Physiopathology of difficult weaning

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Non Financial support for congress

- Hill-Rom
- Dräger

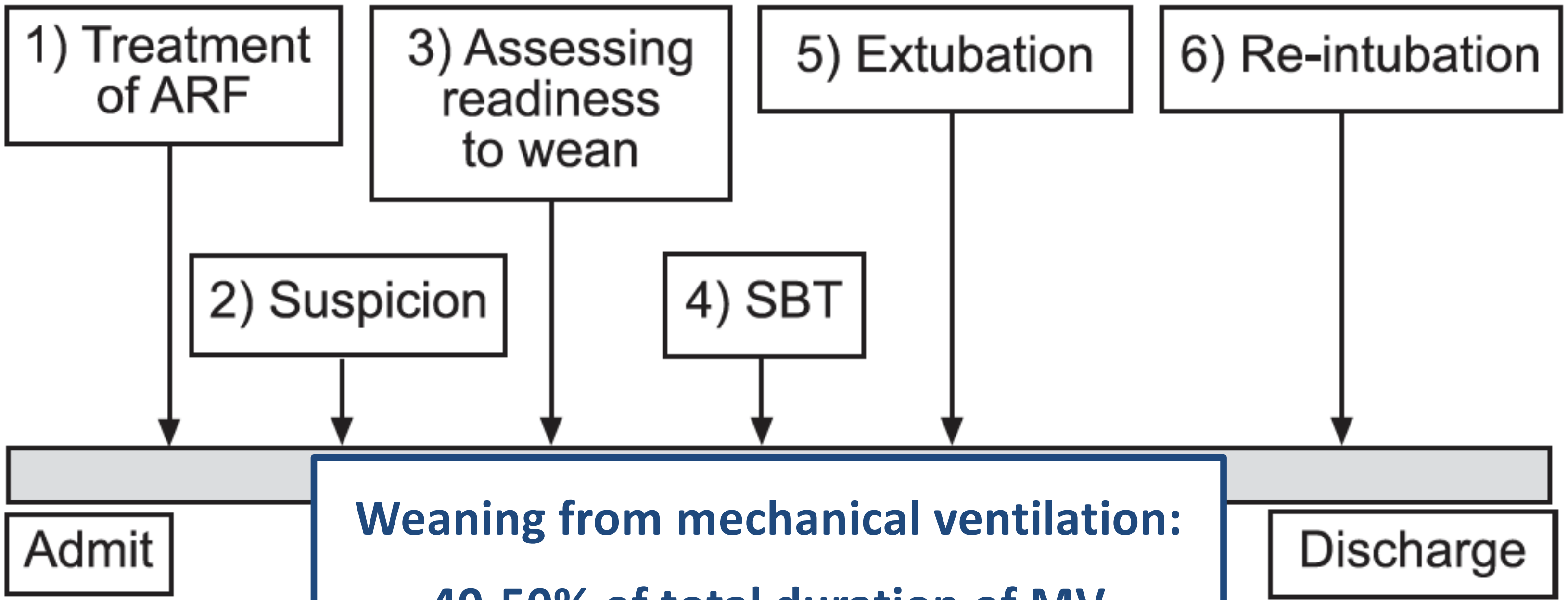
Fees for speaker:

- Covidien
- Lilly oncology
- Boehringher Inghelheim
- Pfizer

Weaning from mechanical ventilation

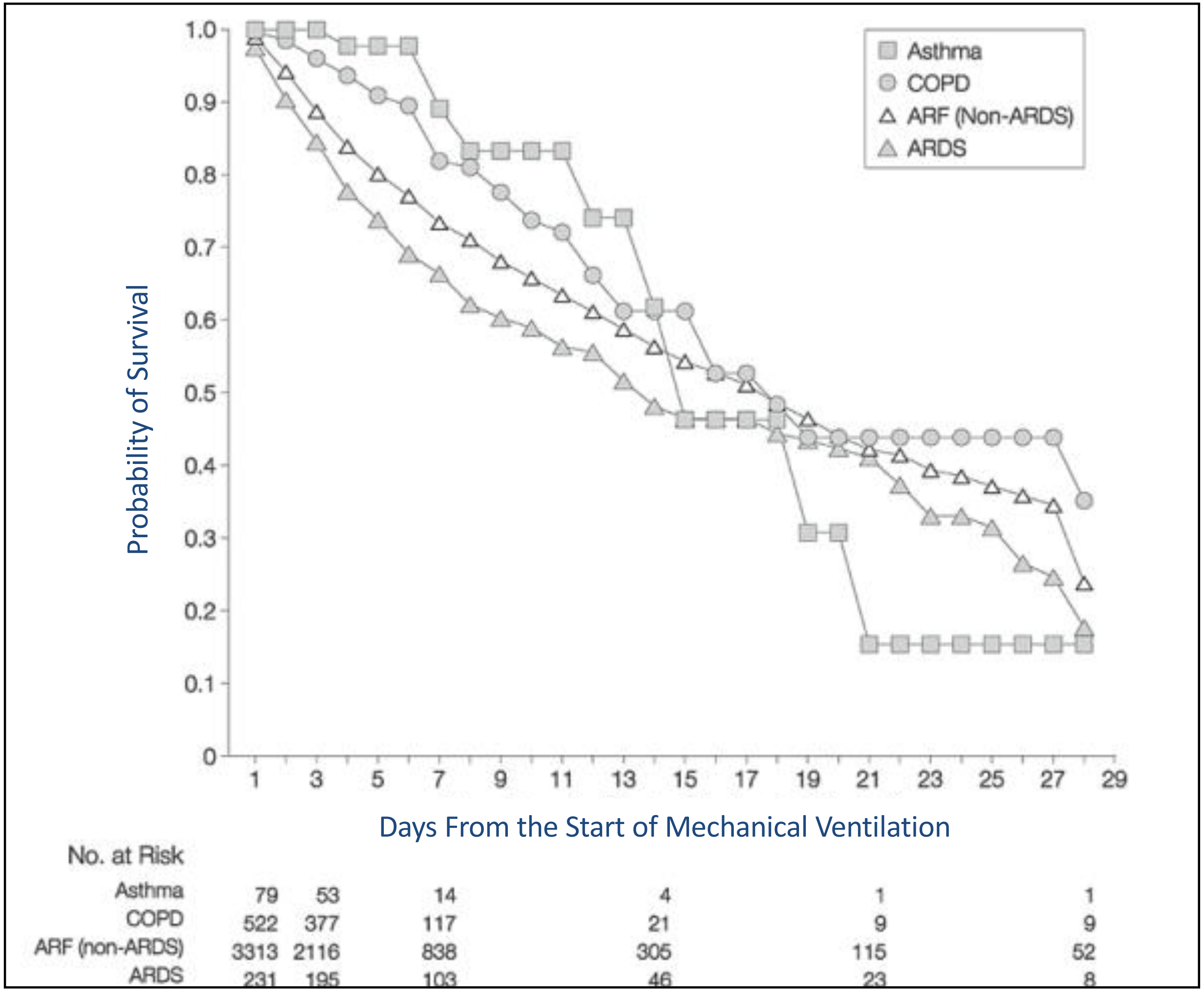
J-M. Boles*, J. Bion#, A. Connors¶, M. Herridge+, B. Marsh§, C. Melotƒ, R. Pearl**, H. Silverman##, M. Stanchina¶¶, A. Vieillard-Baron++, T. Welte§§

ERJ 2007



Weaning from mechanical ventilation:

40-50% of total duration of MV

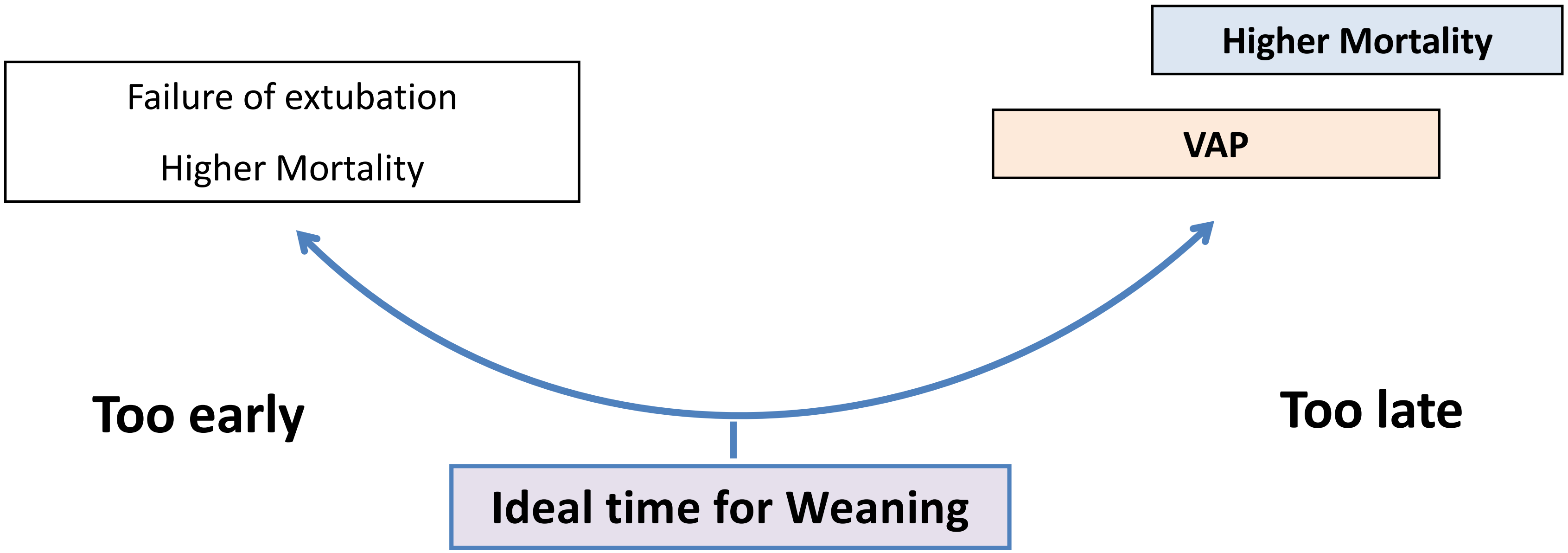


Characteristics and Outcomes in Adult Patients Receiving Mechanical Ventilation: A 28-Day International Study.

Mortality is associated with duration of Mechanical Ventilation

Esteban et al. JAMA 2002

Weaning = Challenge



Difficult weaning : which definition ?

2005: National Association for Medical Direction of Respiratory Care
"the need for more than **21 consecutive days** of MV for more than **6 h/day**"

