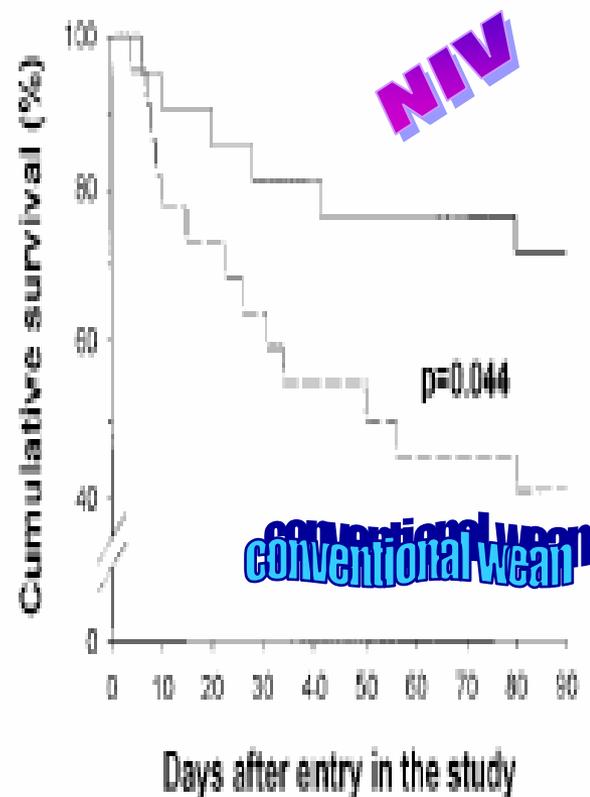
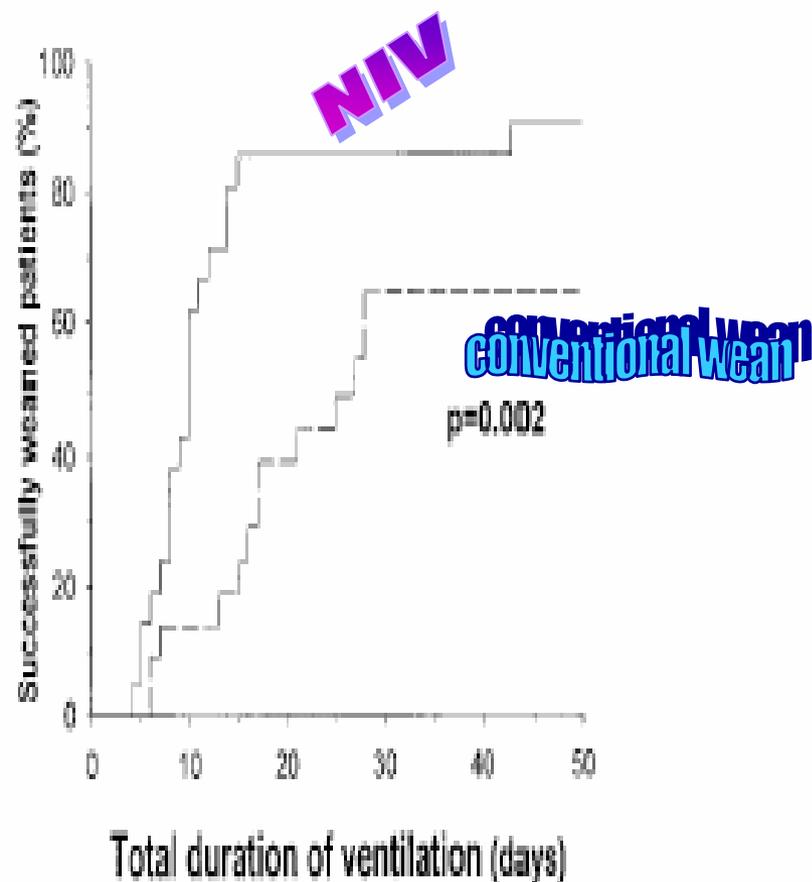
A Randomized Controlled Trial

Am J Respir Crit Care Med Vol 168, pp 70-76, 2003

Miquel Ferrer, Antonio Esquinas, Francisco Arancibia, Torsten Thomas Bauer, Gumersindo Gonzalez, Andres Carrillo, Robert Rodriguez-Roisin, and Antoni Torres

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AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 168 2003



Non-invasive positive pressure ventilation for treatment of respiratory failure due to exacerbations of chronic obstructive pulmonary disease (Review)

Ram FSE, Picot J, Lightowler J, Wedzicha JA

Cochrane Database of Systematic Reviews 2004, Issue 3. Art. No.: CD004104.

