La ventilation mécanique

Les défis du sevrage

Hôpital Maisonneuve-Rosemont
Centre affilié à l'Université de Montréal

Montréal 27-28 Avril 2011

Hospital de la Santa Creu i Sant Pau

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Conflict of Interest:

-Research grant sponsored by Dräger (AJRCCM 2006).

Clinical assessment

-Breathing pattern (control of breathing)
-Resp system mechanics
-Resp μ work
-Gas exchange
-Cardiovascular performance
-Upper airway protection

Esteban A, *et al*. AJRCCM 2008;177:107-7

TABLE 5. CHARACTERISTICS AND OUTCOMES OF PATIENTS WHO UNDERWENT PLANNED EXTUBATION

	1998 Cohort (*n* = 780)	2004 Cohort (*n* = 869)	*P* Value
Age, mean (SD), yr	58 (19)	56 (18)	0.02
Simplified Acute Physiology Score II, mean (SD), points	42 (16)	40 (17)	0.08
Main reason for mechanical ventilation, n (%)			
COPD	85 (11)	53 (6%)	<0.001
Asthma	10 (1)	18 (2%)	0.21
Other chronic pulmonary disease	3 (0.4)	7 (1%)	0.27
Coma	154 (20)	221 (25%)	0.006
Neuromuscular disease	11 (1)	12 (1%)	0.96
Acute respiratory failure			
Postoperative	178 (23%)	163 (19%)	0.04
Pneumonia	85 (11%)	87 (10%)	0.56
Sepsis	50 (6%)	72 (8%)	0.15
ARDS	22 (3%)	24 (3%)	0.94
Congestive heart failure	96 (12%)	51 (6%)	<0.001
Cardiac arrest	14 (2%)	37 (4%)	0.004
Trauma	59 (8%)	37 (4%)	0.004
Aspiration	16 (2%)	15 (2%)	0.63
Other cause	52 (7%)	72 (8%)	0.21
Days of mechanical ventilation prior to weaning, median (IQR)	3 (2,6)	4 (2,7)	0.004
Days of weaning in difficult-to-wean patients median (IQR)*	3 (2, 5)	3 (2, 4)	0.94
Time devoted to weaning, median (IQR), % of total ventilation time	50 (28, 67)	40 (25, 50)	<0.001
Reintubation within 48 h, n (%)	127 (16.3)	105 (12.1)	0.01

Esteban A, *et al*. AJRCCM 2008;177:107-7

%	1998 (n=780)	2004 (n=869)	P
SBT extubation readiness	58	62	0.09
Extubation after 1st SBT	62	77	<0.001
SBT T-piece	76	71	0.07
SBT low PSV	10	14	0.06

Table

VARIABLE	GROUP			
	Simple Weaning n=58 (61%)	Difficult Weaning n=21 (22%)	Prolonged Weaning n=16 (17%)	ANOVA (p)
Age (years)	63±15	64±12	67±10	0,43
SAPS II	49±20	51±18	44±16	0,50
TMV (days)	6±5	10±8	21±17	<0,001[b, c]
ICU length of stay (days)	10±7	17±13	24±15	<0,001[a, b]
REIOT rate	4 (7%)	4 (19%)	8 (73%)	<0,001[b, c]
Tracheotomy rate	2 (3%)	2 (10%)	8 (50%)	<0,001 [b, c]
ICU mortality	2 (3%)	1 (5%)	6 (38%)	<0,001 [b, c]
Halted weaning process	13 (22%)	4 (19%)	10 (63%)	<0,004 [b, c]

[a] Statistical significance between simple and difficult weaning
[b] Statistical significance between simple and prolonged weaning
[c] Statistical significance between difficult and prolonged weaning
SAPS II: Simplified acute physiology score, TMV: Total mechanical ventilation, ICU: Intensive care unit, REIOT: Reintubation.

Evaluating patients under MV

Weaning:

1. SCREENING PHASE: Patients are likely to breathe without the ventilator: underlying cause of respiratory failure improved (respiratory mechanics, gas exchange, hemodynamics).

Predictive indexes or diagnostic tests **($f/V_T < 105$).**

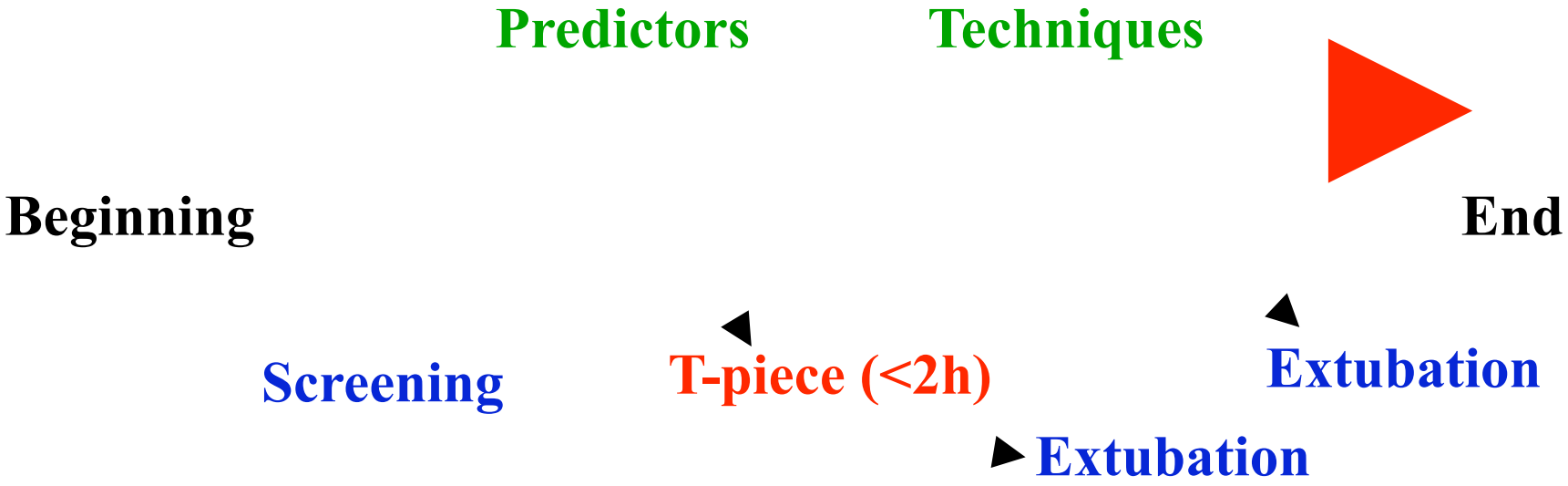
2. CONFIRMATORY PHASE: Withdraw ventilator (SBT ≤ 2h)/reduce assistance (PSV).

3. Extubation, and spontaneous breathing wihout ETT.

Aims: Withdraw as soon as possible

Avoid extubation failure

Clinical approach



Principles and practice of mechanical ventilation. 2nd ed. Tobin MJ, Ed. Mc Graw-Hill. New York, 2006

Diagnostic tests

Screening tests are tipically performed when the pretest probability of Dx+ (WS) is low. Should be quick and easy to perform.

- **SCREENING**
- **Aim: Pick up as many cases of Dx+ as possible**
- **Suspicion: low**
- **Needs high SE (low FN results): a negative test rules out the Dx+. PID.**

- **CONFIRMATORY**
- **Aim: To confirm the suspicion**
- **Suspicion: high**
- **Need high SP (low FP results): a positive test rules in the Dx+. NIH.**

f/V_T has a 97% SE and 64% SP. Corollary: it is extremely good to screen, but not sufficient to confirm. This is why clinicians undertake two diagnostic tests in sequence: f/V_T and T-piece trial.

Principles and practice of mechanical ventilation. 2nd ed. Tobin MJ, Ed. Mc Graw-Hill. New York, 2006

		Gold standard	
		Success (Dx+)	**Failure (Dx-)**
Test f/V_T (predictive index)	**Positive value ($f/V_T \leq 105$)**	**TP**	**FP**
	Negative value ($f/V_T > 105$)	**FN**	**TN**

SE = TP/TP+FN **SP = TN/TN+FP**

Prevalence or *Pretest probability* = TP+FN/TP+FN+FP+TN

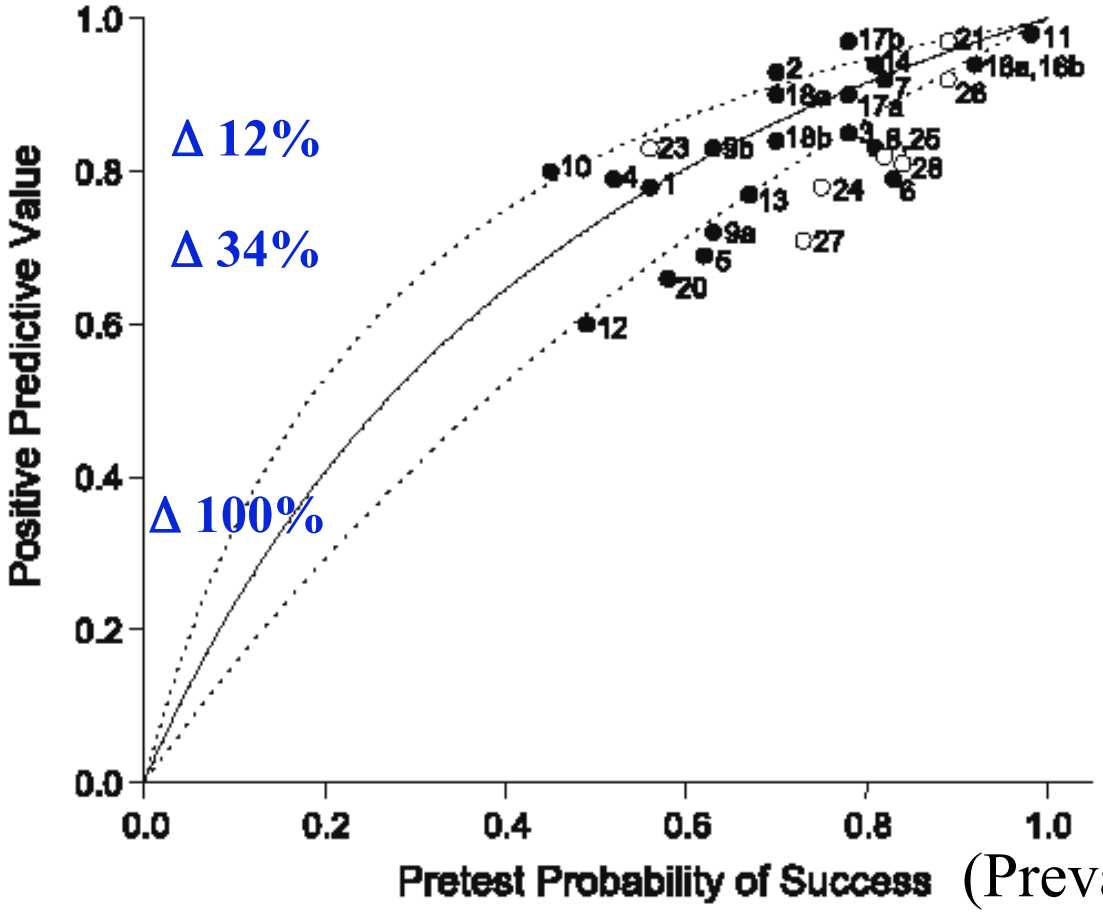
Intensive Care Med (2006) 32:2002–2012
DOI 10.1007/s00134-006-0439-4

ORIGINAL

Martin J. Tobin
Amal Jubran

Variable performance of weaning-predictor tests: role of Bayes' theorem and spectrum and test-referral bias

Post-test probability of successful outcome



(Prevalence)

- Improved/Resolved
- "Good" MS, no sedation
- T < 38
- f < 35 breaths/min
- SaO2 > 90% , FiO2 ≤ .40
- Hemodynamics stable
- Hgb >10

119 episodes MV (MICU)