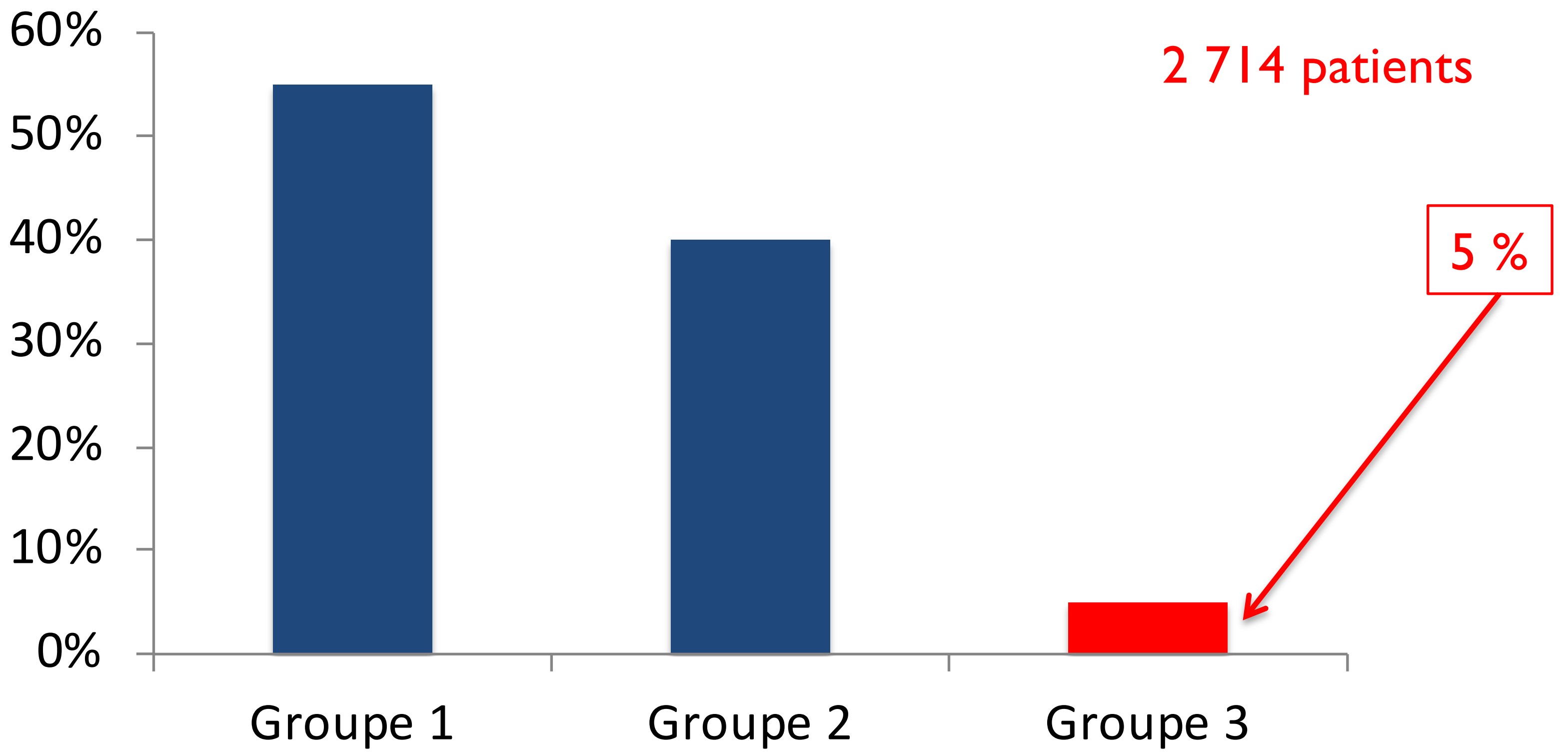
Weaning according to New Definition (WIND) study (2016)
"successful extubation after **more than three SBTs** or taking **more than seven days**"

2007: European Respiratory Society (ERS) Task Force
"the need of more than **7 days of weaning** after the first spontaneous breathing trial (**SBT**)"

Characteristics and Outcomes of Ventilated Patients According to Time to Liberation from Mechanical Ventilation

Oscar Peñuelas[1,2], Fernando Frutos-Vivar[1,2], Cristina Fernández[3], Antonio Anzueto[4], Scott K. Epstein[6], Carlos Apezteguía[7], Marco González[8], Nicolas Nin[1,2], Konstantinos Raymondos[9], Vinko Tomicic[10], Pablo Desmery[11], Yaseen Arabi[12], Paolo Pelosi[13], Michael Kuiper[14], Manuel Jibaja[15], Dimitros Matamis[16], Niall D. Ferguson[5], and Andrés Esteban[1,2] for the Ventila Group*

Am J Respir Crit Care Med Vol 184. pp 430–437, 2011



Characteristics and Outcomes of Ventilated Patients According to Time to Liberation from Mechanical Ventilation

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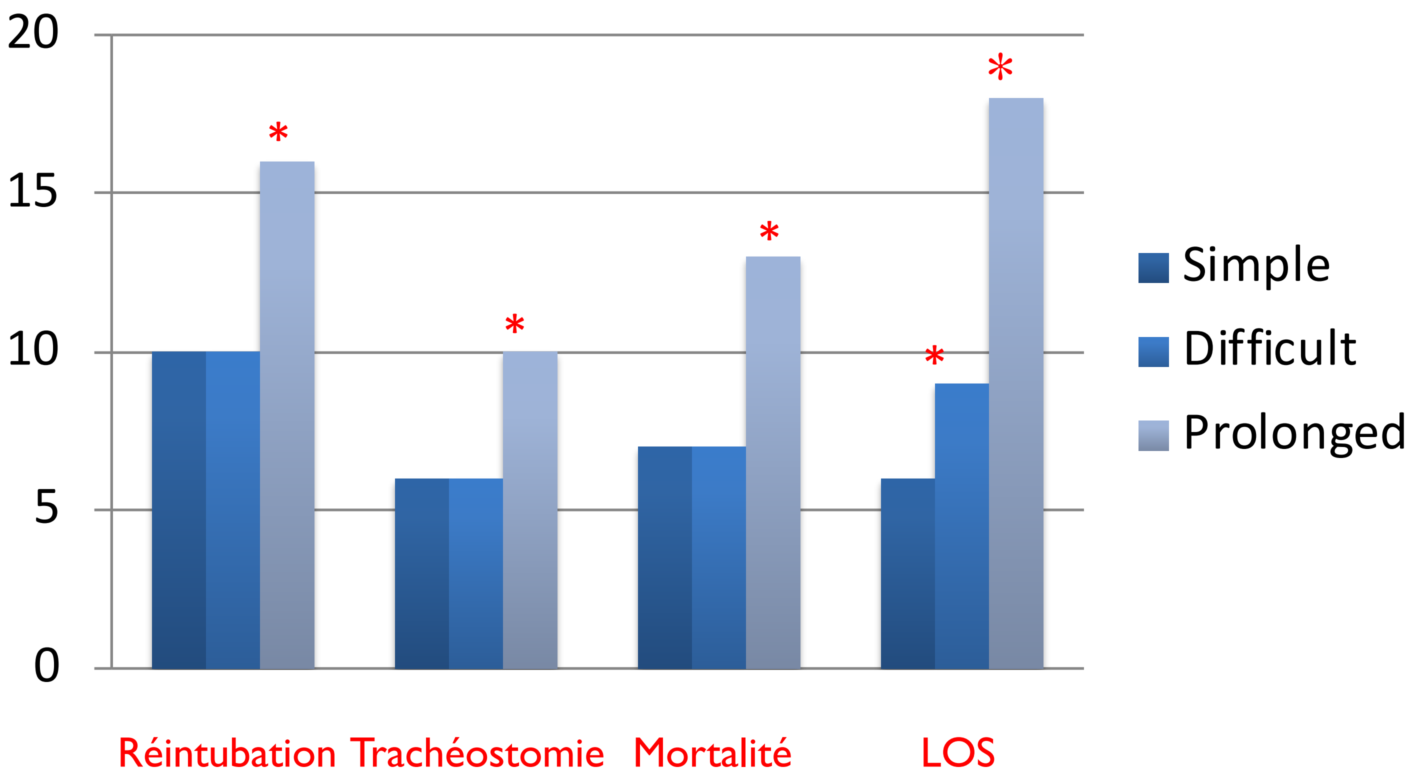
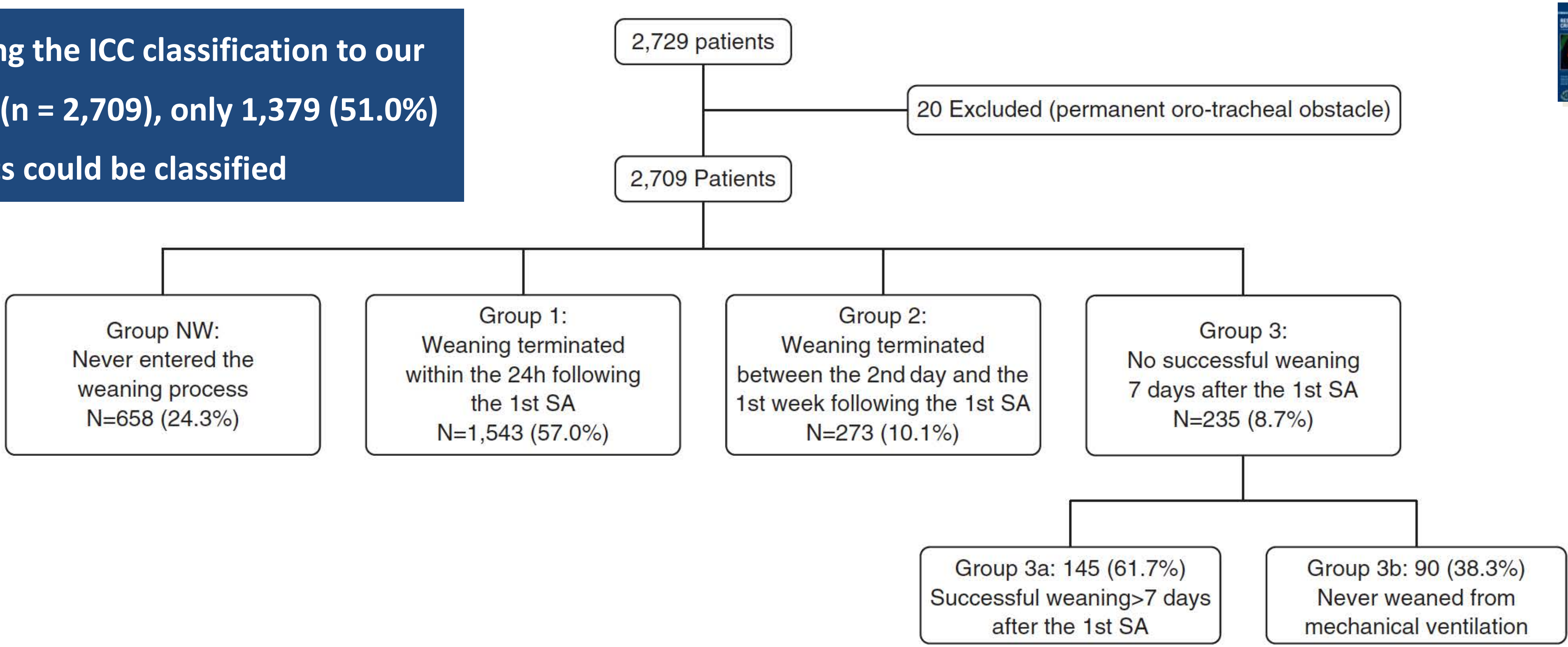


Epidemiology of Weaning Outcome according to a New Definition
The WIND Study

Béduneau et al. AJRCCM 2017

Applying the ICC classification to our cohort (n = 2,709), only 1,379 (51.0%) patients could be classified



Epidemiology of Weaning Outcome according to a New Definition
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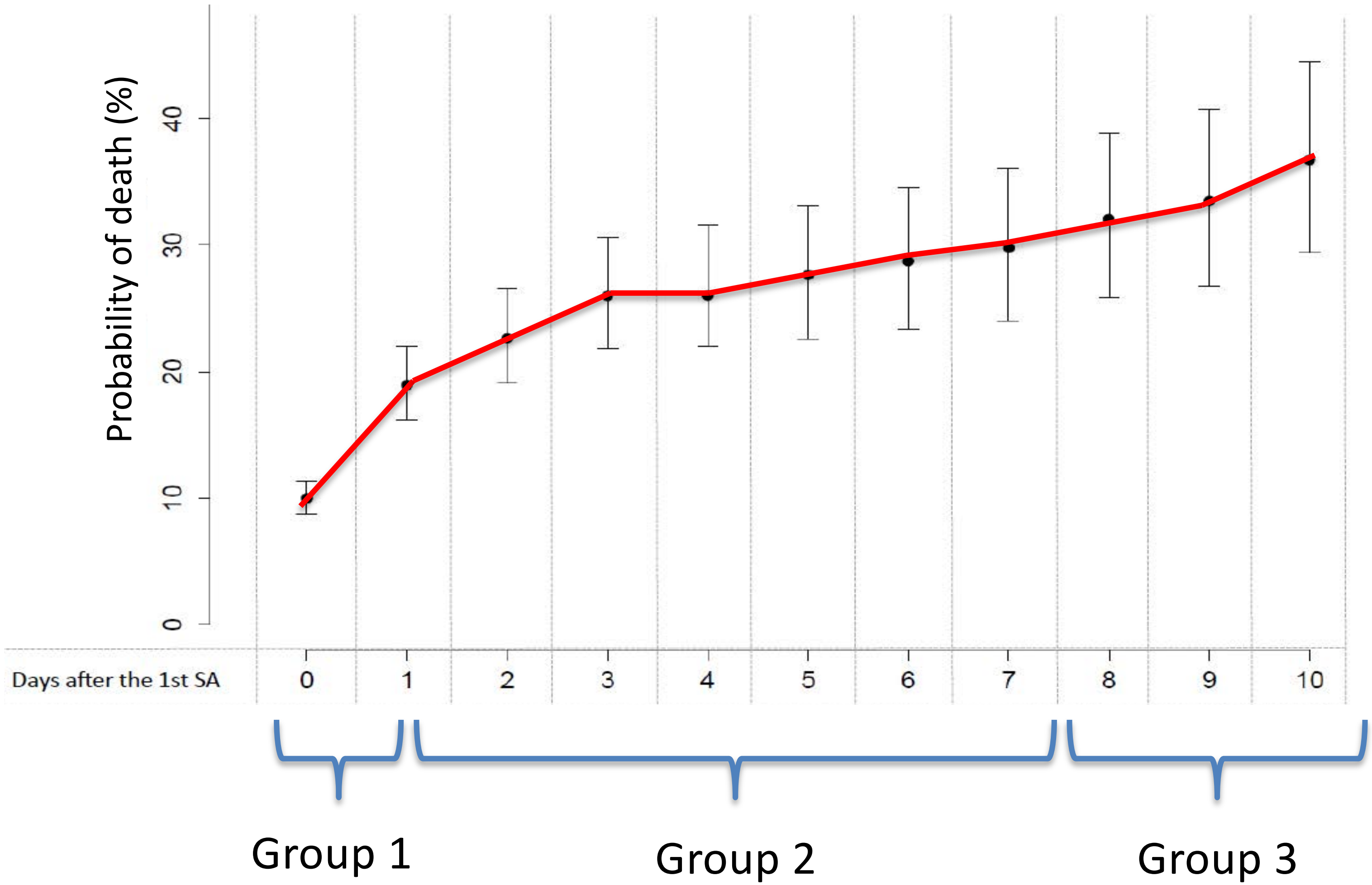
Béduneau et al. AJRCCM 2017