14 studies; 758 patients

Improvements in mortality, length of stay, intubation rate

Failure of non-invasive ventilation in patients with acute lung injury: observational cohort study

Sameer Rana¹, Hussam Jenad¹, Peter C Gay¹, Curtis F Buck², Rolf D Hubmayr¹ and Ognjen Gajic¹

Critical Care 2006, **10**:R79

- Especially those in shock
- Failure associated with mortality

Practical Non-invasive ventilation

Post operative basal atelectasis

Post extubation (moderate) respiratory distress

Cardiogenic pulmonary oedema

Pneumonia

Chronic obstructive airway disease

Young

Children

Pathophysiology and ventilation

Stretch and overdistension

Alveolar collapse

Cyclical opening and closing

Capillary leak

Evidence based ventilation

Low tidal volumes
Appropriate PEEP

SaO₂ ~ 90%

pH 7.2

Cautious fluid administration

6ml/kg

~ 30 cm H₂O plateau
pressure

QuickTime™ and a
H.264 decompressor
are needed to see this picture.

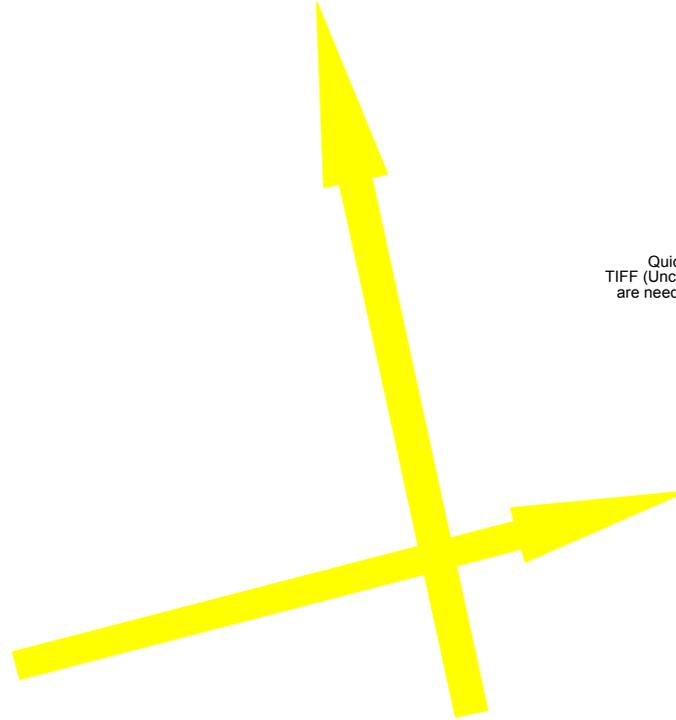


“Houston, we have a problem...”

R

L

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

High frequency, small amplitude
Higher mean, lower peak airway pressures
Alveolar recruitment throughout cycle