2 min T piece

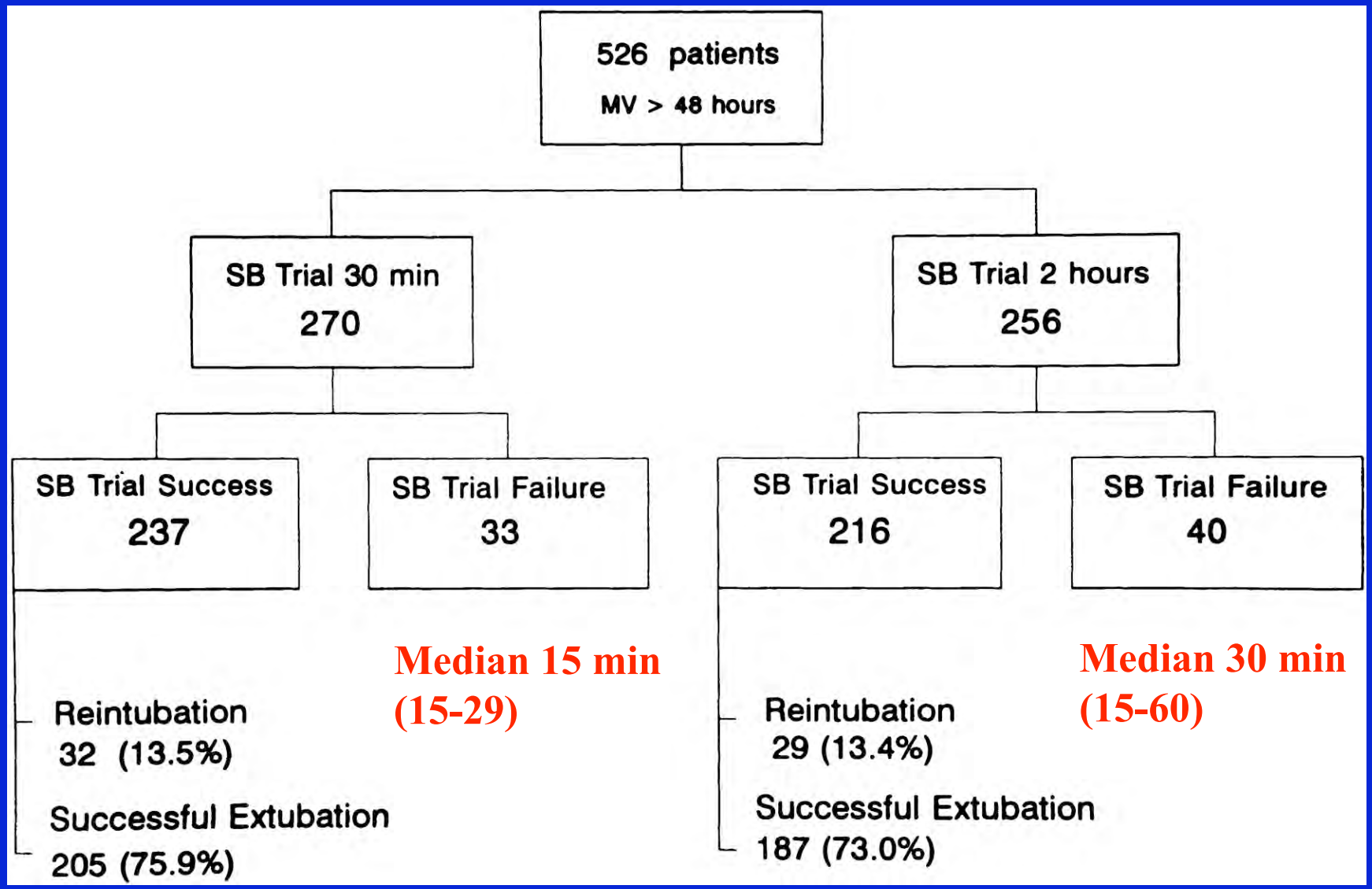
Extubated

Reintubated 44 (37%)

Success 75 (63%)

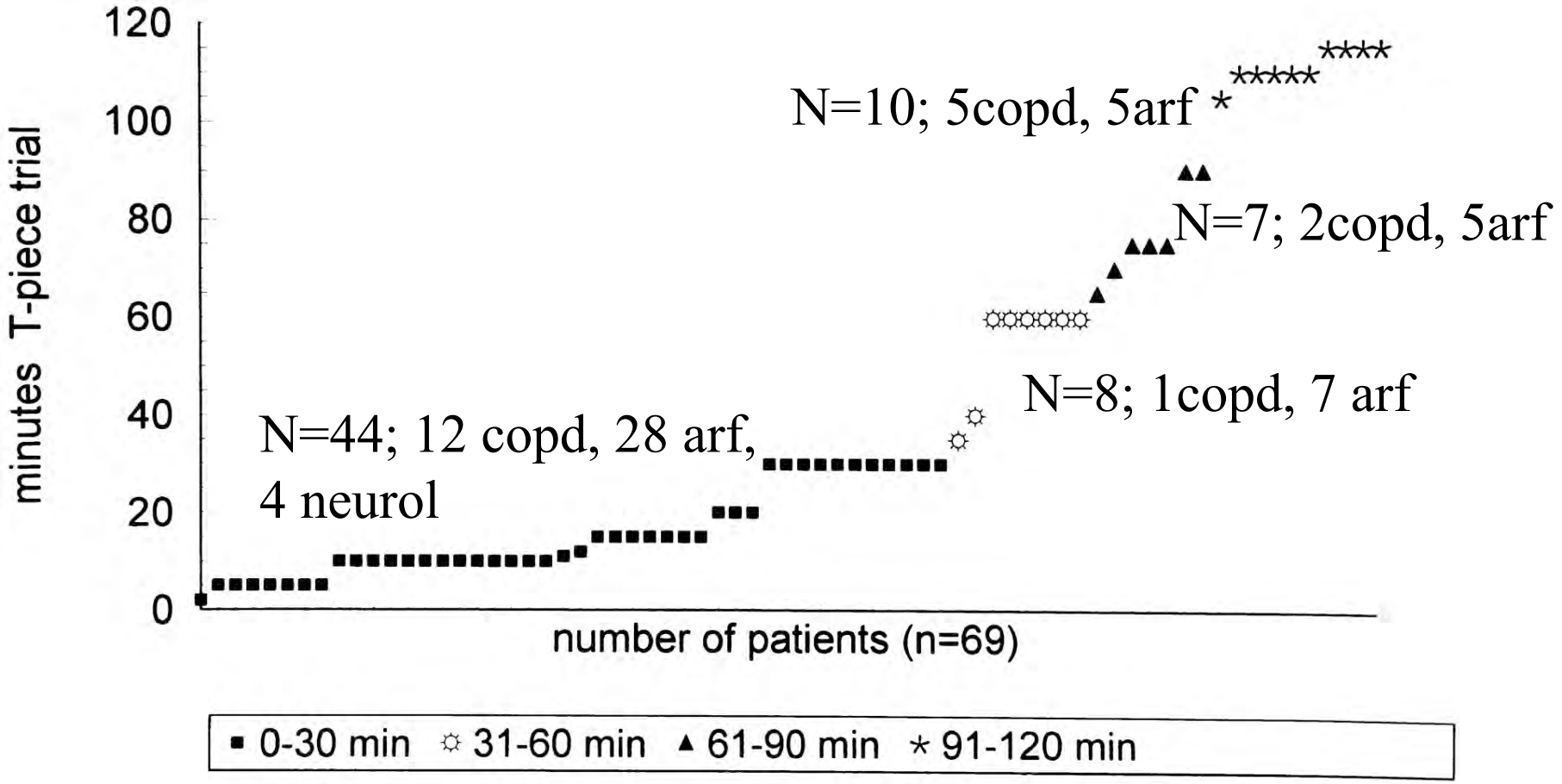
Zeggwagh AA, *et al.* ICM 1999;25:1077-83

Esteban A, *et al*.AJRCCM;1999;159:512-8



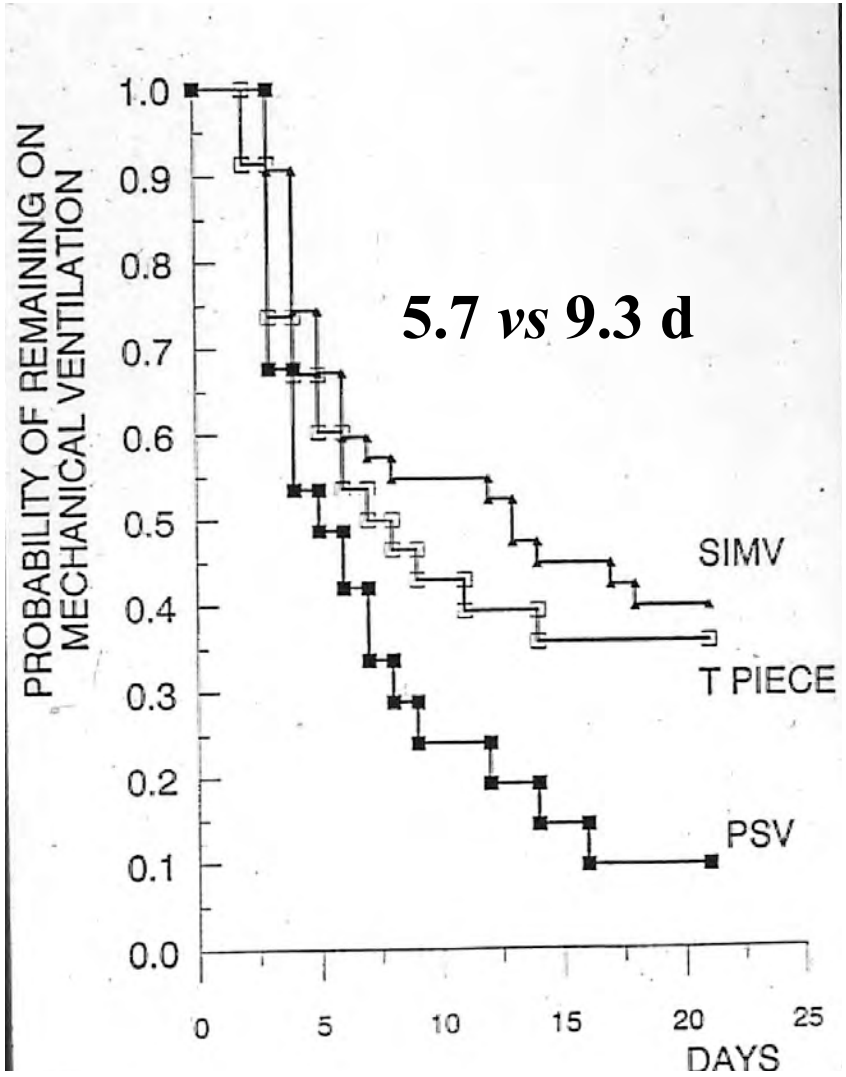
Vallverdú I, *et al.* AJRCCM 1998;158:1855-62

217 Patients: 69 failed/ 148 extub/ 23 reintub



25/69 (36%) failed after 30 min

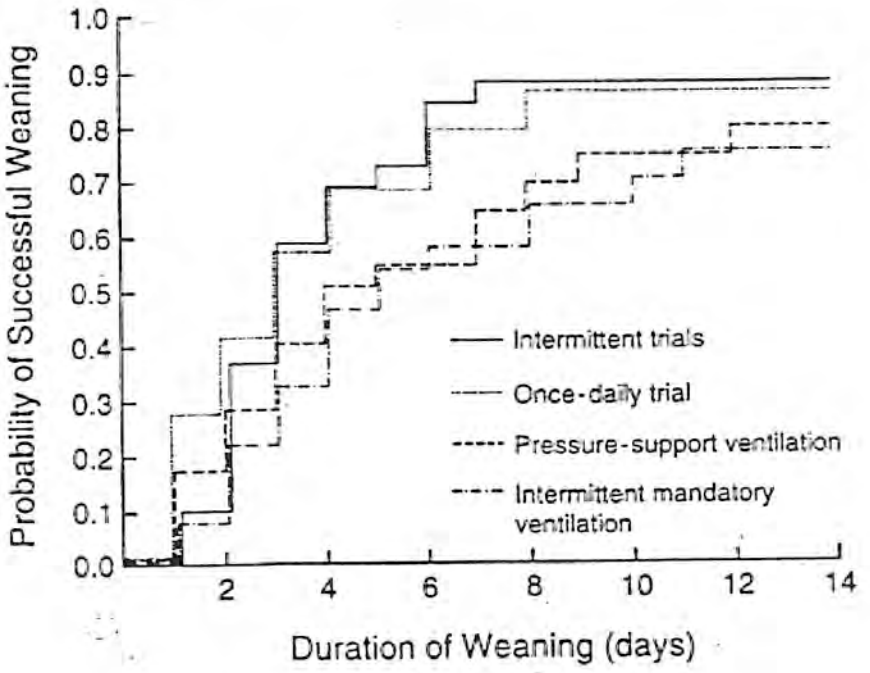
Brochard L, *et al*. AJRCCM 1994;150:896-903



Factors explaining weaning duration: Etiology of the disease (COPD), p=0.01 and mode of ventilation (PSV), p=0.03