Clinical challenges in mechanical ventilation

Ewan C Goligher, Niall D Ferguson, Laurent J Brochard

Lancet 2016

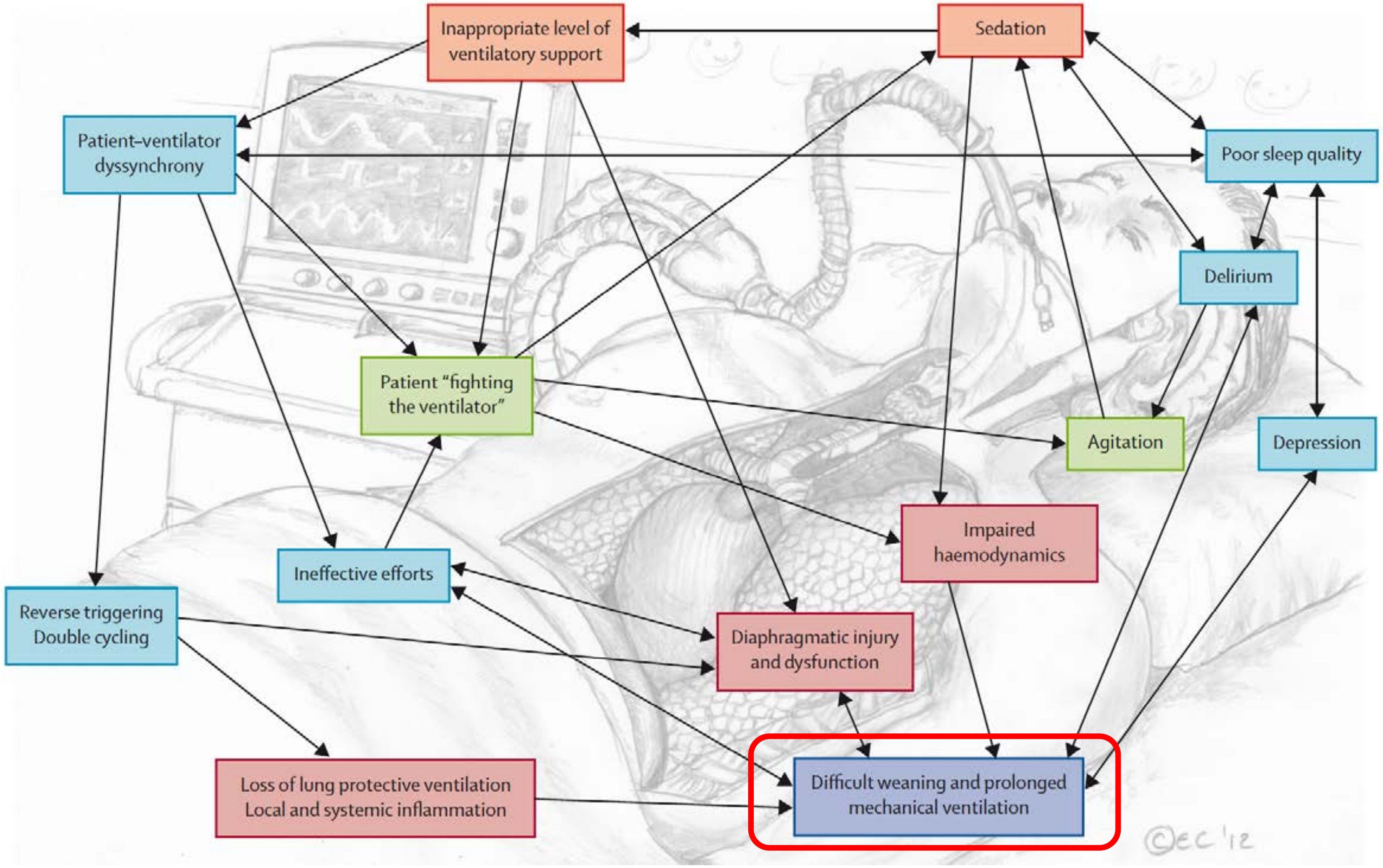


TABLE 4 Common pathophysiologies and their incidence, which may impact on the ability to wean a patient from mechanical ventilation

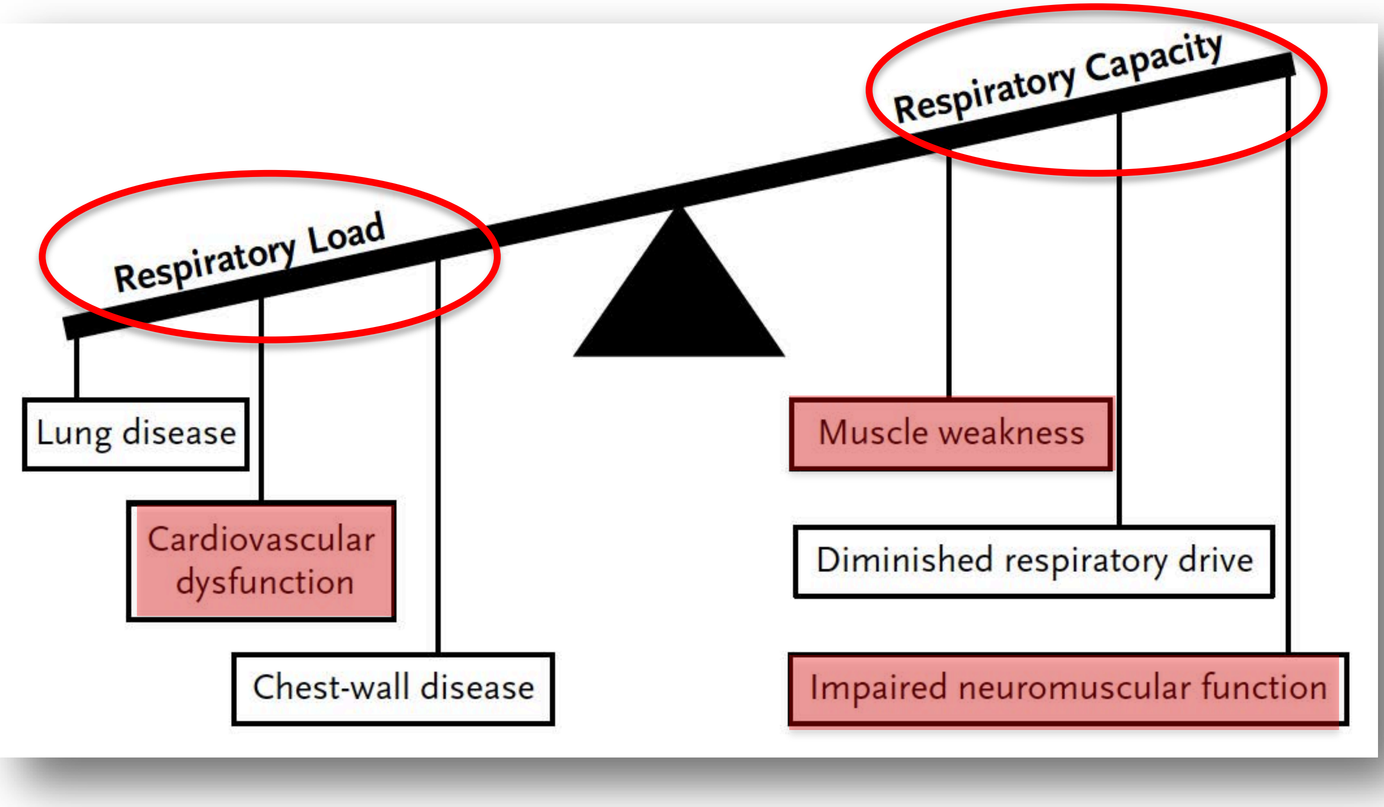
Pathophysiology	Consider
Respiratory load	Increased work of breathing: inappropriate ventilator settings
	Reduced compliance: pneumonia (ventilator-acquired); cardiogenic or noncardiogenic oedema; pulmonary fibrosis; pulmonary haemorrhage; diffuse pulmonary infiltrates
	Airway bronchoconstriction
	Increased resistive load
	During SBT: endotracheal tube
	Post-extubation: glottic oedema; increased airway secretions; sputum retention
Cardiac load	Cardiac dysfunction prior to critical illness
	Increased cardiac workload leading to myocardial dysfunction: dynamic hyperinflation; increased metabolic demand; unresolved sepsis
Neuromuscular	Depressed central drive: metabolic alkalosis; mechanical ventilation; sedative/hynotic medications
	Central ventilatory command: failure of the neuromuscular respiratory system
	Peripheral dysfunction: primary causes of neuromuscular weakness; CINMA
Neuropsychological	Delirium
	Anxiety, depression
Metabolic	Metabolic disturbances
	Role of corticosteroids
	Hyperglycaemia
Nutrition	Overweight
	Malnutrition
	Ventilator-induced diaphragm dysfunction
Anaemia	

CURRENT CONCEPTS

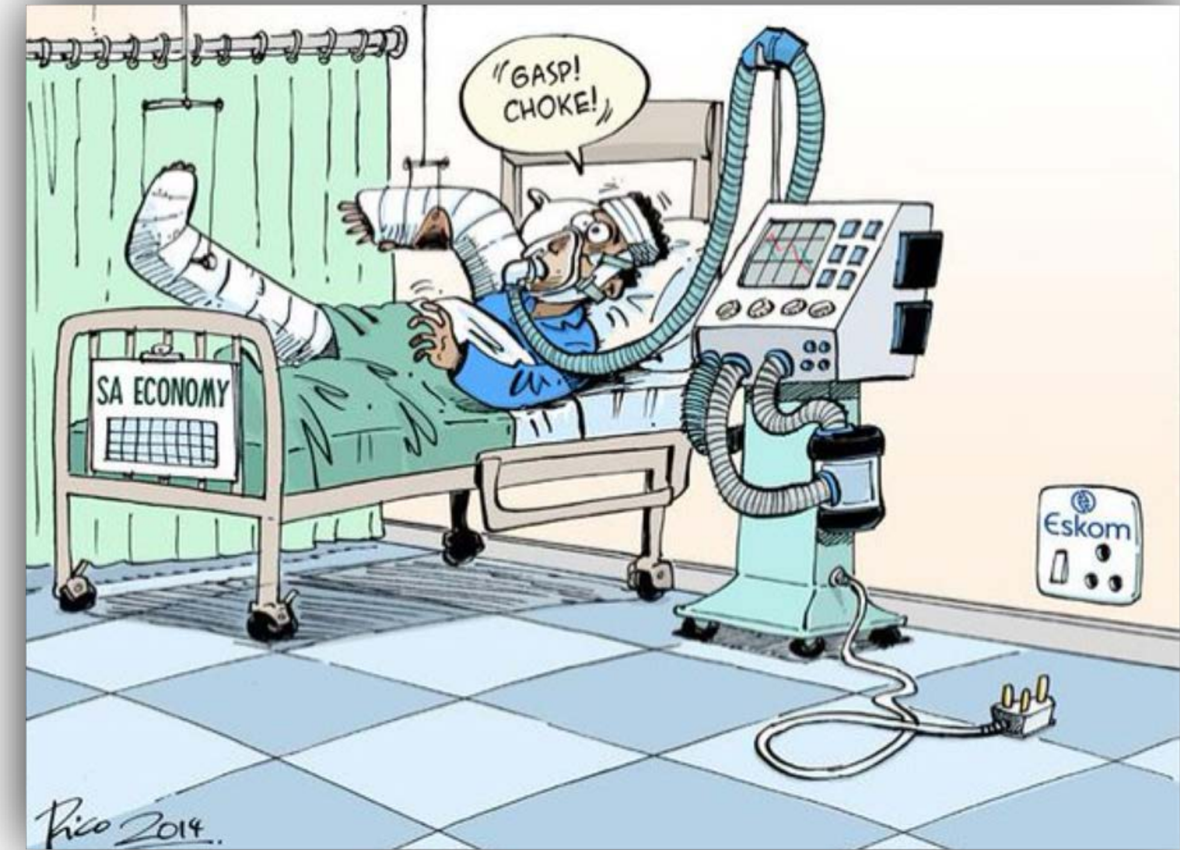
Weaning Patients from the Ventilator

N Engl J Med 2012;367:2233-9.