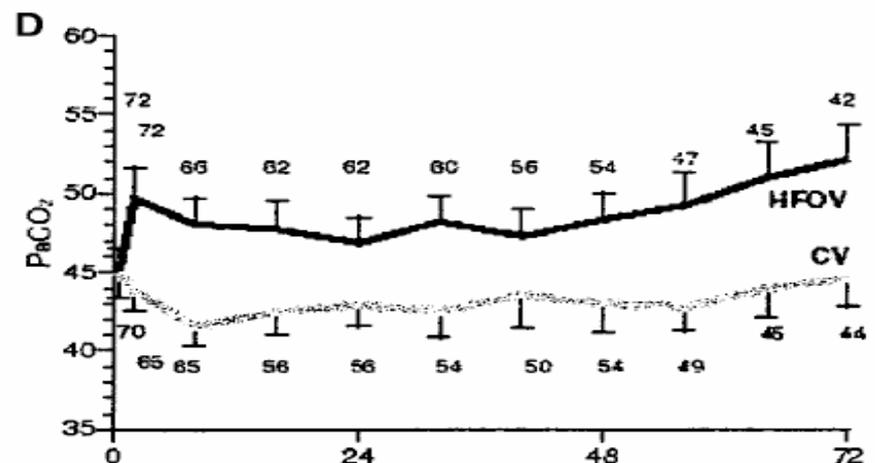
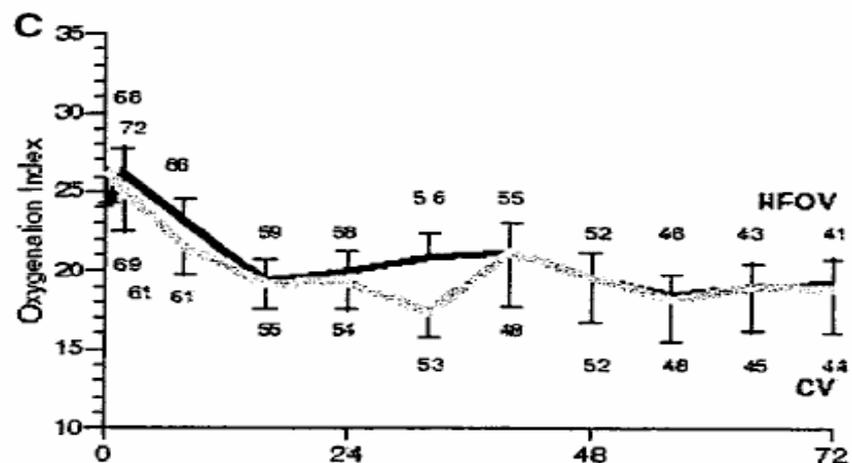
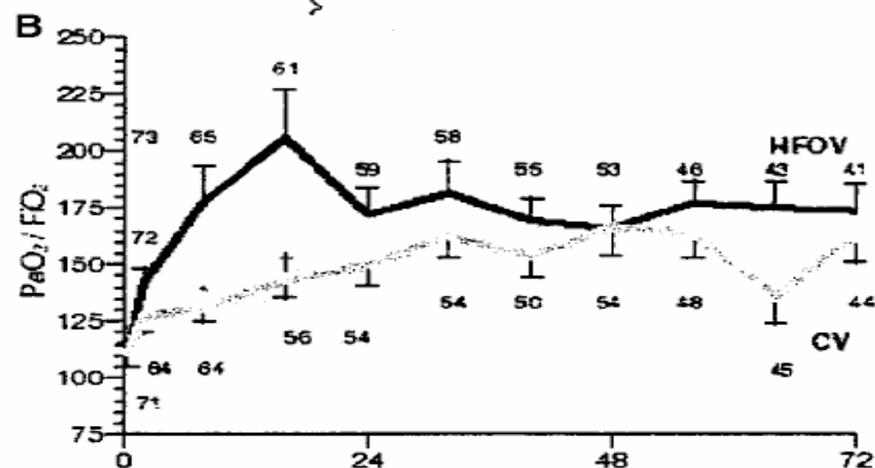
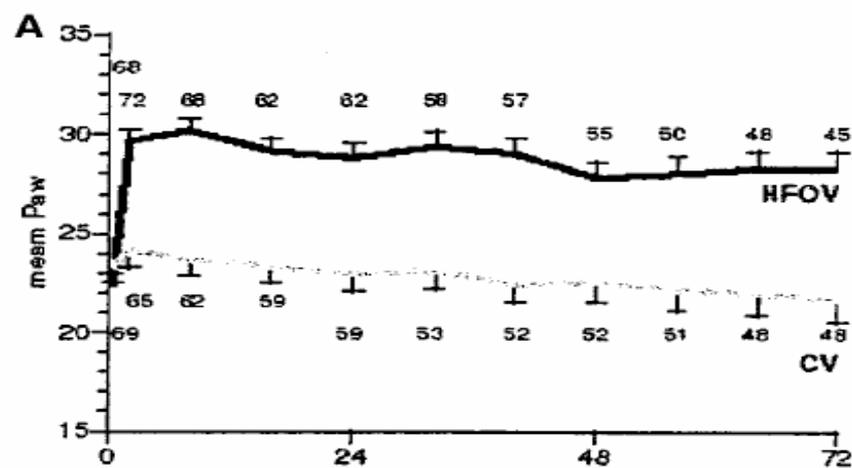
CMHG 1.08