Esteban A, *et al*. NEJM 1995;332:345-50

3.4 *vs* 6.4 d



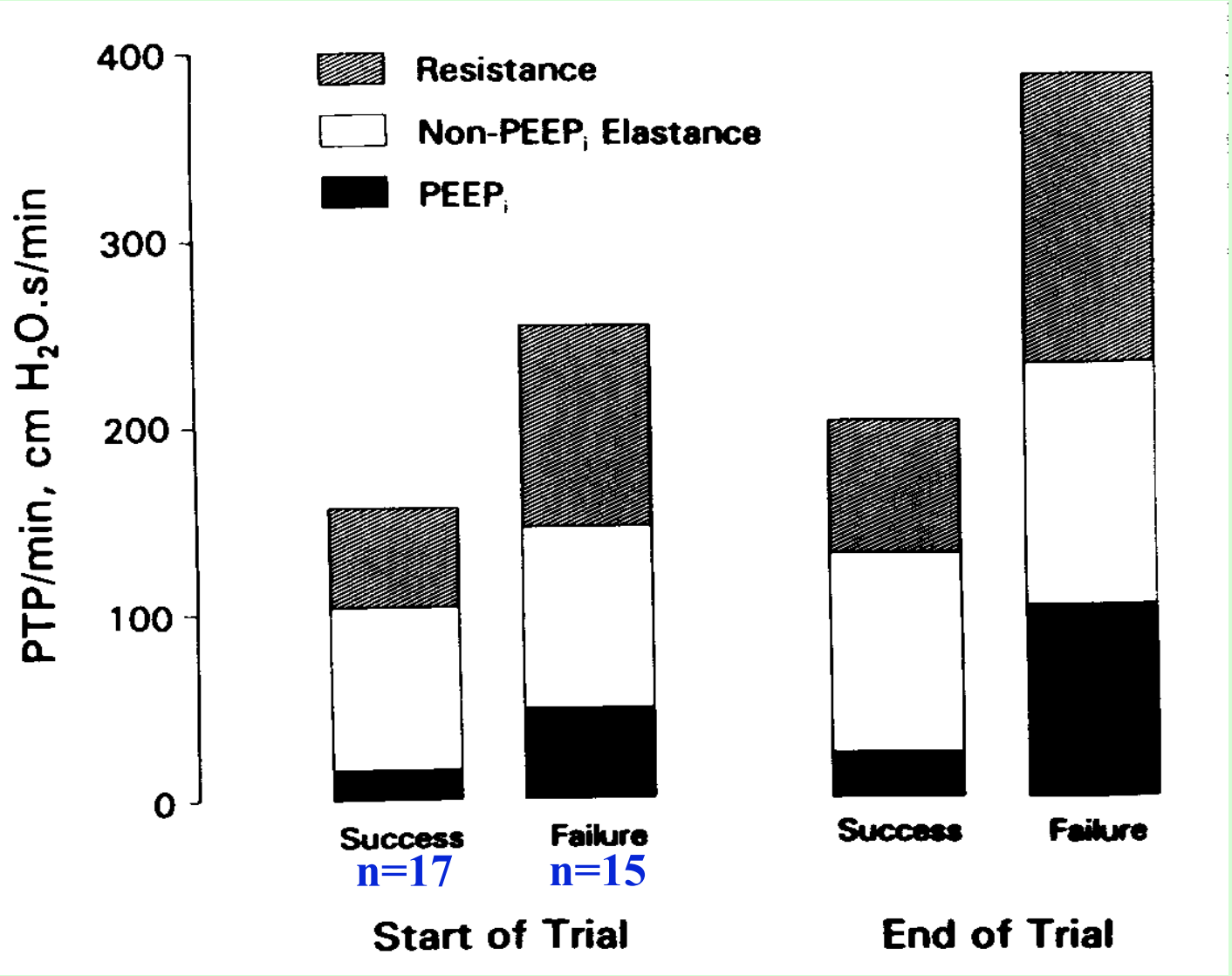
Probability of success over time: Rate of SW with a once daily SBT was 2.83 times higher than that with SIMV (p<0.006) and 2.05 times higher than that with PSV (p<0.04).

Extubation Outcome after Spontaneous Breathing Trials with T-Tube or Pressure Support Ventilation

Esteban A, *et al*. AJRCCM 1997;156:459-65

	n	R	SE, 48hr
2hr T-T	246	36	63% (156/246)
2hr PSV 7	238	38	70% (167/238)
P=		NS	NS

Jubran A, Tobin MJ. AJRCCM 1997;155:906-15



Jubran A, Tobin MJ. AJRCCM 1997;155:906-15

31 COPD patients
A significant increase in Rinsp was found in WF patients.
Why?

-Increase in Vt/Ti. No, because increased by the same degree in WF and WS groups.
-Decrease in lung volume. Unlikely, because PEEPi increased
-Secretions. But both groups were equally suctioned before SBT

***It could be due to bronchoconstriction*...but why only in WF?**

Mechanisms of SBT induced heart failure

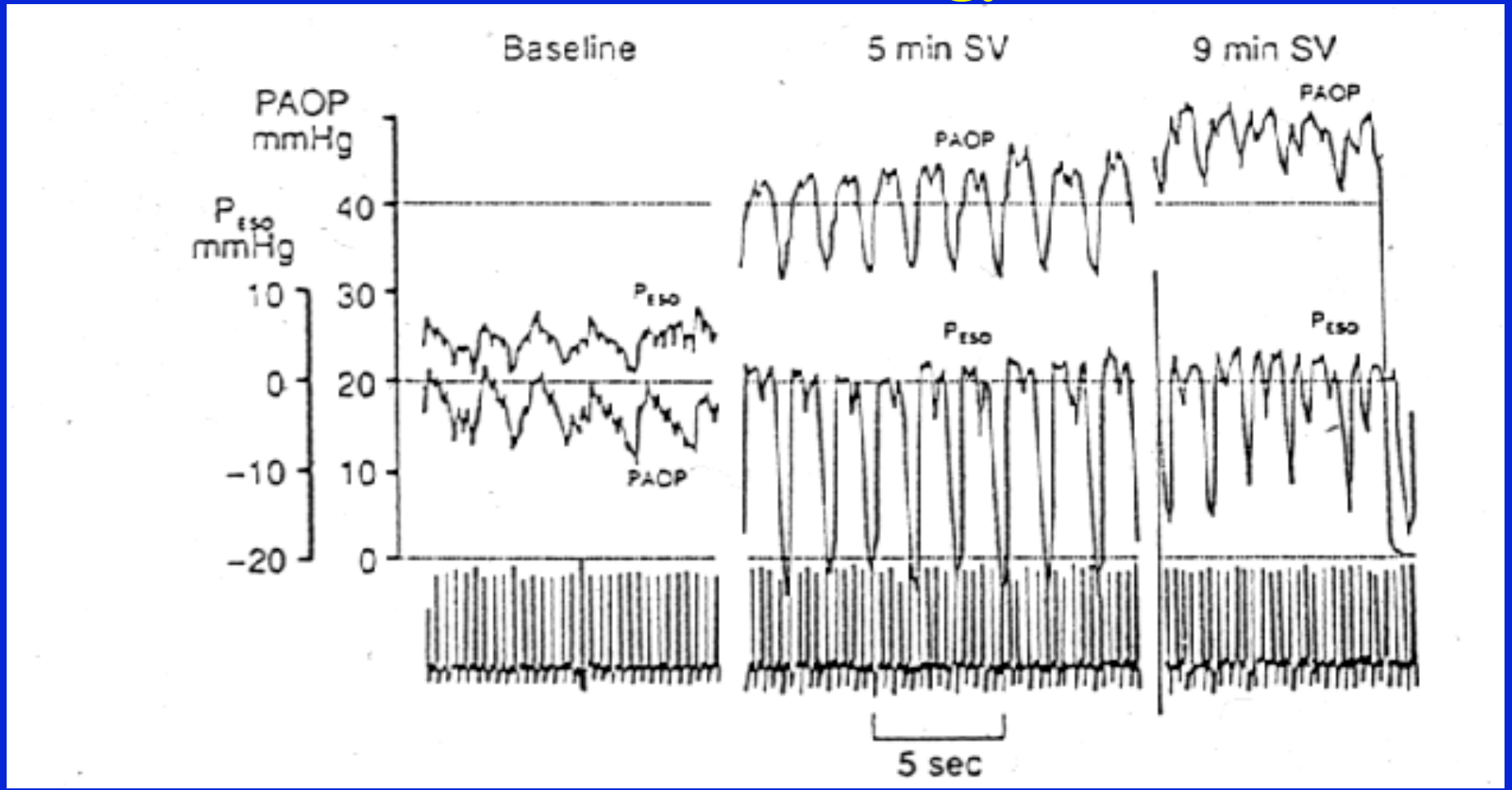
-Increased venous return.

-Increased LV afterload.

-Increased myocardial O_2 demand (may cause ischemia if CAD exists).

-Reduced LV compliance (DHF, ventricular interdependence).

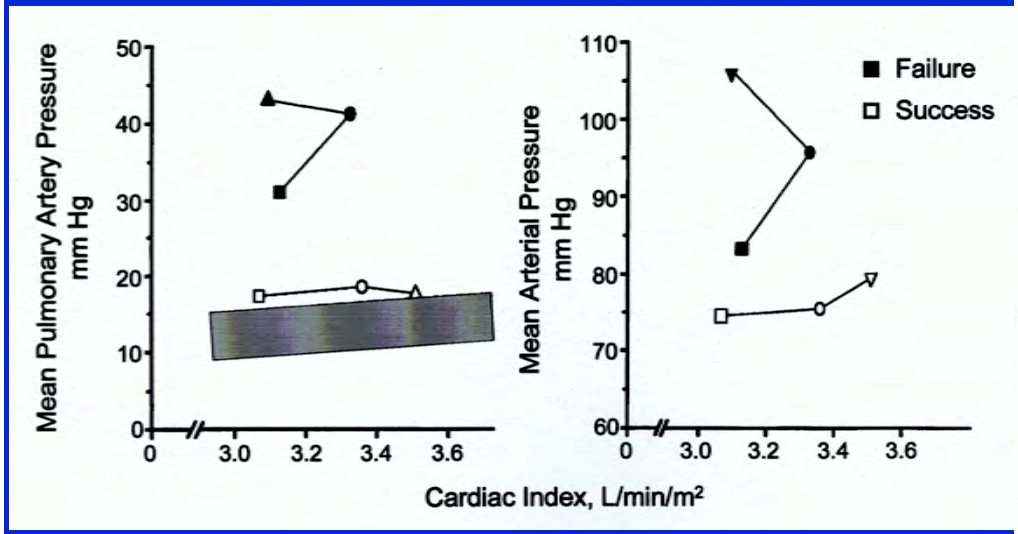
Lemaire F, *et al.* Anesthesiology 1988;69:171-9

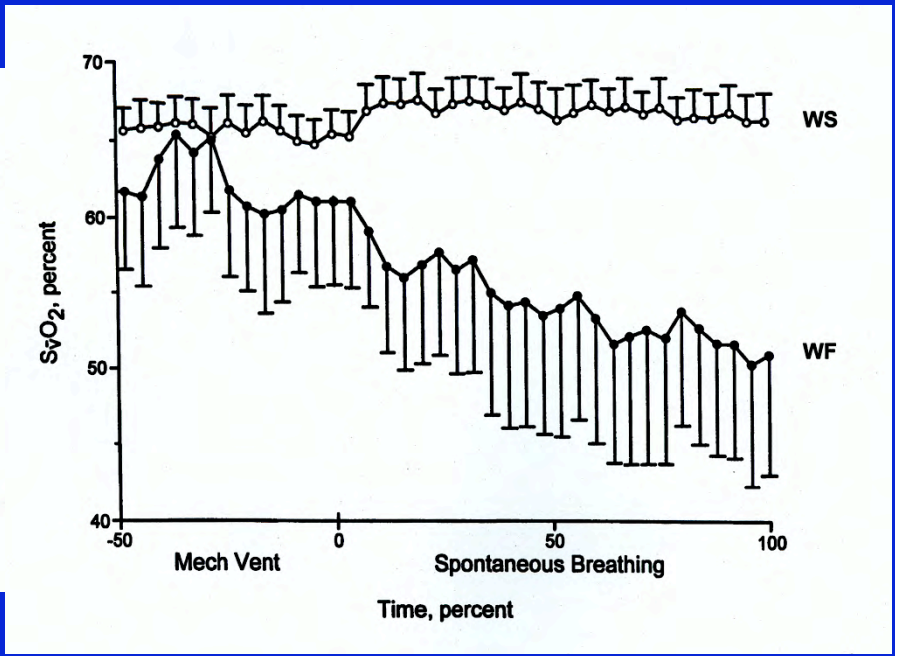


15 COPD and cardiovascular disease

Transition from CMV to SB significantly increased: Mean fall in Ppl swings, Cardiac index, Mean arterial blood pressure, Heart rate, and Transmural PCWP (from 8 to 25 mmHg)