John F. McConville, M.D., and John P. Kress, M.D.



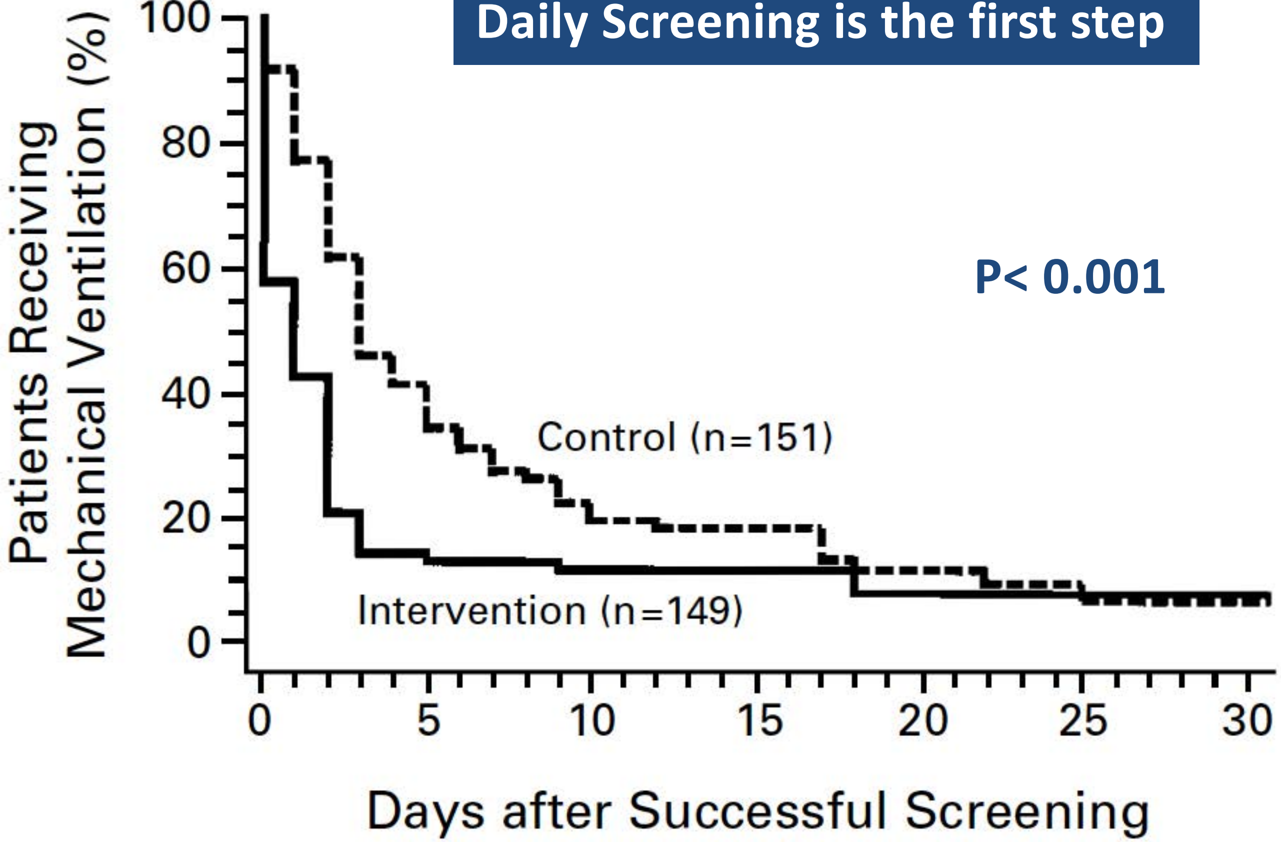
Sevrage possible mais non identifié



EFFECT ON THE DURATION OF MECHANICAL VENTILATION OF IDENTIFYING PATIENTS CAPABLE OF BREATHING SPONTANEOUSLY

N=300 Patients

Daily Screening is the first step



P< 0.001

<u>**Intervention Group**</u>

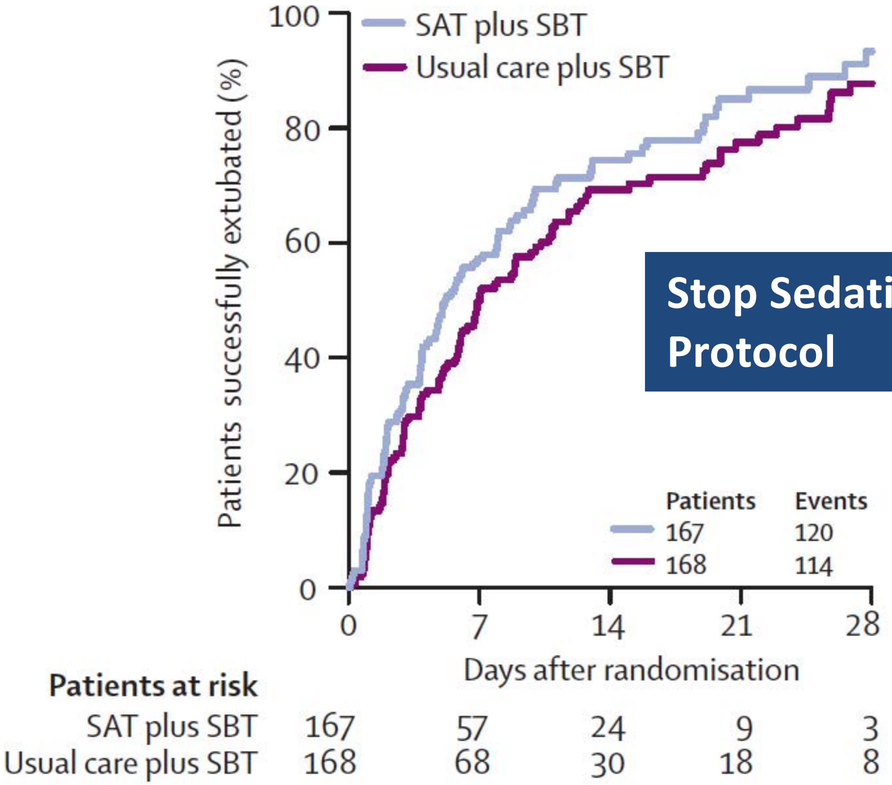
1) **A daily screening of respiratory function**

2) **A 2-hour trial of spontaneous Breathing**

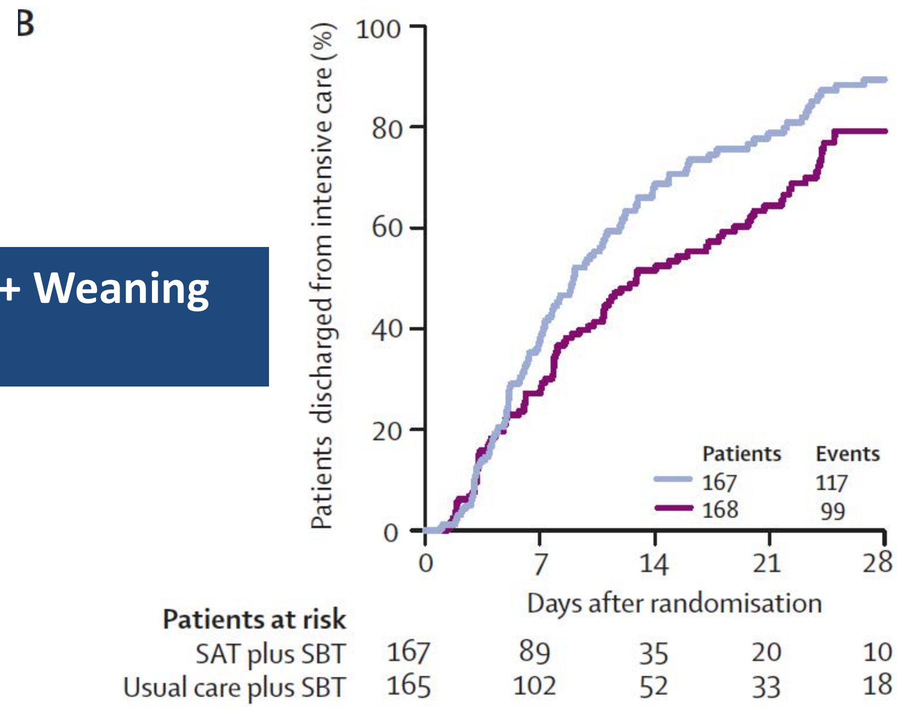
3) **Notification of the physician of the successful results**

Ely W et al. NEJM 1996

Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): a randomised controlled trial



Stop Sedation + Weaning Protocol

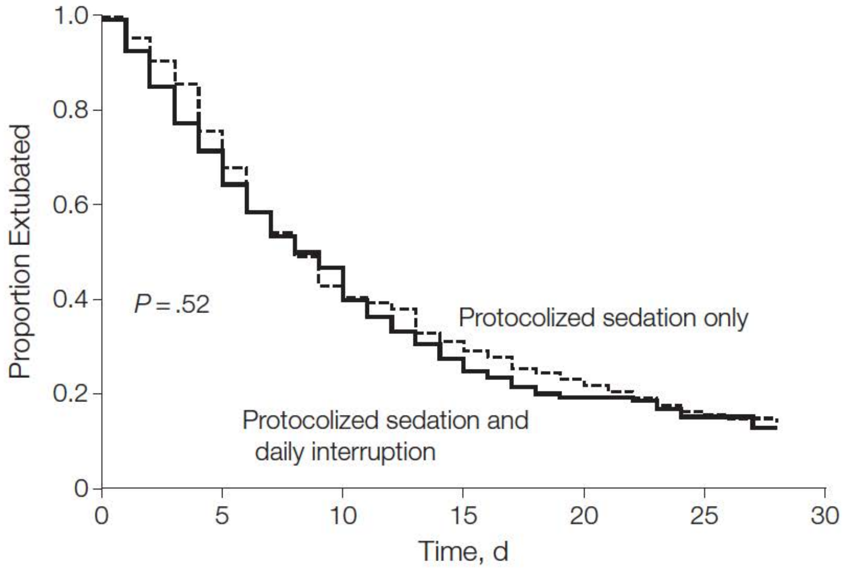


Girard T et al. Lancet 2008

Daily Sedation Interruption in Mechanically Ventilated Critically Ill Patients Cared for With a Sedation Protocol