Singh. Curr Op Crit Care '03: 9: 28

High-Frequency Oscillatory Ventilation for Acute Respiratory Distress Syndrome in Adults

A Randomized, Controlled Trial

Stephen Derdak, Sangeeta Mehta, Thomas E. Stewart, Terry Smith, Mark Rogers, Timothy G. Buchman, Brian Carlin, Stuart Lowson, John Granton, and the Multicenter Oscillatory Ventilation for Acute Respiratory Distress Syndrome Trial (MOAT) Study Investigators

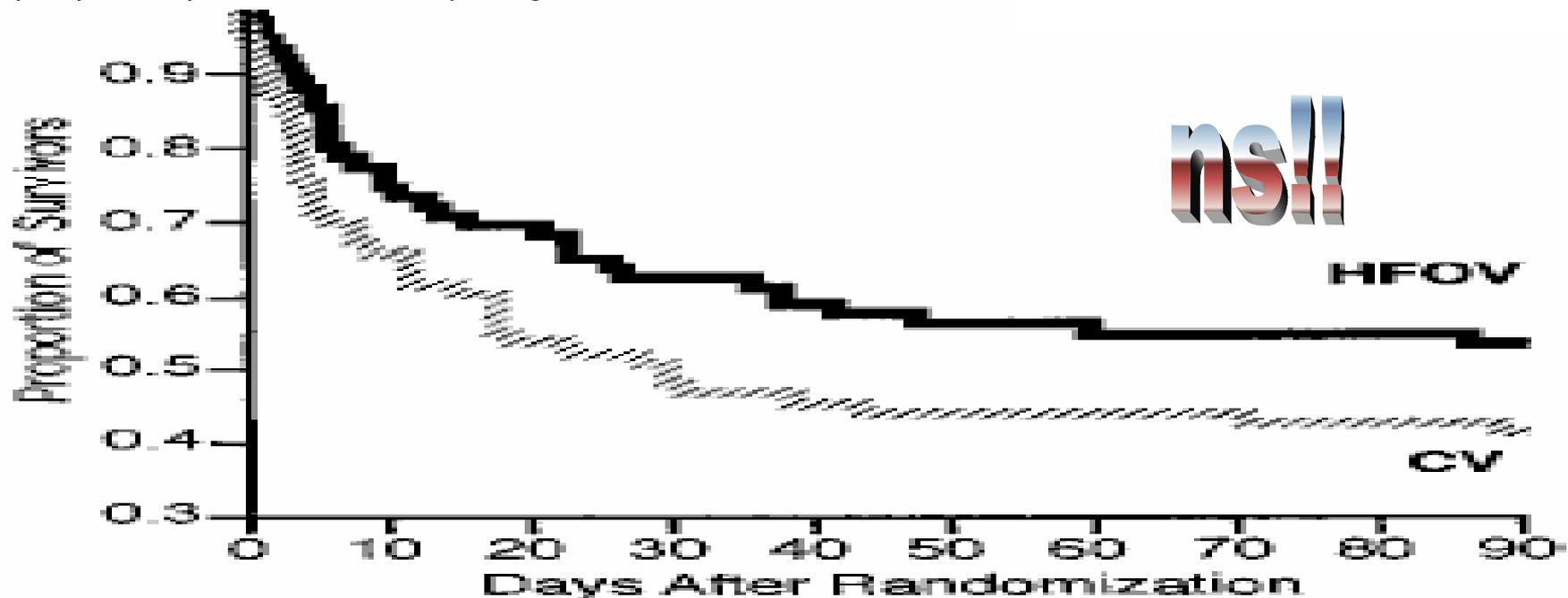


High-Frequency Oscillatory Ventilation for Acute Respiratory Distress Syndrome in Adults