Jubran A, *et al.* AJRCCM 1998;158:1763-9





WF: O_2 transport did not increase and O_2 extraction increased

11 WS (5 COPD) and 8 WF (5 COPD)

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Physiological comparison of three spontaneous breathing trials in difficult-to-wean patients

ICM 2010; 36:1171-9

Table 1 Patient characteristics

N	Age (year)	Sex	SAPS II	Comorbidities	Reason for MV	PAOP ≥18 mmHg during T-piece	Duration of MV (days)
1	76	F	45	MI	Cardiac arrest[a]	Yes	40
2	66	F	19	No	Pneumonia	Yes	21
3	55	M	26	COPD	Mitral valve replacement[a]	Yes	11
4	56	M	29	COPD	Exacerbation of COPD	Yes	6
5	69	M	25	HT	Acute pancreatitis	Yes	21
6	69	M	45	COPD, HT	Exacerbation of COPD	Yes	6
7	79	M	53	MI	CABG	Yes	30
8	78	M	27	COPD, MI	Aortic valve replacement[a]	Yes	4
9	79	M	27	No	Abdominal surgery	No	16
10	58	M	22	COPD, HT	Pneumothorax	Yes	15
11	39	M	25	No	Septic Shock	No	10
12	75	M	68	COPD, HT	Abdominal aortic aneurysm[a]	Yes	21
13	69	M	30	HT	Abdominal surgery	Yes	30
14	67	M	37	COPD	Pneumonia	No	13
Median (IQR)	69 (58–77)		28 (25–45)				16 (9–23)

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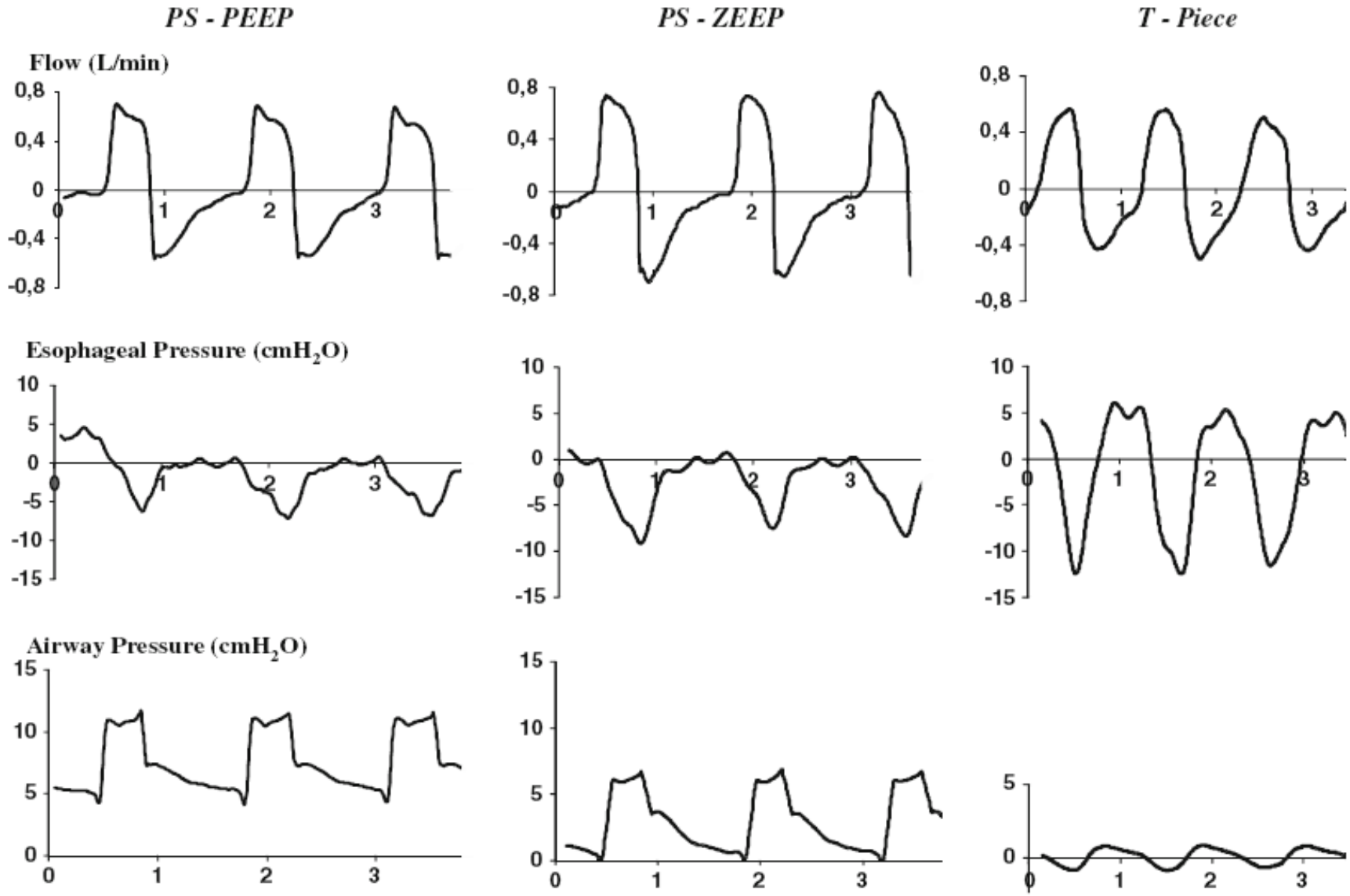
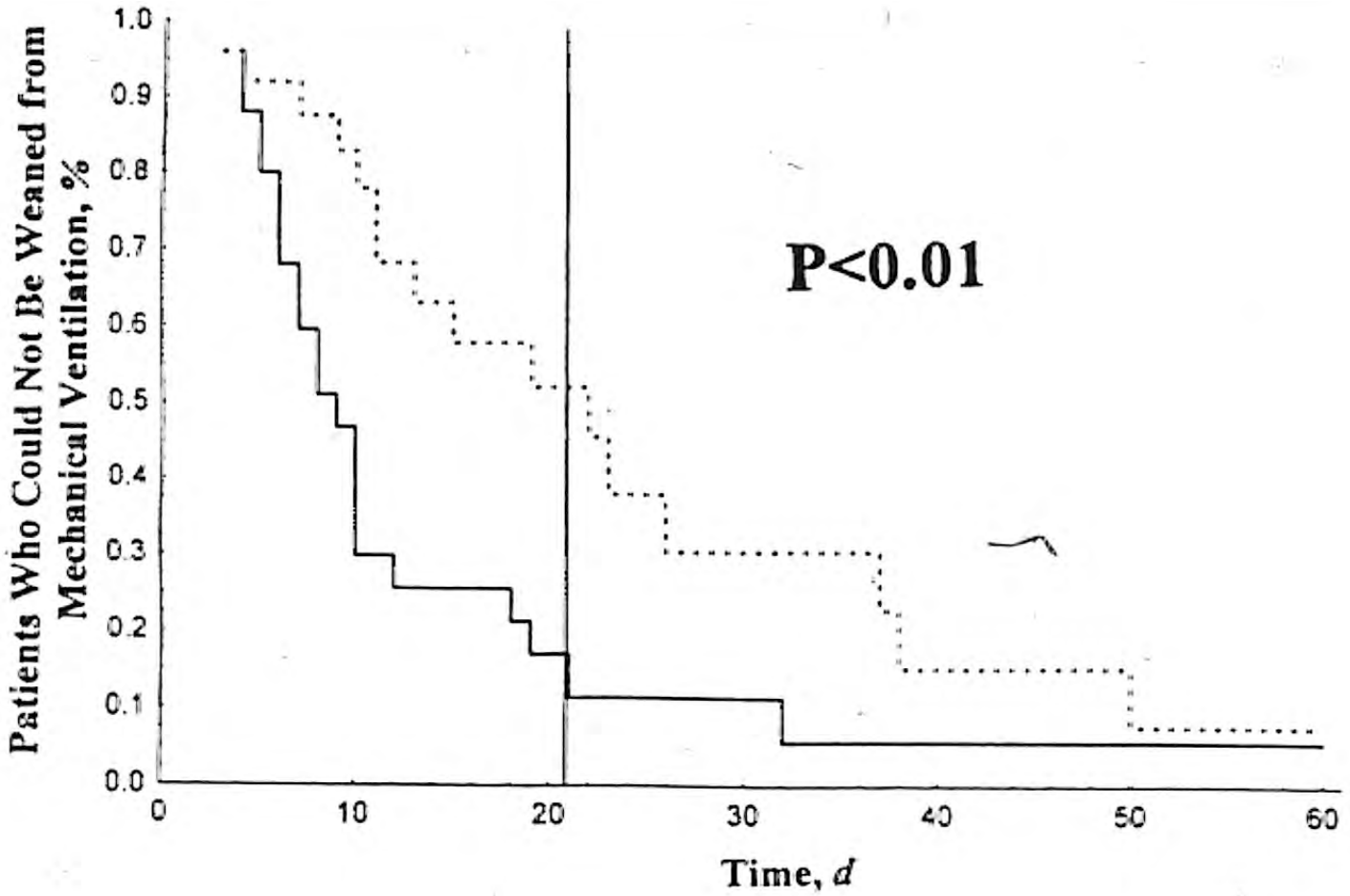


Cabello B, *et al*. ICM 2010; 36:1171-9

Table 3 Comparison of hemodynamic parameters during T-piece and pressure support trials

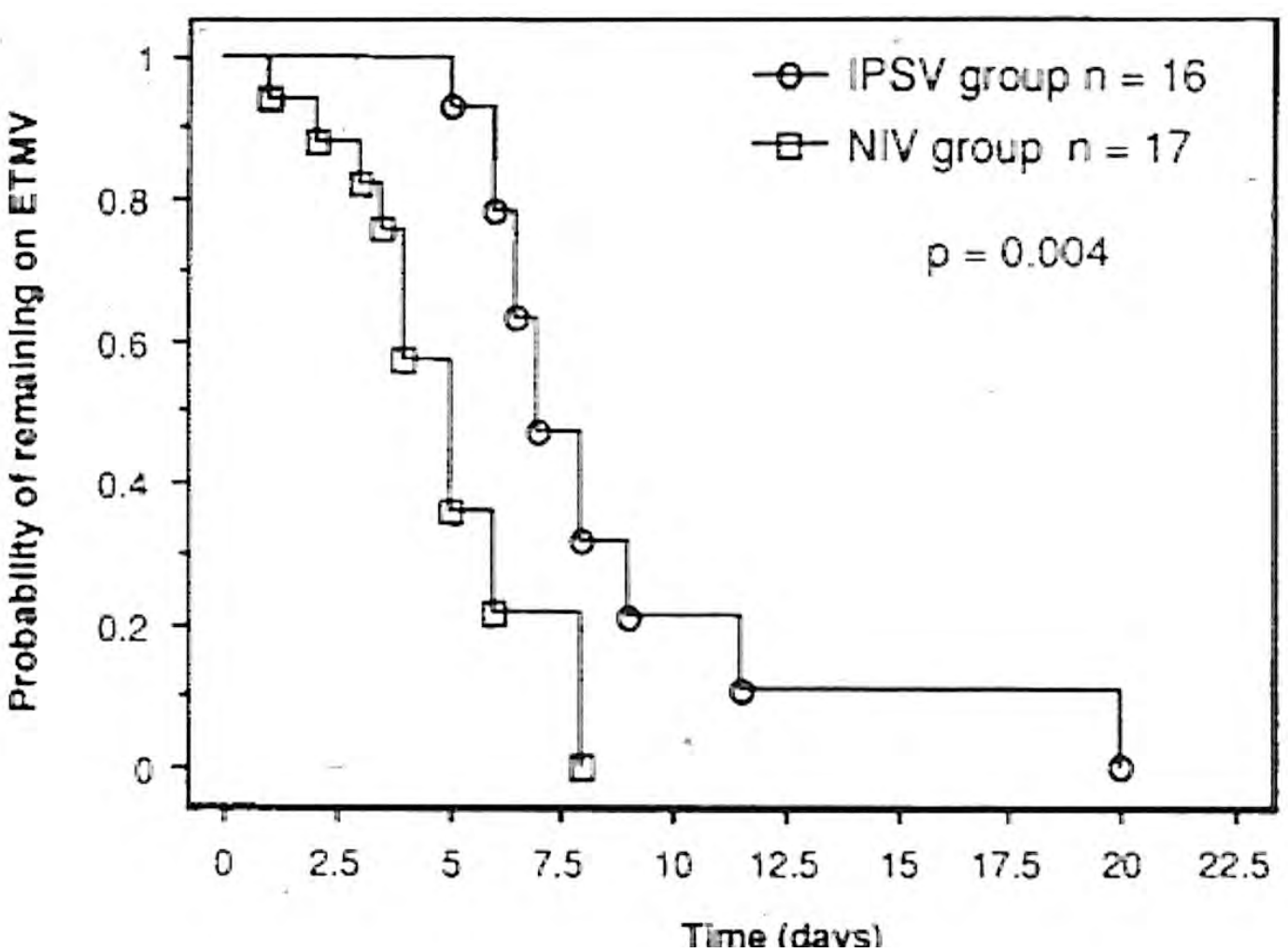
	ACV	PS-PEEP	PS-ZEEP	T-Piece
Heart rate (beats/min)	88 (80–98)	89 (81–100)	94 (87–103)	98 (88–106)*
Systolic blood pressure (mmHg)	116 (108–131)	124 (118–139)	138 (118–158)	158 (126–162)**
PAOP (mmHg)	15 (12–18)	17 (14–22)	20 (15–25)*	21 (18–24)*
Cardiac output (l/min)	7.1 (6.1–7.6)	7.2 (6.1–7.8)	7.2 (6.1–7.8)	6.9 (6.3–7.8)
SVO_2 $(\%)_2$	69 (64–73)	69 (65–71)	69 (65–74)	69 (64–74)