A Randomized Controlled Trial

Figure 2. Kaplan-Meier Curves for Time to Successful Extubation



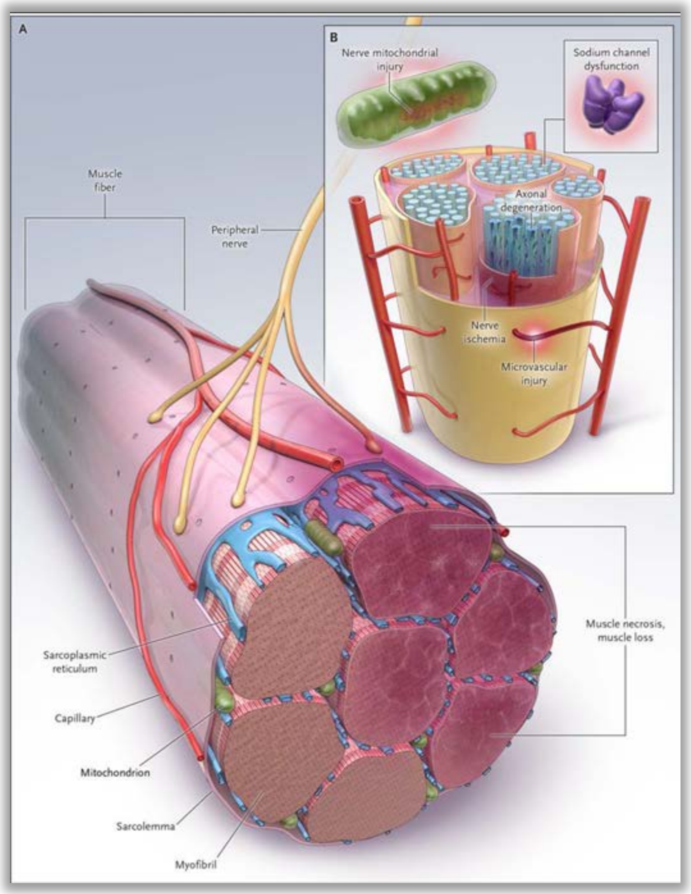
No. at risk						
Protocolized sedation only	209	146	72	49	34	23
Protocolized sedation and daily interruption	214	140	81	42	28	16

N=430 Patients

Mehta et al. JAMA 2012

ICU-Acquired Weakness and Recovery from Critical Illness

NEJM



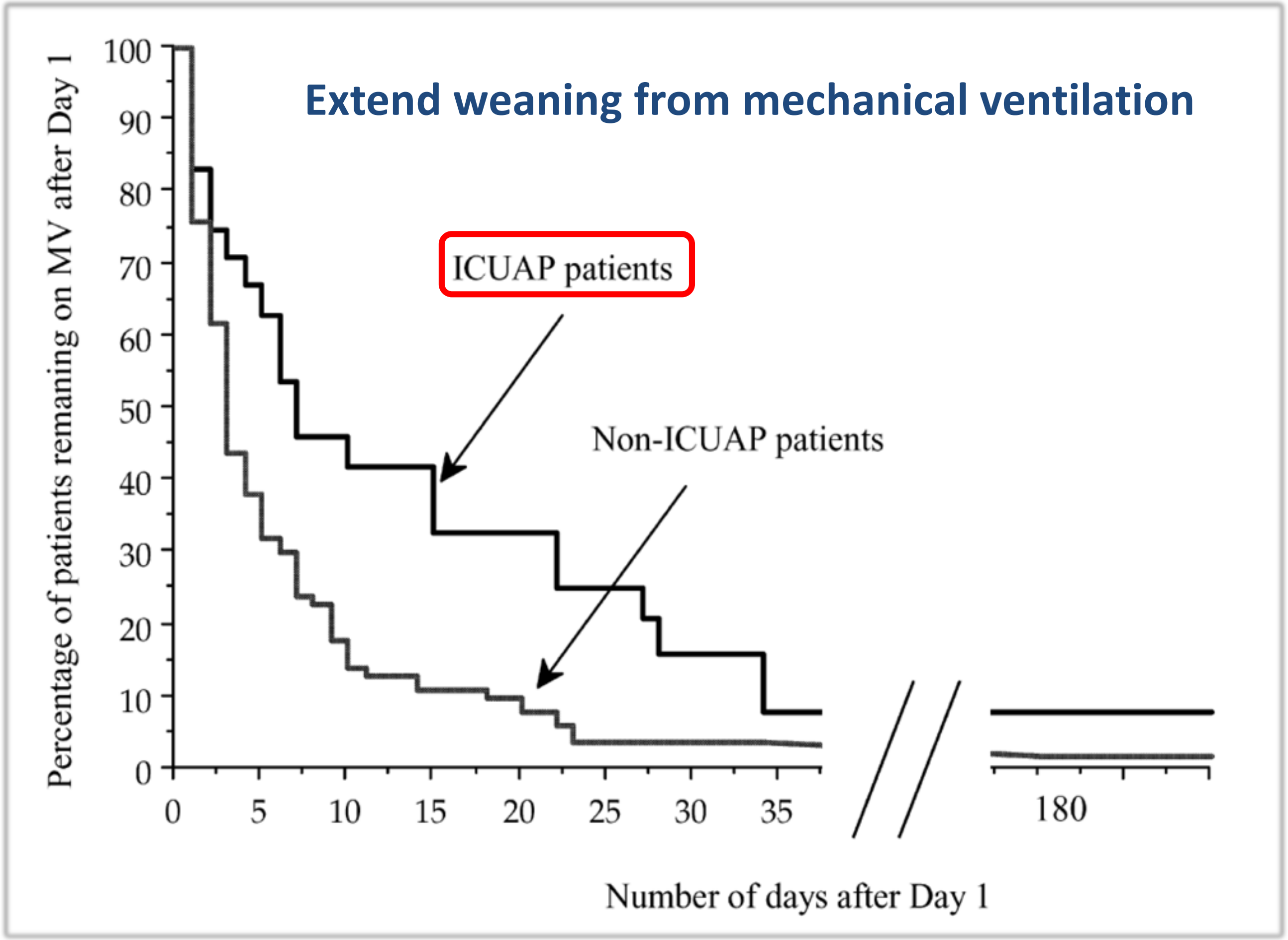
The reported incidence of

ICU-acquired weakness ranges

from 25 to 100%

Kress JP et al. 2014

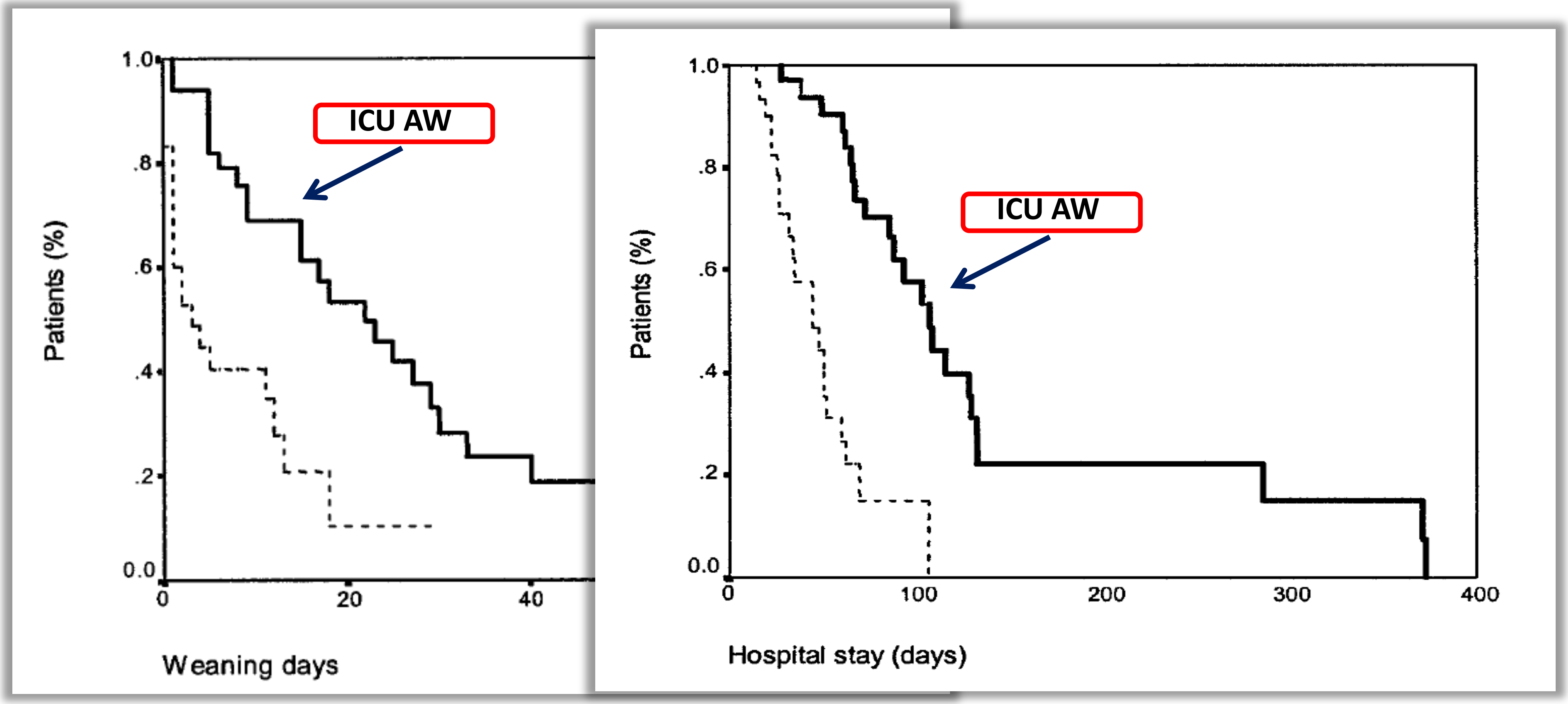
Does ICU-acquired paresis lengthen weaning from mechanical ventilation?



De Jonghe et al. 2004

Effect of critical illness polyneuropathy on the withdrawal from mechanical ventilation and the length of stay in septic patients*