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QUESTIONS AND
ANSWERS
ARE WELCOME TO SEE THE JOURNAL



	HFOV	CV
Intractable hypotension, %*	0 (0%)	2 (3%)
Oxygenation failure [†]	4 (5%)	6 (8%)
Ventilation failure [‡]	4 (5%)	6 (8%)
Air leak developed or worsened [§]	7 (9%)	9 (12%)
Mucus-plugged ET tube	4 (5%)	3 (4%)
Six-month mortality	35 (47%)	43 (59%)
Six-month mechanical ventilation	0 (0%)	2 (3%)

Alternatives

Extracorporeal CO₂ removal

Extracorporeal membrane oxygenation-ECMO

Lynch. Semin Thorac Cardiovasc Surg '06; 18:20



AVCO₂R

New membranes

No pump

“simpler”

Tolerable shunt

Promising

Morris. Am J Res Crit Care Med '94; 149:295

Conrad. Intensive Care Med '01; 27:1340

Extracorporeal Life Support for Severe Acute Respiratory Distress Syndrome in Adults

Mark R. Hemmila, MD, Stephen A. Rowe, MD, Tamer N. Boules, MD, Judiann Miskulin, MD, John W. McGillicuddy, MD, Douglas J. Schuerer, MD, Jonathan W. Haft, MD, Fresca Swaniker, MD, Saman Arbabi, MD, MPH, Ronald B. Hirschl, MD, and Robert H. Bartlett, MD

(Ann Surg 2004;240: 595–607)

15 year retrospective series

405 patients

255 on ECMO

67% weaned off ECMO

52% hospital survival

CESAR trial

www.cesar-trial.org

Transport to Leicester, UK



conventional vs ECMO

Reporting February 2008 at SCCM Hawaii

ECMO: Preliminary results

Relative risk (ECMO) 0.69 (0.05 - 0.97)

Unpublished results

Limitations

Randomisation
transport



TASK FORCE

Weaning from mechanical ventilation

J-M. Boles*, **J. Bion[#]**, **A. Connors[¶]**, **M. Herridge⁺**, **B. Marsh[§]**, **C. Melot^f**, **R. Pearl^{**}**,
H. Silverman^{###}, **M. Stanchina^{¶¶}**, **A. Vieillard-Baron⁺⁺**, **T. Welte^{§§}**

Statement of the Sixth International Consensus Conference on Intensive Care Medicine

Consistency
Freedom from infection
Cardio-pulmonary interaction
Nutrition
Daily weaning trial
Multi-disciplinary approach
Never give up