Tolerance: **100%** **11/14 (79%)** **8/14 (57%)** **0%**



Nava S, et al. AIM 1998;128:721-8

Girault Ch, *et al*. AJRCCM 1999;160:86-92



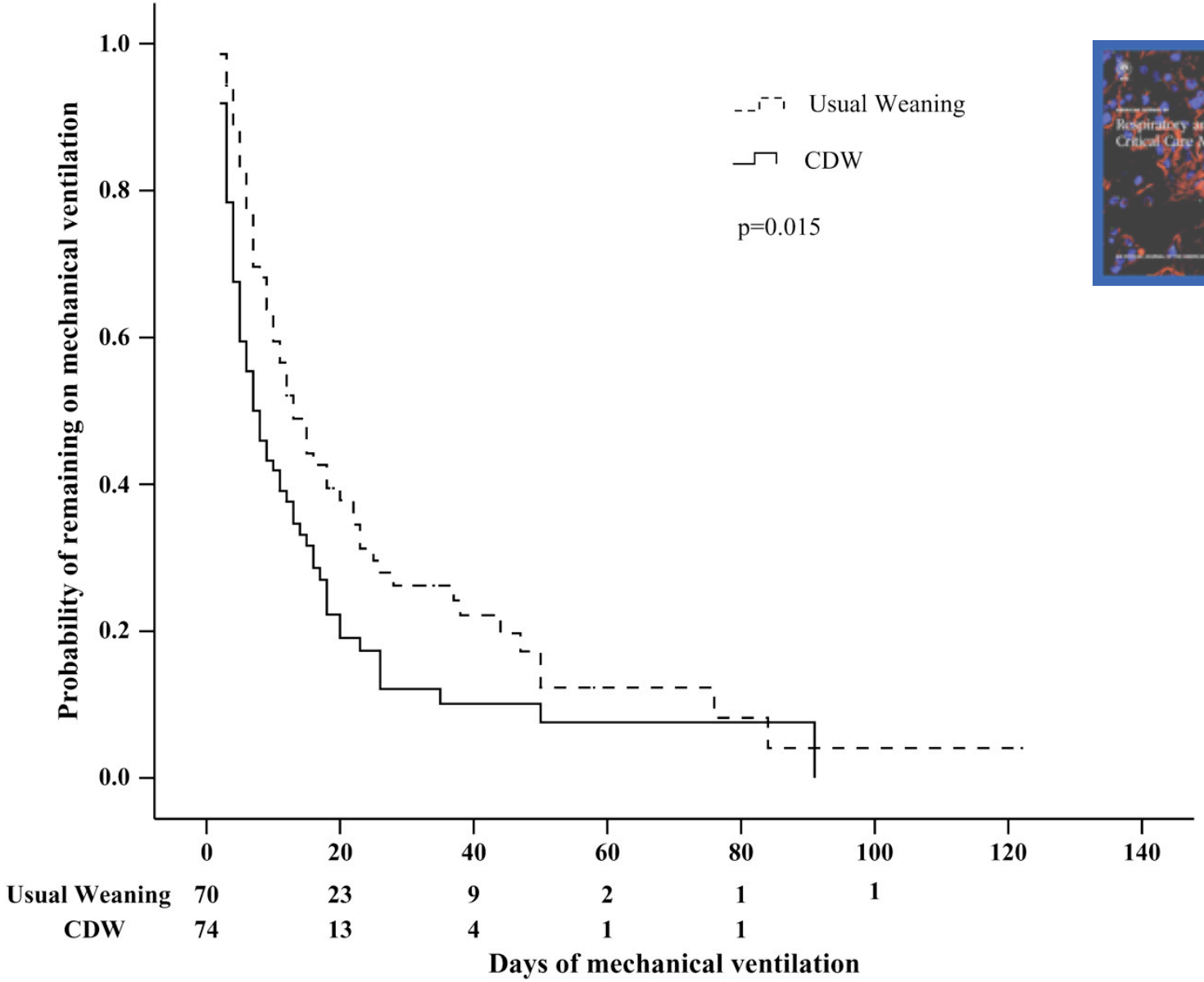
Ferrer M, *et al.* AJRCCM 2003;168:70-6

TABLE 3. WEANING RESULTS, LENGTH OF STAY, OUTCOME VARIABLES, AND CAUSES OF DEATH FOR THE NONINVASIVE VENTILATION AND THE CONVENTIONAL-WEANING GROUPS

	NIV Group (n = 21)	Conventional-Weaning Group (n = 22)	p Value
Duration of invasive ventilation, d	9.5 ± 8.3	20.1 ± 13.1	0.003
Total period of ventilatory support*, d	11.4 ± 8.0	20.1 ± 13.1	0.012
ICU stay, d	14.1 ± 9.2	25.0 ± 12.5	0.002
Hospital stay, d	27.8 ± 14.6	40.8 ± 21.4	0.026
Reintubation, n (%)	3 (14)	6 (27)	0.457
Main causes of reintubation, n			
Severe persistent hypoxemia	1	3	
Severe dyspnea	–	2	
Inability to manage secretions	2	–	
Hemodynamic instability	–	1	
Tracheotomy, n (%)	1 (5)	13 (59)	<0.001
ICU survival, n (%)	19 (90)	13 (59)	0.045
Causes of death within 90 d after entry in the study			
Septic shock/MOF	1	9	
Refractory hypoxemia	1	2	
Cardiac arrest	2	1	
Pneumothorax	–	1	
Stroke	1	–	
Pulmonary embolism	1	–	

RCT: 43 assorted patients with persistent weaning failure

Lellouche F, *et al*. AJRCCM 2006;174:894-900



Lellouche F, *et al*. AJRCCM 2006;174:894-900

TABLE 2. COMPARISON OF OUTCOME BETWEEN STUDY GROUPS

Outcome	CDW Group ($n = 74$)	Usual Weaning Group ($n = 70$)	p Value
Time to first extubation*	2.00 (1.75–6.25)	4.00 (2.00–8.25)	0.02
Duration of mechanical ventilation until first extubation*	6.50 (3.00–12.25)	9.00 (5.75–16.00)	0.03
Time to successful extubation†	3.00 (2.00–8.00)	5.00 (2.00–12.00)	0.01
Total duration of mechanical ventilation†	7.50 (4.00–16.00)	12.00 (7.00–26.00)	0.003
Intensive care length of stay	12.00 (6.00–22.00)	15.50 (9.00–33.00)	0.02
Hospital length of stay	30.00 (17.00–54.75)	35.00 (21.00–60.25)	0.22

Lellouche F, *et al*. AJRCCM 2006;174:894-900

TABLE 3.COMPLICATIONS OF MECHANICAL VENTILATION

COMPLICATION	CDV group (N = 74)	Usual weaning group (N = 70)	*P* Value
	no. of patients (%)		
Reintubation within 72 h	12 (16)	16 (23)	0.40
Any reintubation	17 (23)	23 (33)	0.20
Need for non invasive ventilation	14 (19)	26 (37)	0.02
Self-extubation	8 (11)	7 (10)	0.99
Tracheostomy	12 (16)	13 (19)	0.83
Mechanical ventilation duration > 14 d	12 (16)	20 (29)	0.11
Mechanical ventilation duration > 21 d	5 (7)	11 (16)	0.11

Intensive Care Med (2008) 34:1788–1795
DOI 10.1007/s00134-008-1179-4

ORIGINAL

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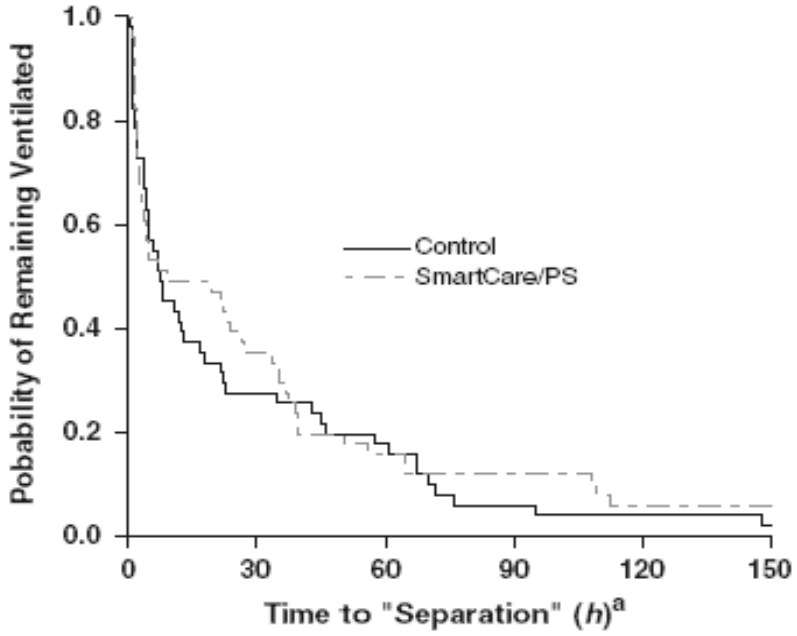
A randomised, controlled trial of conventional versus automated weaning from mechanical ventilation using SmartCare™/PS



Number at risk					
SmartCare/PS 51	19	9	7	4	4
Control 51	15	10	4	3	2

Fig. 2 Kaplan–Meier estimated probability of remaining ventilated. Log-rank test $P = 0.3$. Plot truncated at 150 h due to small numbers of patients beyond that point. [a] Time in hours from randomisation to the time of declaration of "separation potential"