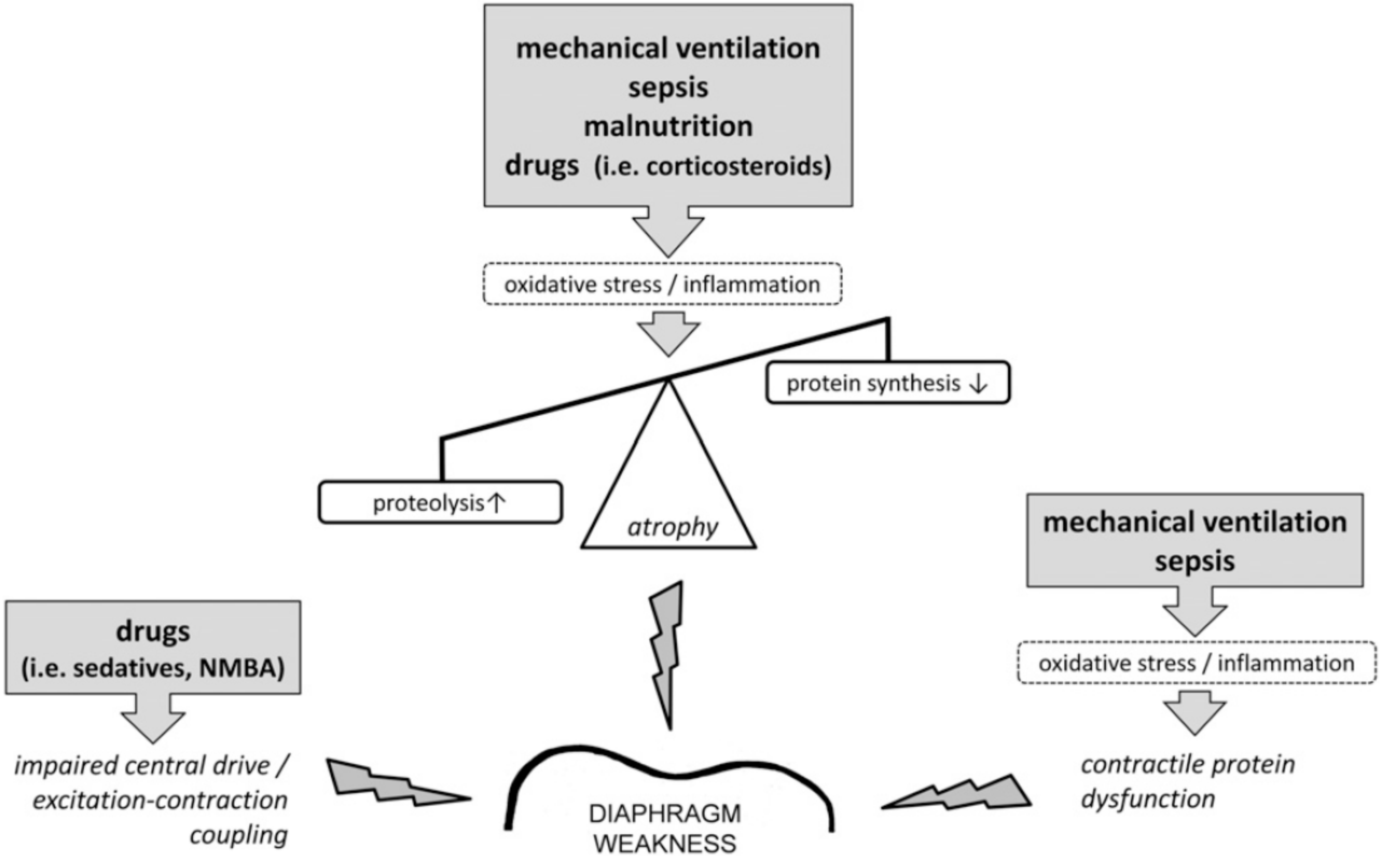
Garnacho-Montero et al. 2005



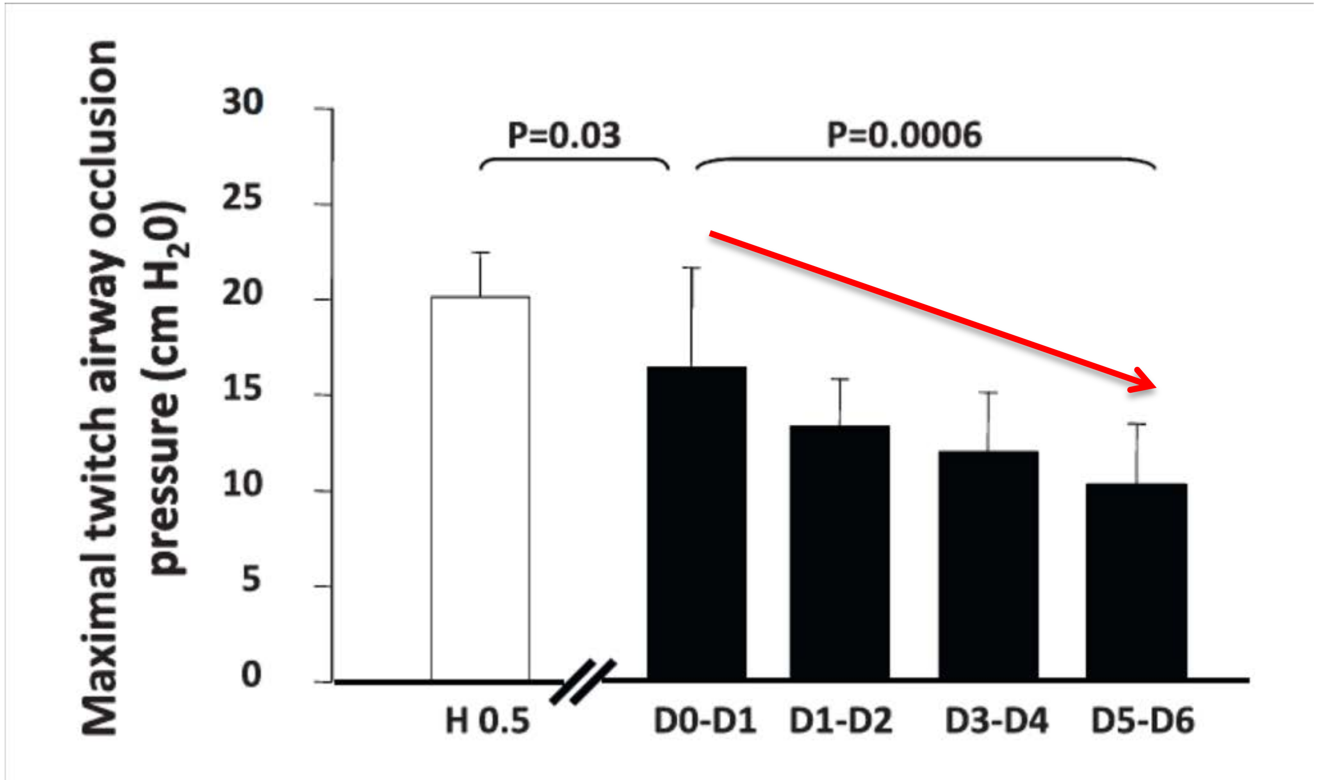
Monitoring of the Respiratory Muscles in the Critically Ill

Jonne Doorduin[1], Hieronymus W. H. van Hees[2], Johannes G. van der Hoeven[1], and Leo M. A. Heunks[1]

2013

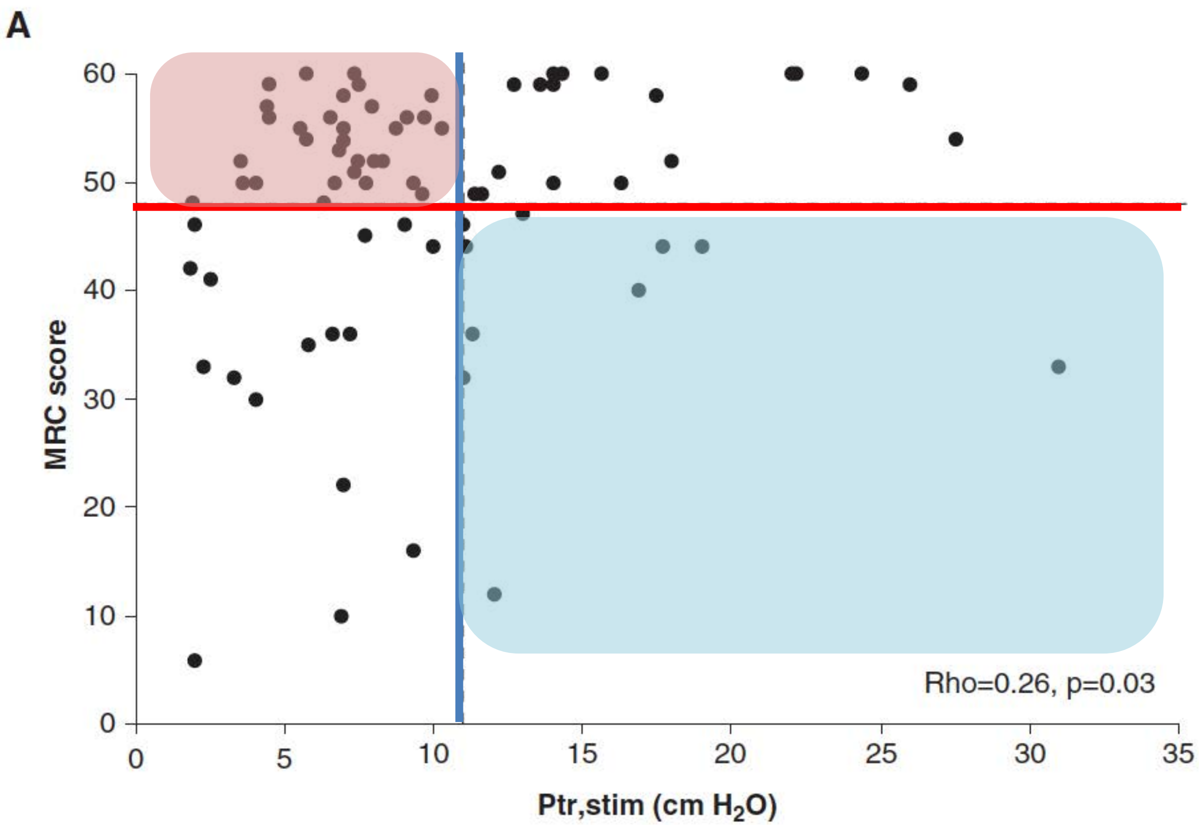


Rapidly Progressive Diaphragmatic Weakness and Injury during Mechanical Ventilation in Humans



Jaber et al. 2010

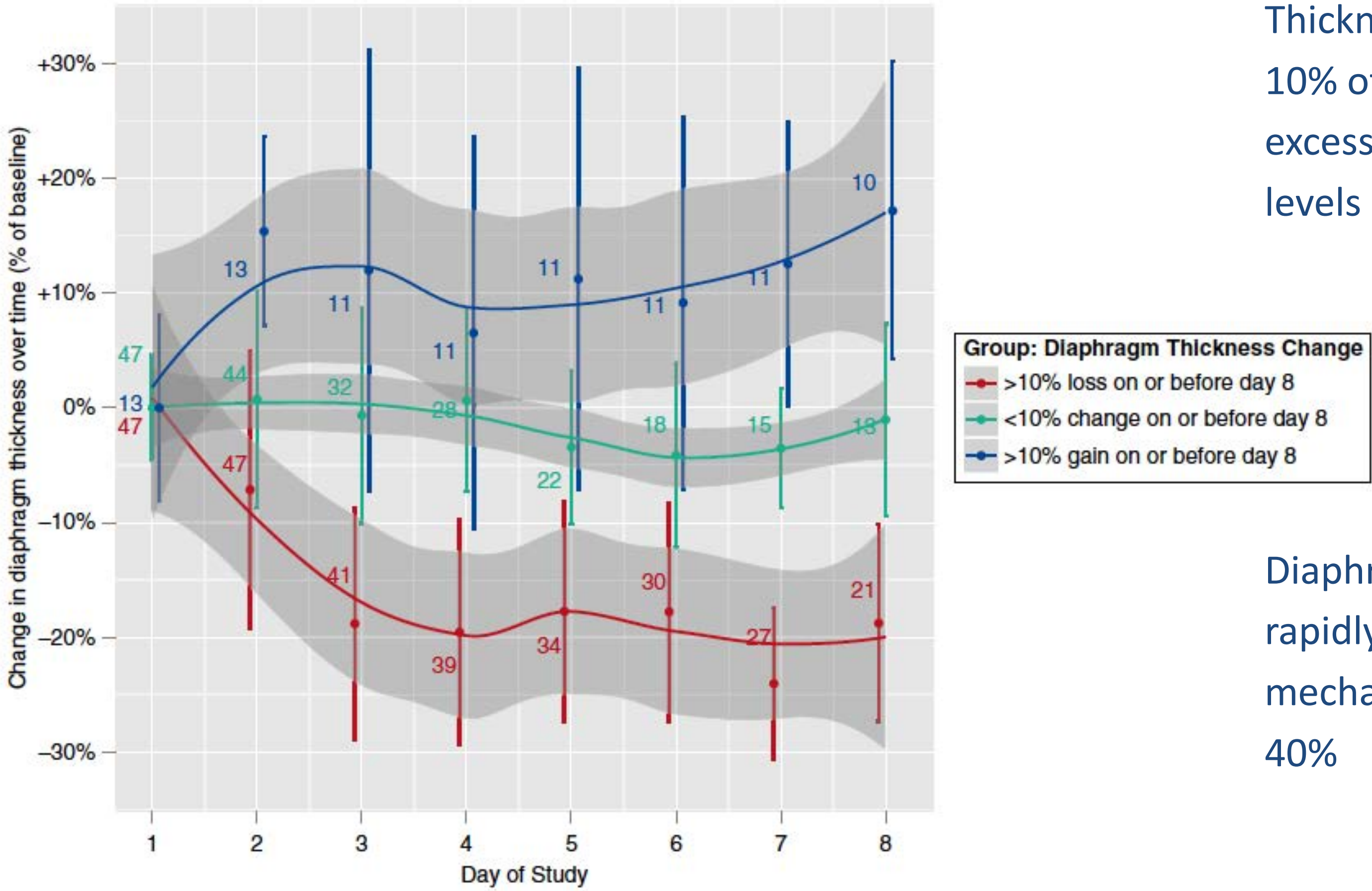
Coexistence and Impact of Limb Muscle and Diaphragm Weakness at Time of Liberation from Mechanical Ventilation in Medical Intensive Care Unit Patients



76 patients at their first weaning attempt: 63% had diaphragm dysfunction, 34% had limb muscle weakness and 21% had both

Dres M et al. 2017

Evolution of Diaphragm Thickness during Mechanical Ventilation
Impact of Inspiratory Effort