The New England Journal of Medicine

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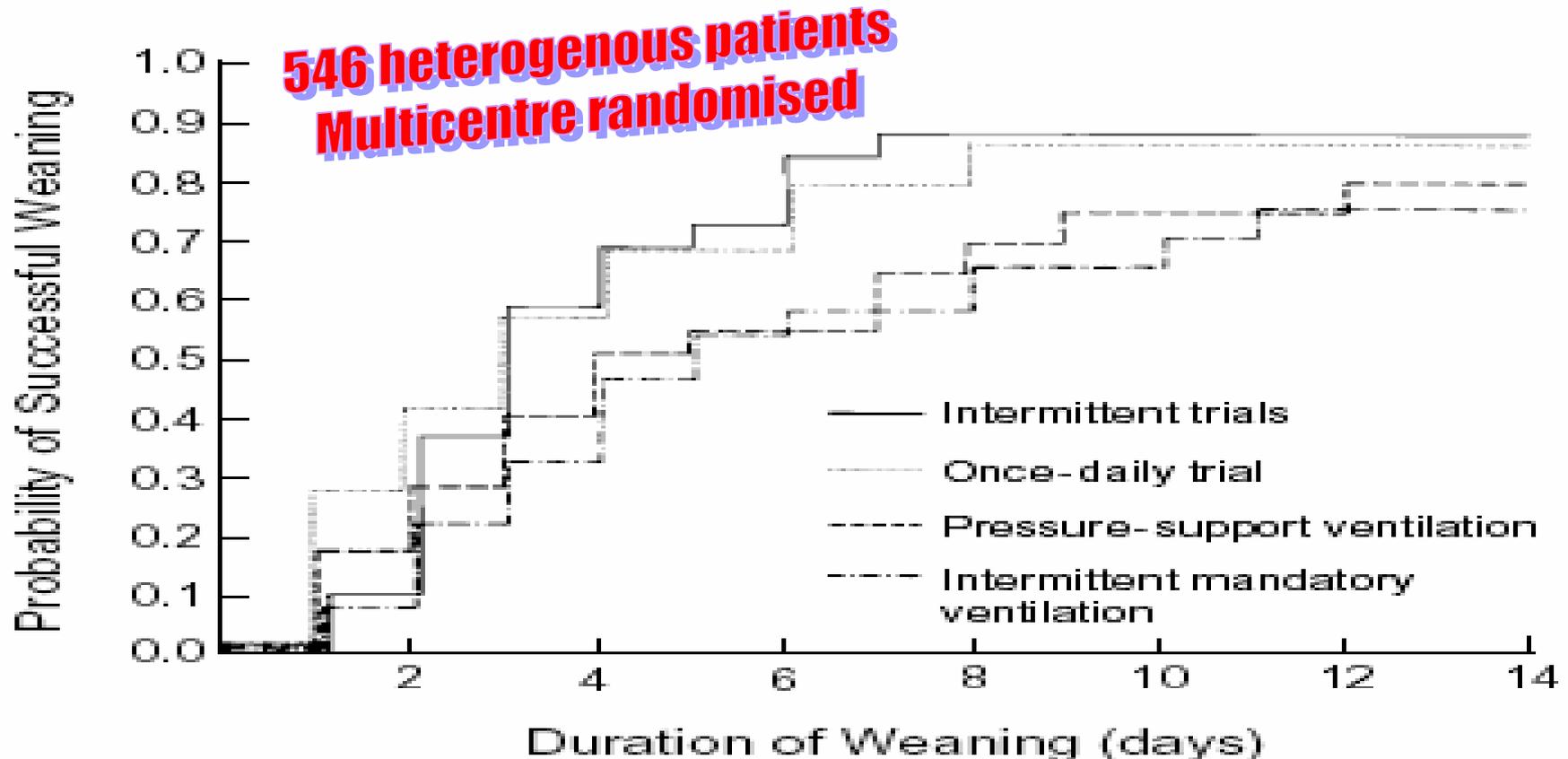
Volume 332

FEBRUARY 9, 1995

Number 6

A COMPARISON OF FOUR METHODS OF WEANING PATIENTS FROM MECHANICAL VENTILATION

ANDRÉS ESTEBAN, M.D., PH.D., FERNANDO FRUTOS, M.D., MARTIN J. TOBIN, M.D., INMACULADA ALÍA, M.D., JOSÉ F. SOLSONA, M.D., INMACULADA VALVERDÚ, M.D., RAFAEL FERNÁNDEZ, M.D., MIGUEL A. DE LA CAL, M.D., SALVADOR BENITO, M.D., PH.D., ROSER TOMÁS, M.D., DEMETRIO CARRIEDO, M.D., SANTIAGO MACÍAS, M.D., AND JESÚS BLANCO, M.D.,
FOR THE SPANISH LUNG FAILURE COLLABORATIVE GROUP*





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The Harley Street Clinic, London UK

Patients