Intensive Care Med (2008) 34:1788–1795
DOI 10.1007/s00134-008-1179-4

ORIGINAL

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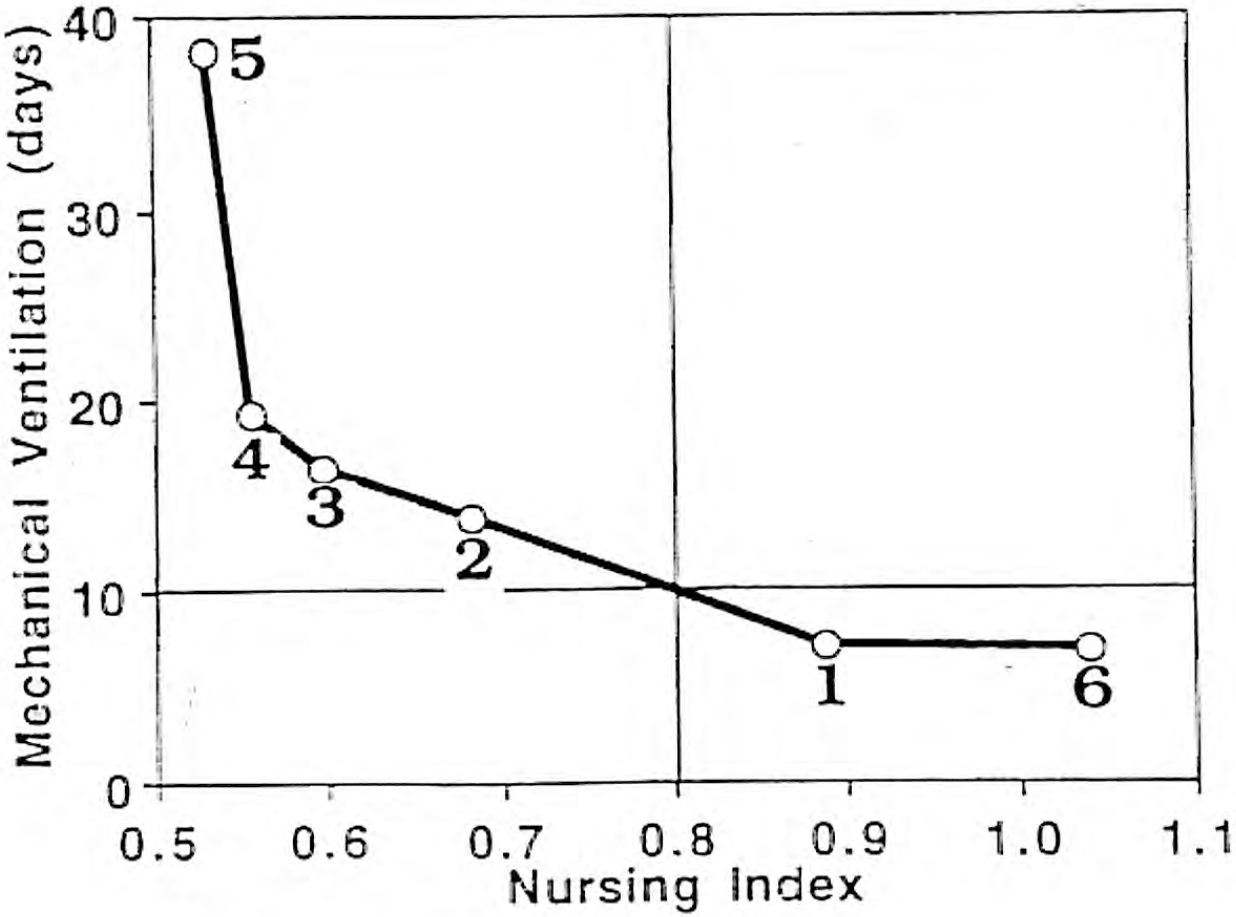
A randomised, controlled trial of conventional versus automated weaning from mechanical ventilation using SmartCare™/PS

Table 2 Primary and secondary outcomes

	SmartCare/PS	Control	*P* value
Primary outcome			
Time to "separation" (h)[a]	20 (2–40)	8 (2–43)	0.3
Secondary outcomes			
Time to successful extubation (h)[b]	43 (6–169)	40 (14–87)	0.6
Ventilation to first extubation (h)[c]	119 (66–218)	128 (54–218)	0.9
Total duration of ventilation (h)[d]	119 (69–226)	129 (62–243)	0.9
Length of ICU stay (h)[e]	146 (106–286)	196 (97–293)	0.7
Length of hospital stay (h)[f]	445 (301–788)	532 (334–791)	0.9

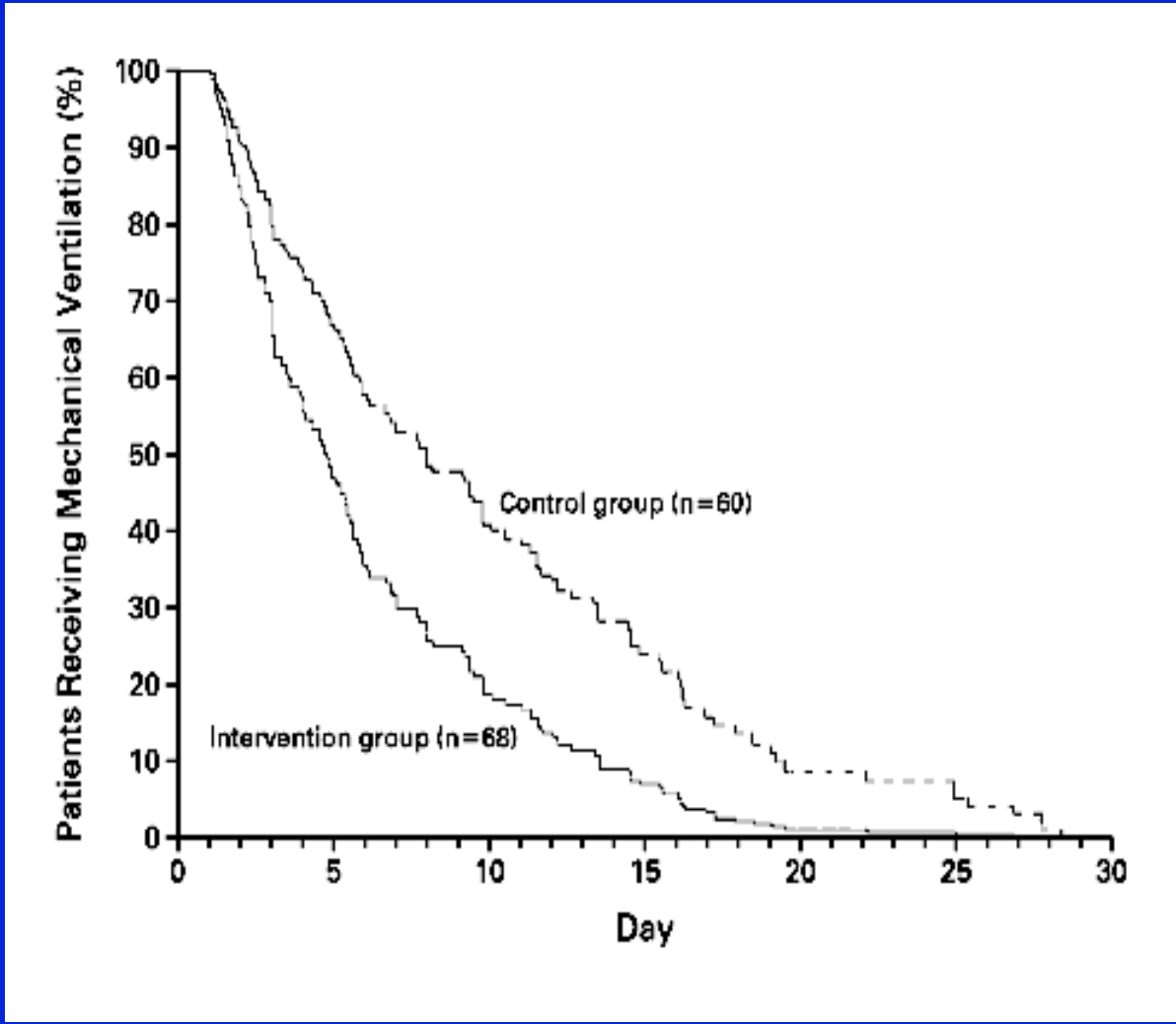


Thorens JB, et al. CCM 1995;23:1807-15

- Increases patient comfort
- Reduces patient anxiety
- Can rapidly identify patients who present signs of poor clinical tolerance

Thorens JB, *et al.* CCM 1995;23:1807-15

Kress JP, *et al.* NEJM 2000;342:1471-7



RCT of 128 MICU patients

Daily SAT *vs* control on vent: 4.9 *vs* 7.3 days (p=.004)

Spontaneous Awakening Trials (SAT)

- ICU stay 3 days less in SAT group (6.4 vs 9.9 d, P=0.02)
- 27% of control patients had diagnostic tests due to altered mental status vs. only 9% of SAT group (P=0.02)

Kress JP, *et al*. N Engl J Med 2000;342:1471-7

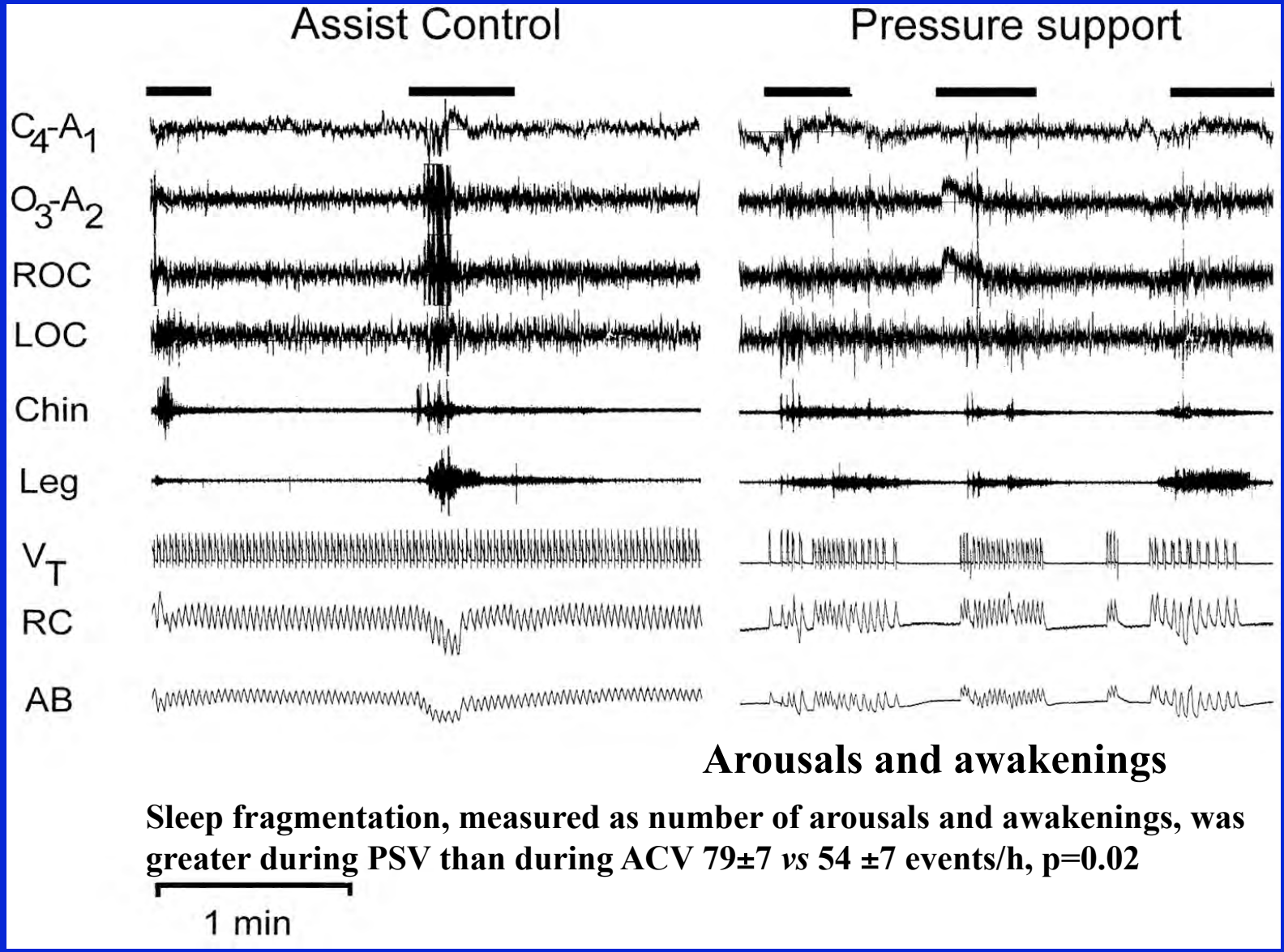
Lancet 2010

A protocol of no sedation for critically ill patients receiving mechanical ventilation: a randomised trial

Thomas Strøm, Torben Martinussen, Palle Toft

Interpretation No sedation of critically ill patients receiving mechanical ventilation is associated with an increase in days without ventilation. A multicentre study is needed to establish whether this effect can be reproduced in other facilities.