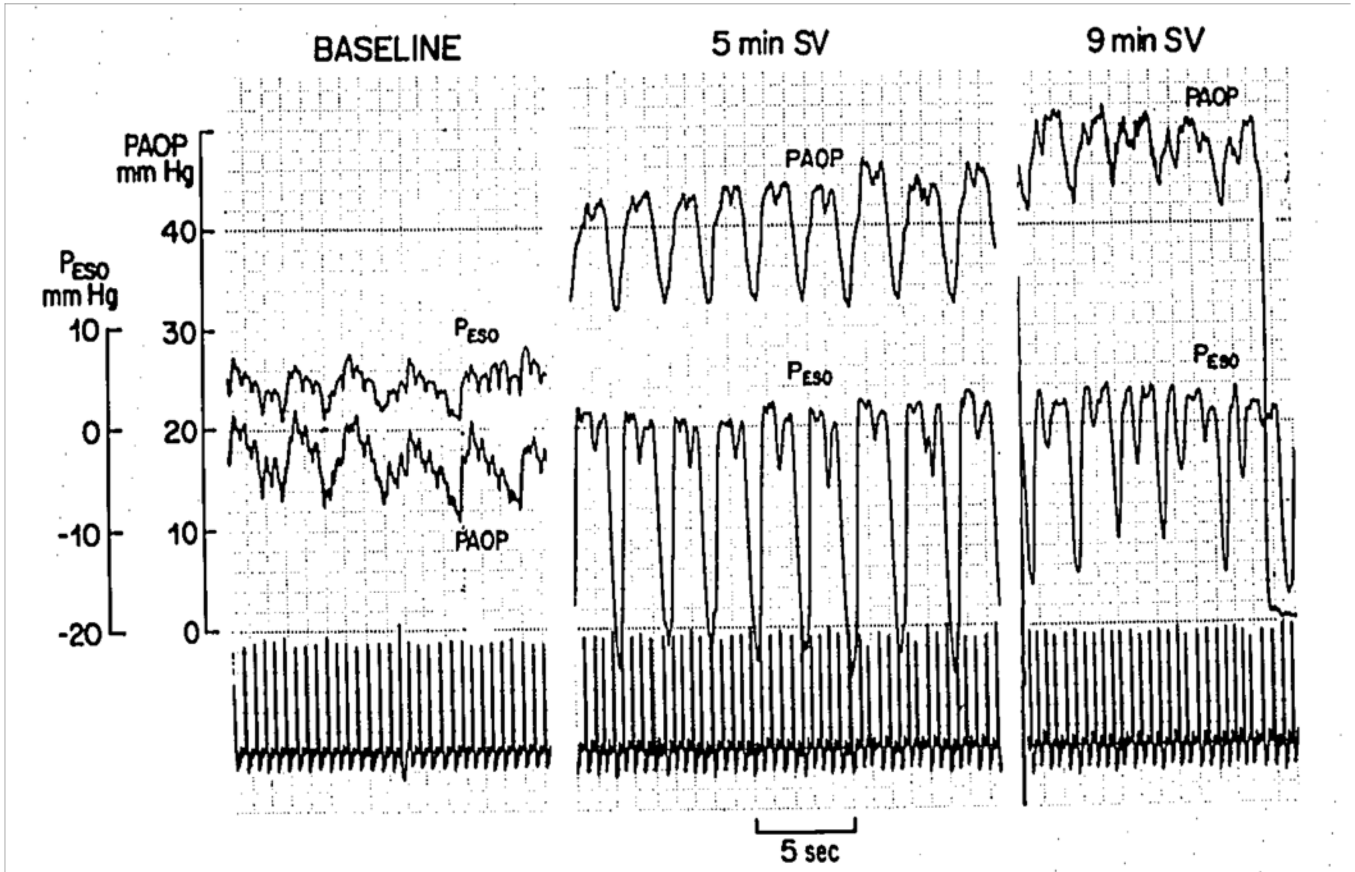
Thickness increases in approximately 10% of patients in association with excess inspiratory effort and lower levels of ventilatory support

Diaphragm thickness decreases rapidly during the first several days of mechanical ventilation in more than 40%

Goligher E et al. AJRCCM 2015

Acute Left Ventricular Dysfunction during Unsuccessful Weaning from Mechanical Ventilation

Lemaire et al. Anesthesiology 1988



Weaning → ↑ **preload**, ↑ **afterload**; ↑ **WOB**; ↑ **chatecholamines**

↓

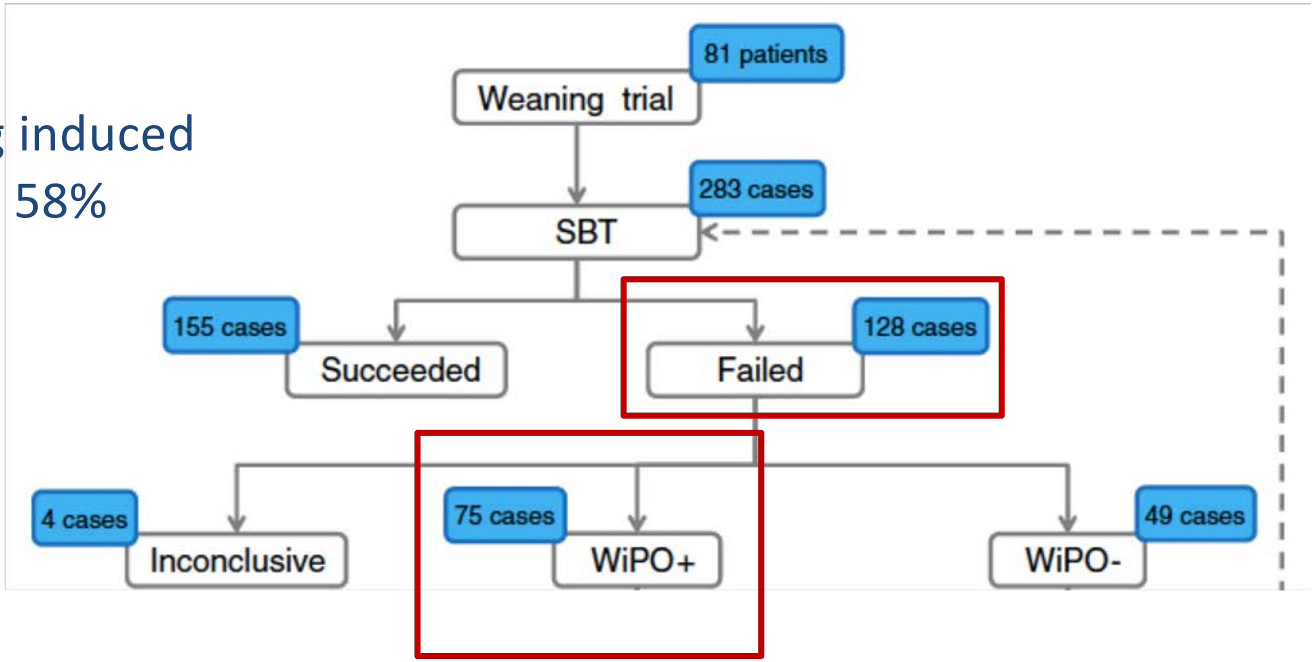
↑ **VO_2**

Cardiac dysfunction induced by weaning from mechanical ventilation: incidence, risk factors, and effects of fluid removal

Critical Care

Jinglun Liu[1,2,3,4†], Feng Shen[1,2,3,5†], Jean-Louis Teboul[1,2,3], Nadia Anguel[1,2,3], Alexandra Beurton[1,2,3], Nadia Bezaz[1,2,3], Christian Richard[1,2,3] and Xavier Monnet[1,2,3*]

Incidence of weaning induced cardiac dysfunction = 58%

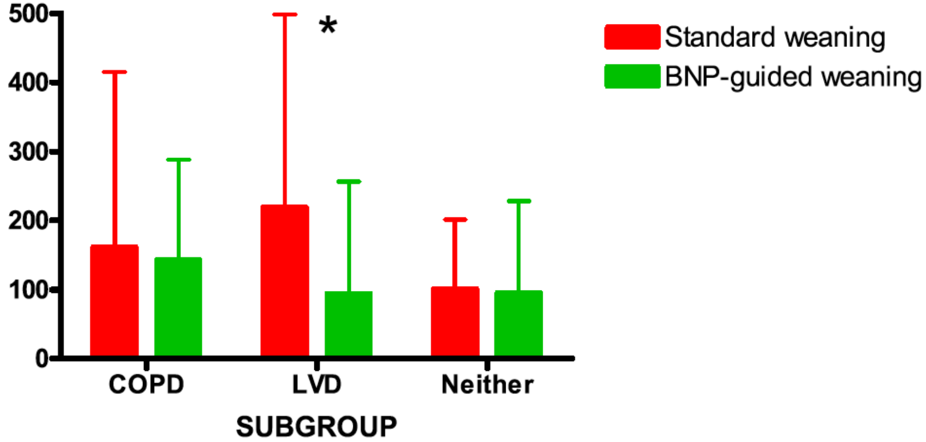


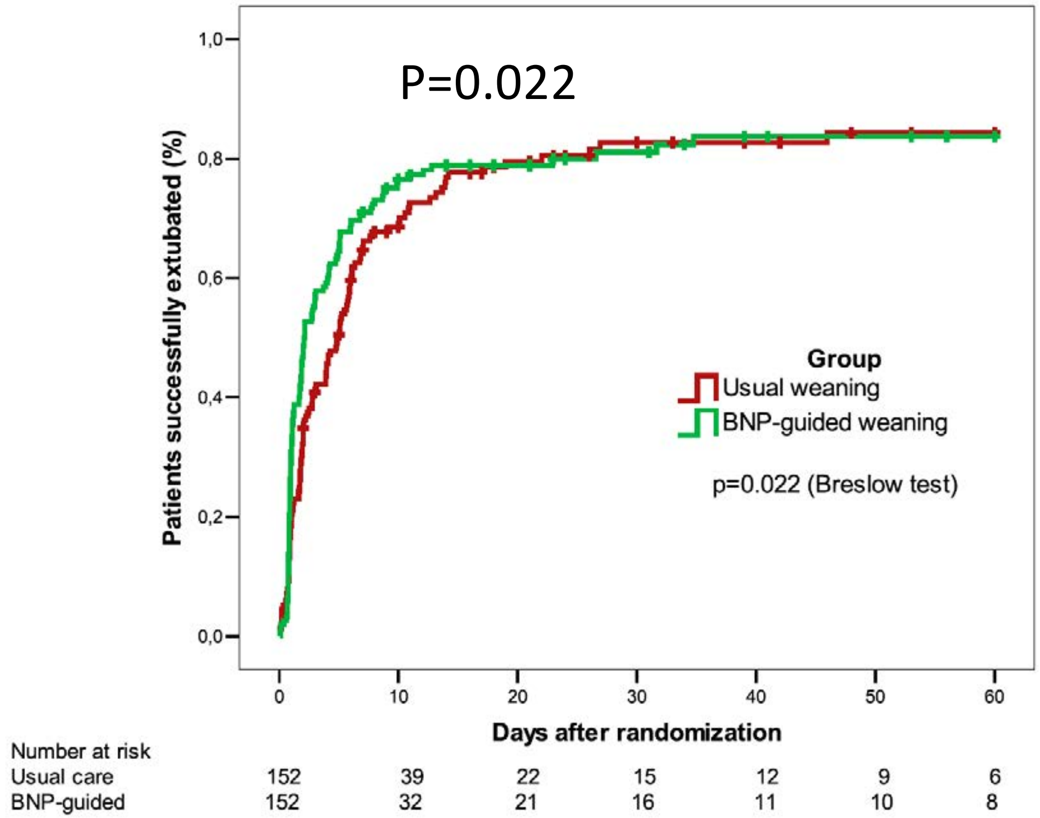
Natriuretic Peptide–driven Fluid Management during Ventilator Weaning