Parthasarathy S, Tobin MJ. AJRCCM 2002;166:1423-9



Arousals and awakenings

Sleep fragmentation, measured as number of arousals and awakenings, was greater during PSV than during ACV 79±7 *vs* 54 ±7 events/h, p=0.02

Bosma KJ, *et al*. CCM 2007;35:1048-54

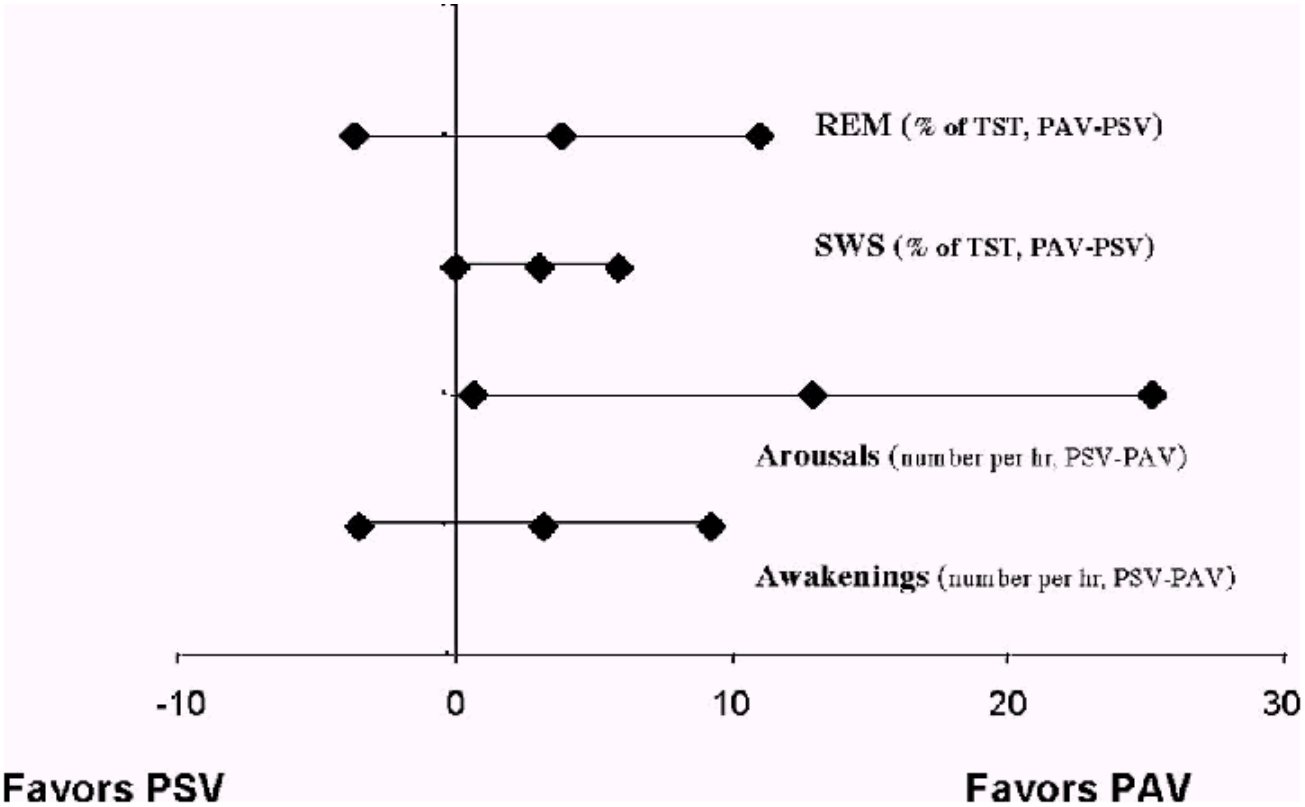
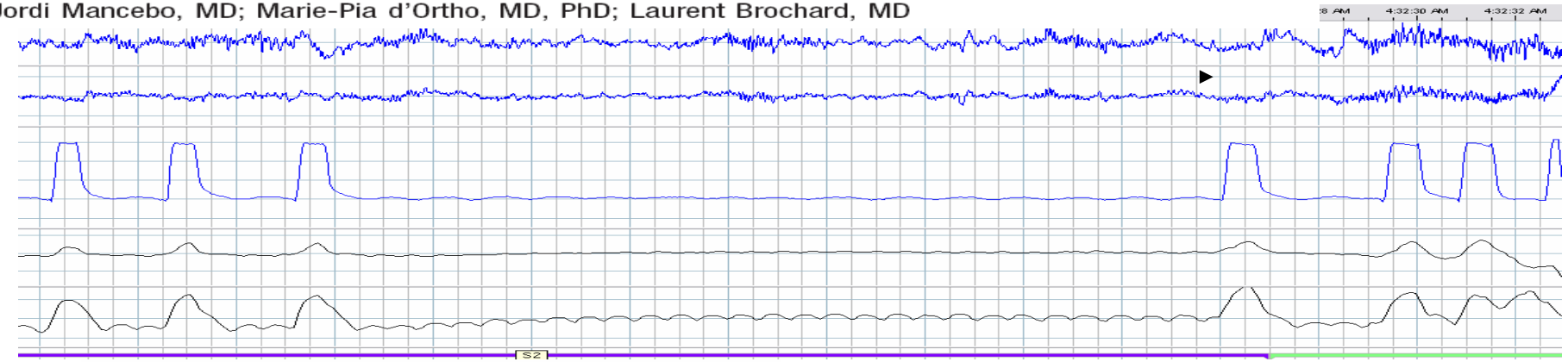


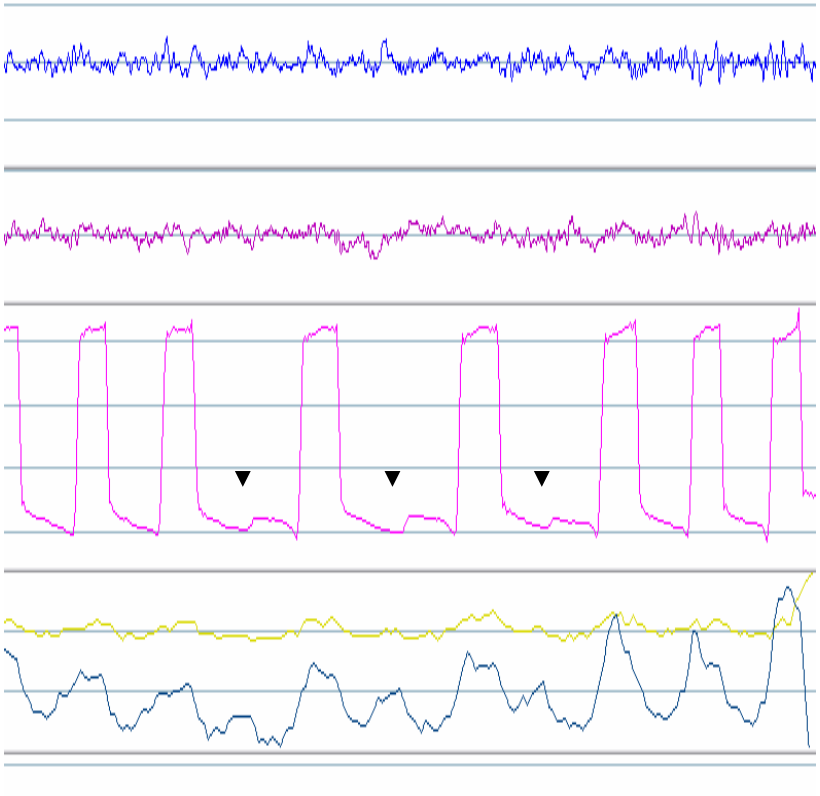
Figure 3. Multivariate analysis of variance of the effect of modes of ventilation on comprehensive sleep quality. Central diamond indicates the mean absolute difference between proportional assist ventilation (*PAV*) and pressure support ventilation (*PSV*); horizontal bar indicates the 95% confidence interval. The combined effect of fewer arousals per hour, fewer awakenings per hour, greater rapid eye movement (*REM*) sleep, and greater slow wave sleep (*SWS*) accounted for the significant ($p < .05$) overall improvement in sleep quality with PAV. *TST*, total sleep time.

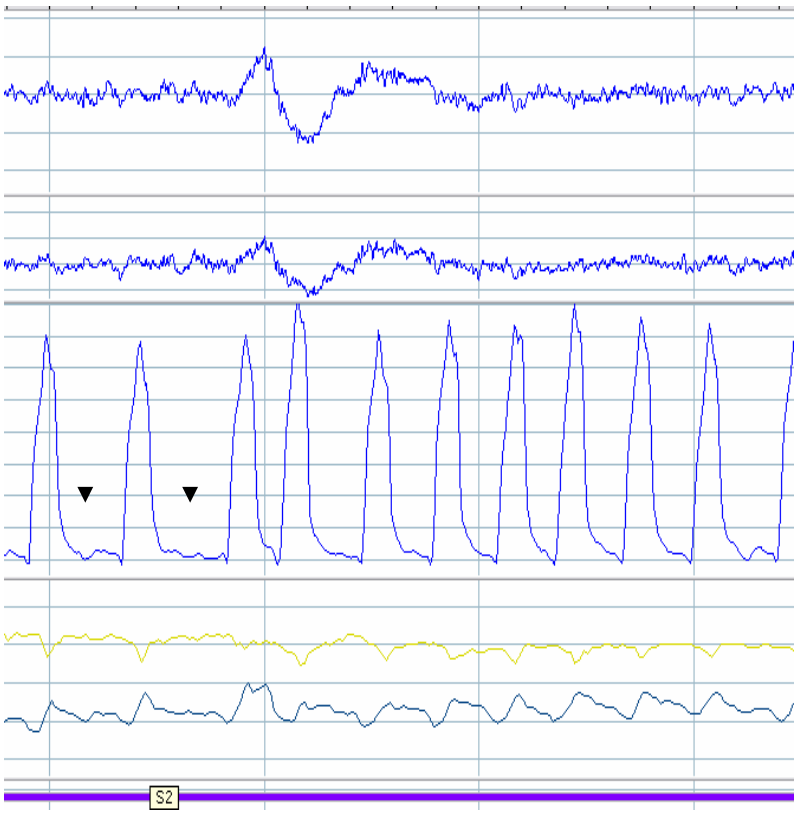
Sleep quality in mechanically ventilated patients: Comparison of three ventilatory modes

CCM 2008;36:1749-55

Belen Cabello, MD; Arnaud W. Thille, MD; Xavier Drouot, MD, PhD; Fabrice Galia, Biomed Eng Master; Jordi Mancebo, MD; Marie-Pia d'Ortho, MD, PhD; Laurent Brochard, MD



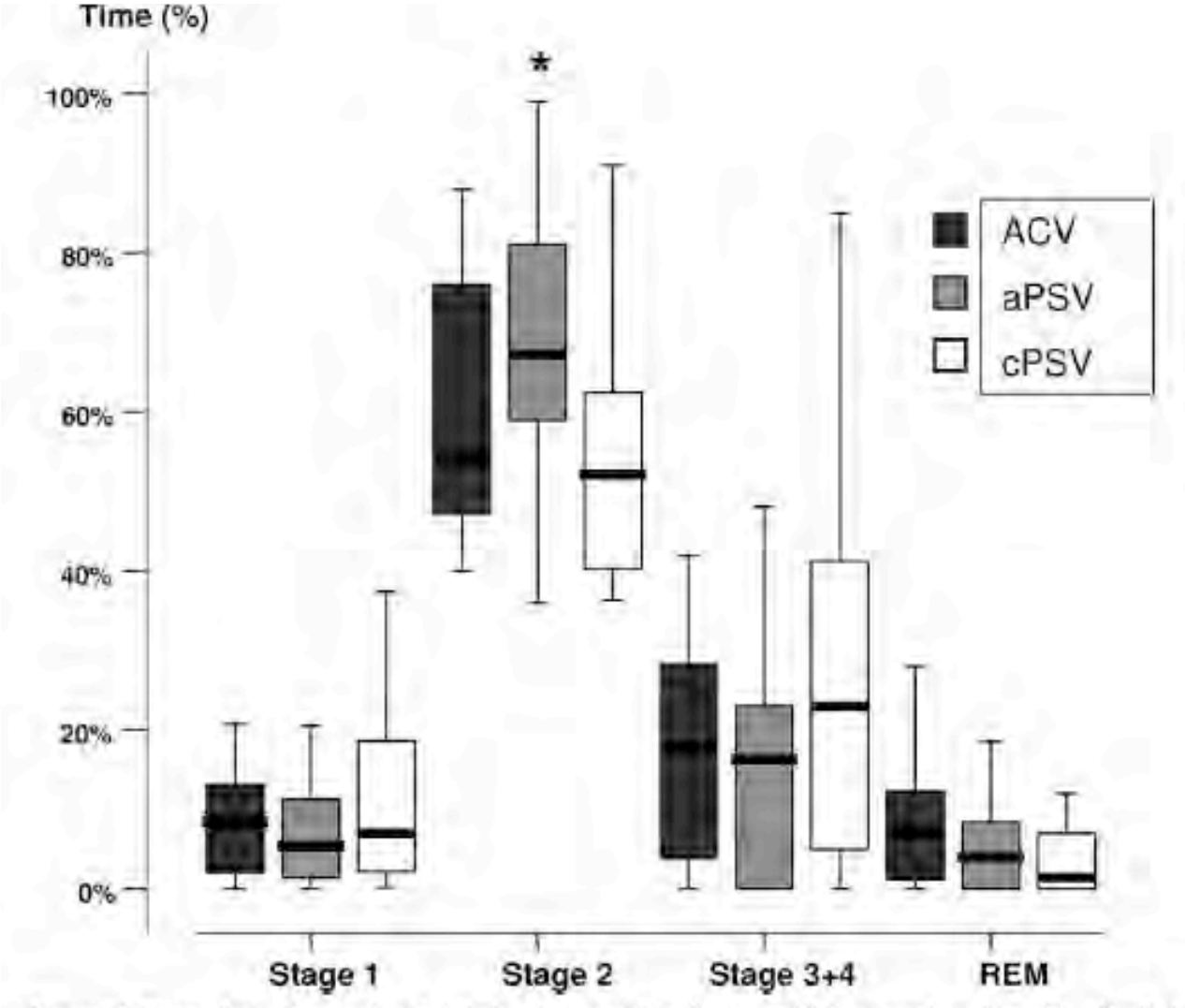




Sleep quality in mechanically ventilated patients: Comparison of three ventilatory modes

CCM 2008;36:1749-55

Belen Cabello, MD; Arnaud W. Thille, MD; Xavier Drouot, MD, PhD; Fabrice Galia, Biomed Eng Master; Jordi Mancebo, MD; Marie-Pia d'Ortho, MD, PhD; Laurent Brochard, MD



Cabello B, *et al*. CCM 2008;36:1749-55

CONCLUSION

Sleep quality is markedly abnormal in conscious, nonsedated patients under assisted mechanical ventilation in ICUs. The ventilatory mode does not seem to influence the quality of sleep in terms of fragmentation and architecture in these individuals. The ventilatory settings may be more important than the ventilatory mode *per se* to avoid or minimize sleep fragmentation.

De Jonghe B, *et al.* JAMA 2002;288:2859-67

Patients under MV for at least of 7 days were screened daily for awakening (D1). Cohort study March 1999-June 2000 (5 ICUs). ICU acquired paresis: severe muscle weakness on D7 after awakening.

Results: 95 patients achieved awakening, and 25% had ICUAP. Duration of MV after D1 longer in ICUAP patients compared to those w/o (18.2 vs 7.6 days, p=.03).

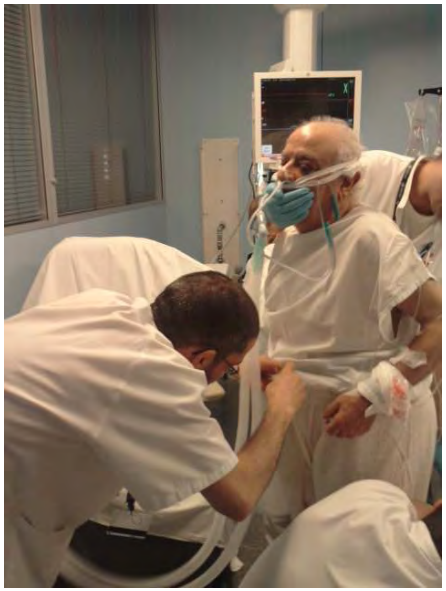
Independent predictors of ICUAP: female, # days with dysfuction of 2 or more organs, duration of MV, and administration of corticosteroids.

JAMA 2008

GRAND ROUNDS

AT THE JOHNS HOPKINS HOSPITAL

CLINICIAN'S CORNER



Mobilizing Patients in the Intensive Care Unit

Improving Neuromuscular Weakness and Physical Function

Dale M. Needham, MD, PhD

Early mobilization of patients in the hospital and the intensive care unit

Lancet 2009

Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial

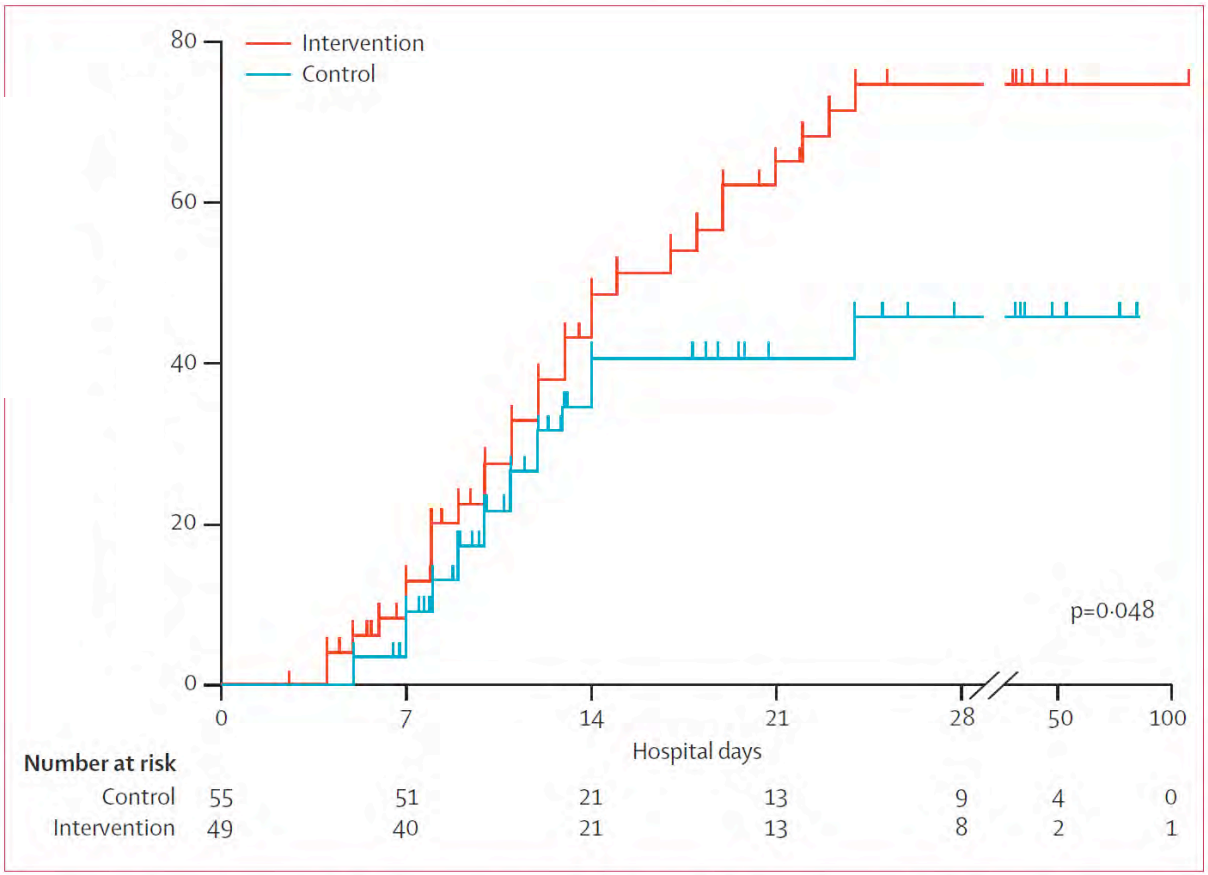
William D Schweickert, Mark C Pohlman, Anne S Pohlman, Celerina Nigos, Amy J Pawlik, Cheryl L Esbrook, Linda Spears, Megan Miller, Mietka Franczyk, Deanna Deprizio, Gregory A Schmidt, Amy Bowman, Rhonda Barr, Kathryn E McCallister, Jesse B Hall, John P Kress

Interpretation A strategy for whole-body rehabilitation—consisting of interruption of sedation and physical and occupational therapy in the earliest days of critical illness—was safe and well tolerated, and resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care.

Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial

Lancet 2010

William D Schweickert, Mark C Pohlman, Anne S Pohlman, Celerina Nigos, Amy J Pawlik, Cheryl L Esbrook, Linda Spears, Megan Miller, Mietka Franczyk, Deanna Deprizio, Gregory A Schmidt, Amy Bowman, Rhonda Barr, Kathryn E McCallister, Jesse B Hall, John P Kress



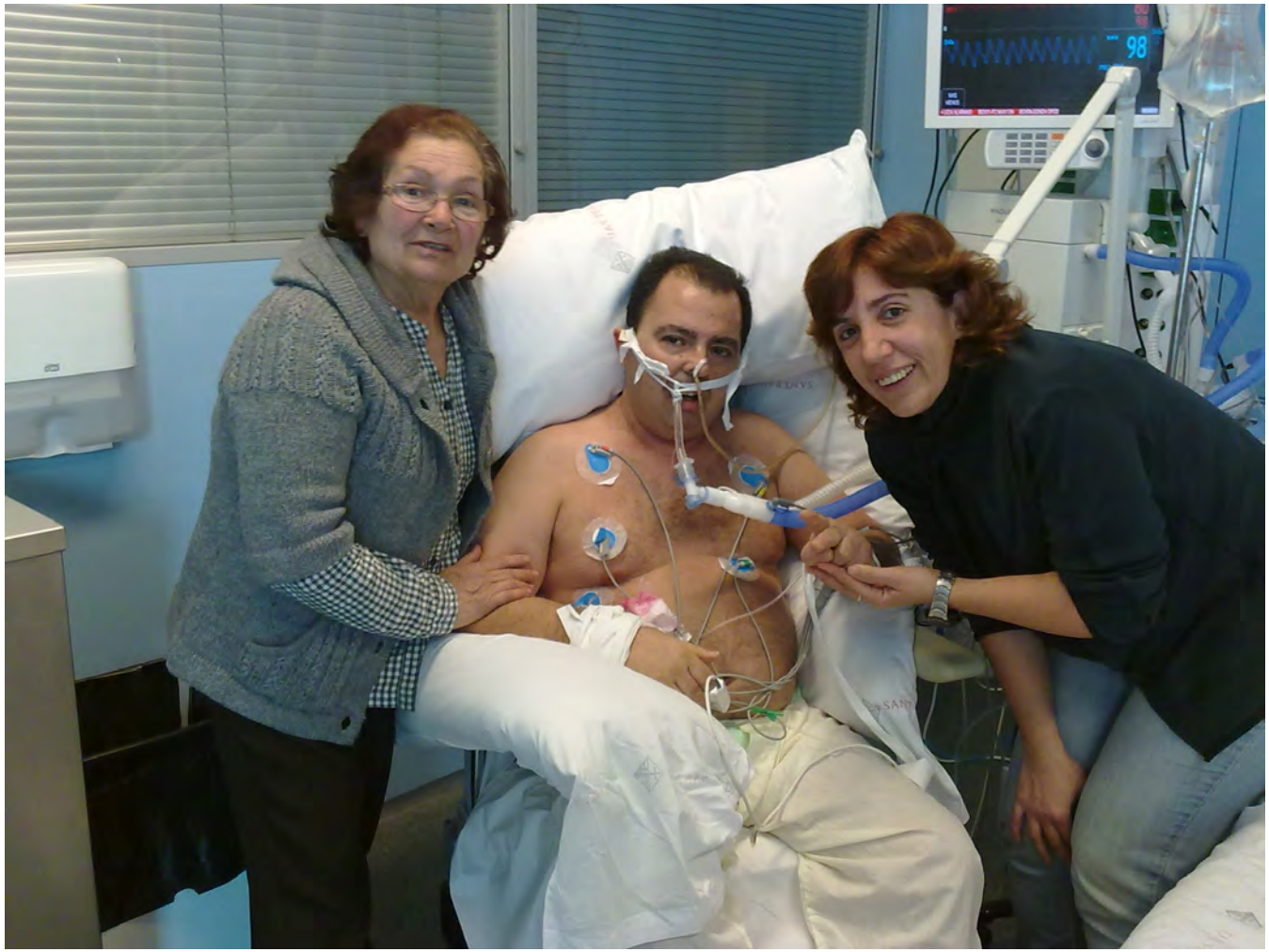
Rehab group

Control group

Figure 2: Probability of return to independent functional status in intervention and control groups


MODUTEC
18
SANITPAL


MAQUET
MODUTEC


98

NO ME CANSAT JENS

SI
SI NOTAVE QUE M'AGAFABAV
MASSE FORT

GRACIES

Weaning: summary

-Time course of weaning depends on a predefined clinical strategy.
-In the majority of cases (~ 2/3), a progressive weaning is unnecessary.
-Optimal withdrawal is based on a simple, rigorous, and reproducible strategy.
-Clinical practice and organization may profoundly affect outcomes of both, the whole mechanical ventilation and the weaning process.