A Randomized Controlled Trial

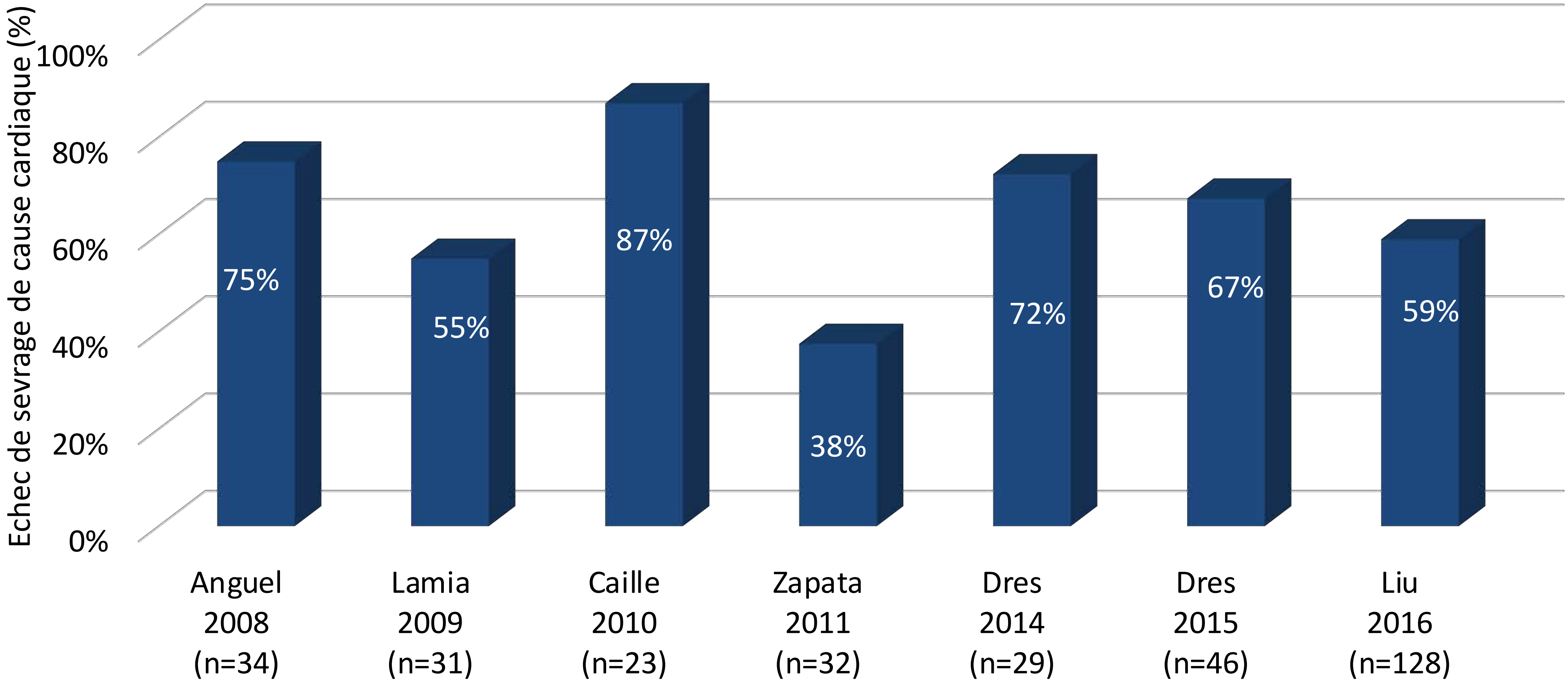
Mekontso-Dessap et al. AJRCCM 2012

Time to sucessful weaning

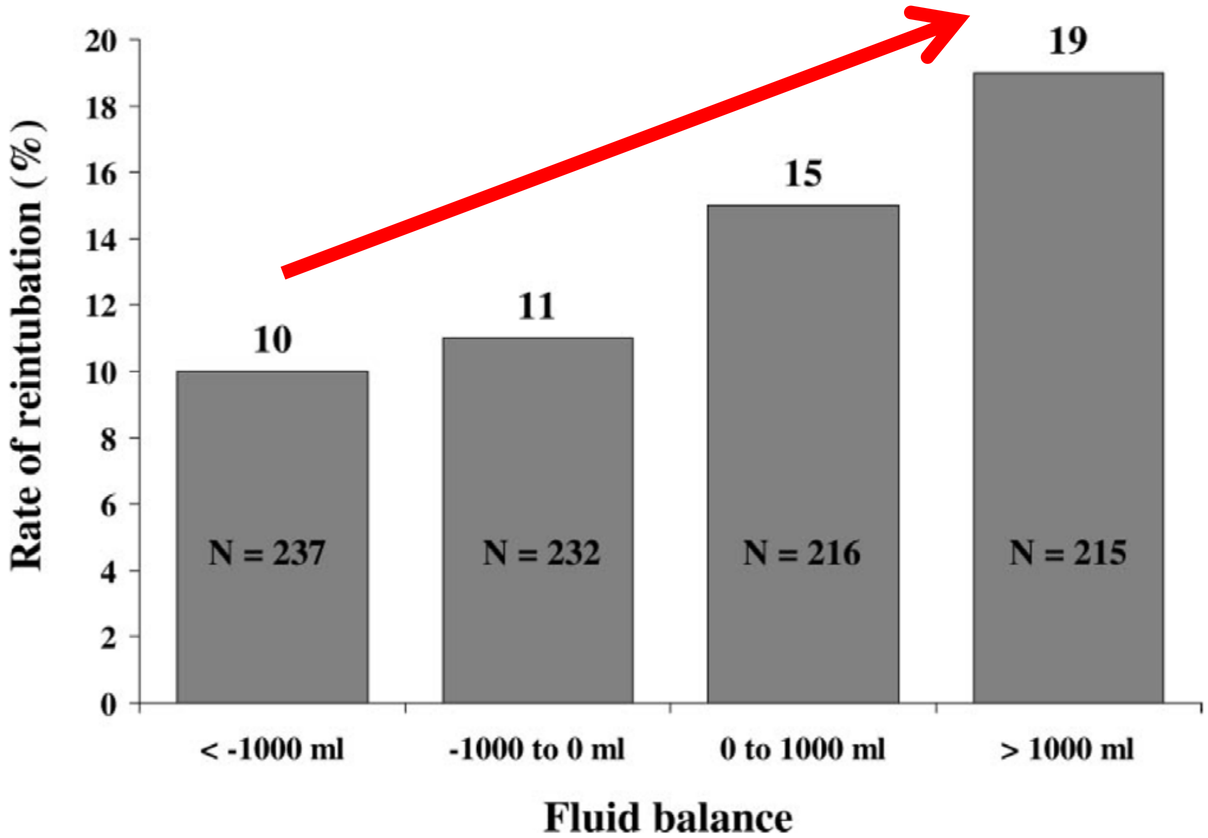




Incidence de l'OAP au cours du sevrage



Risk Factors for Extubation Failure in Patients Following a Successful Spontaneous Breathing Trial*



N=900 Patients

121 Extubation Failure

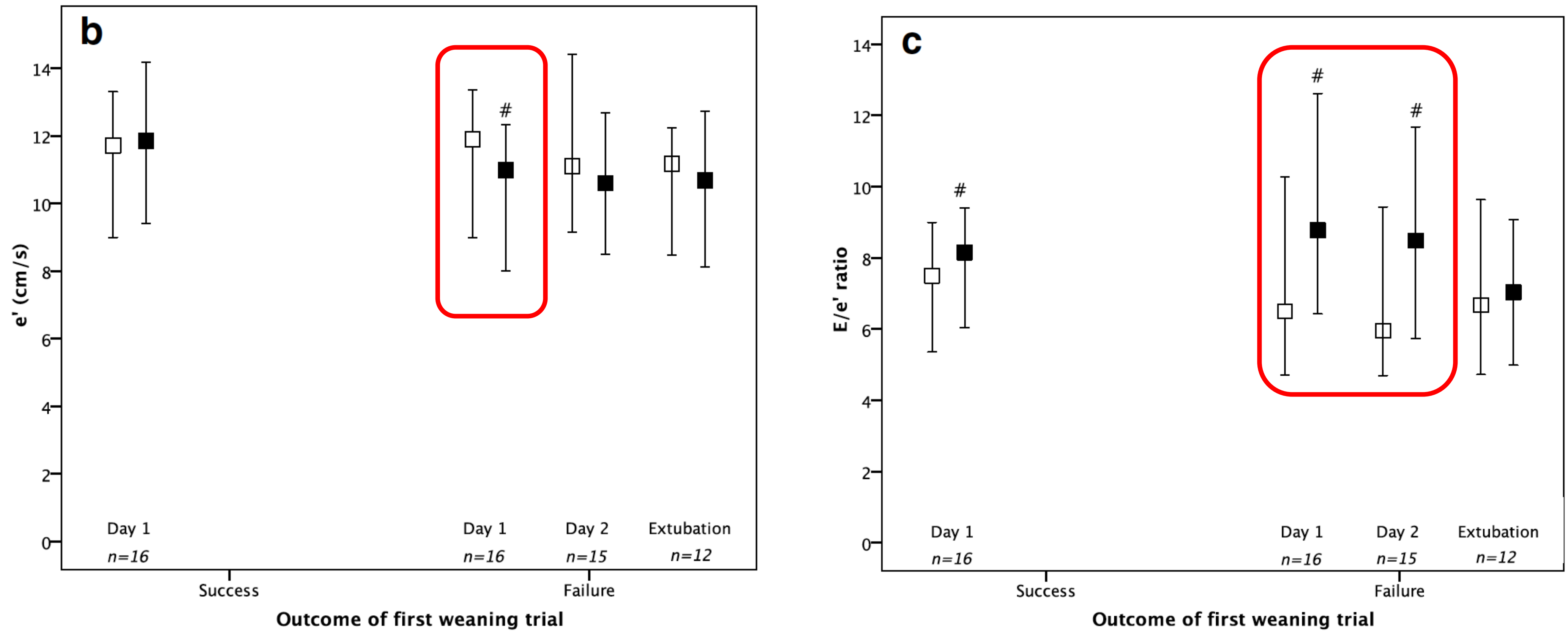
Frutos-Vivar et al. Chest 2006

Cardiac function during weaning failure: the role of diastolic dysfunction

Annals of Intensive Care

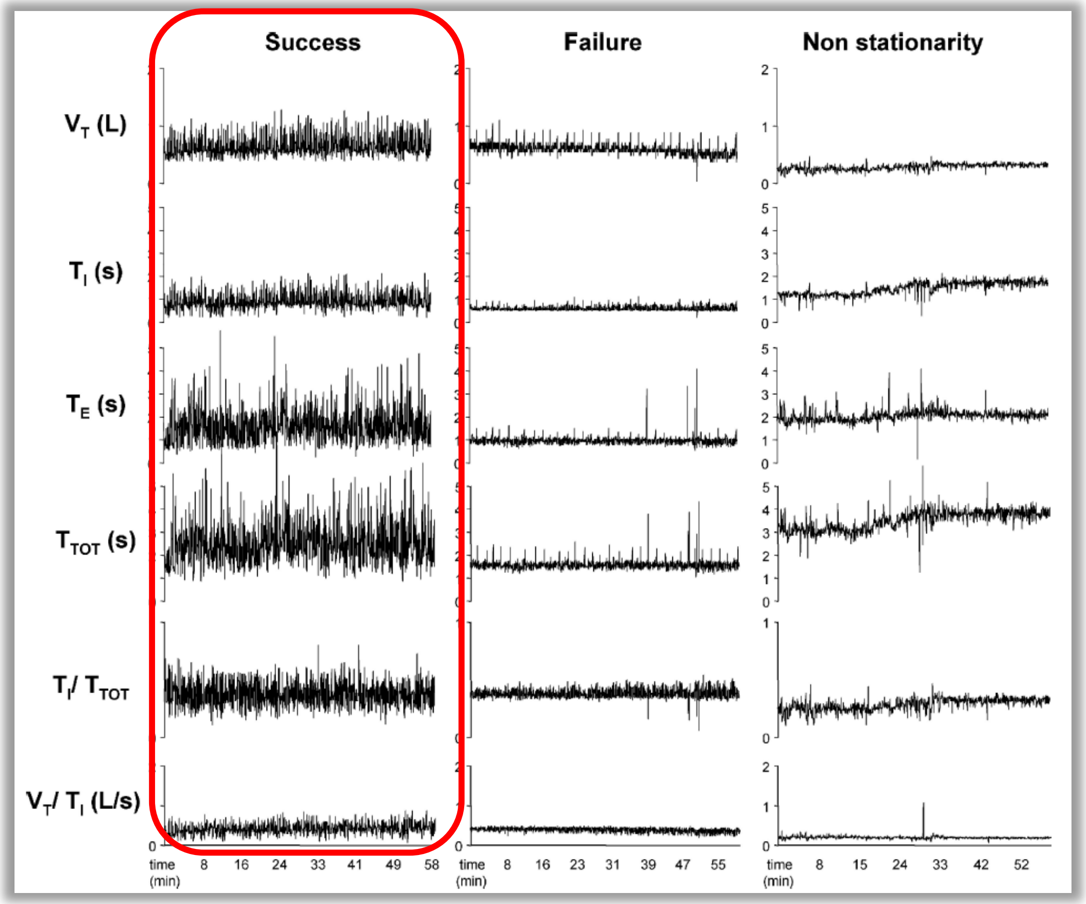
Roche-campo et al. 2017

N=67



Reduced breathing variability as a predictor of unsuccessful patient separation from mechanical ventilation*

Wysocki et al. 2006



51 patients – 46 analyzed

Variability is a main characteristic of ventilation

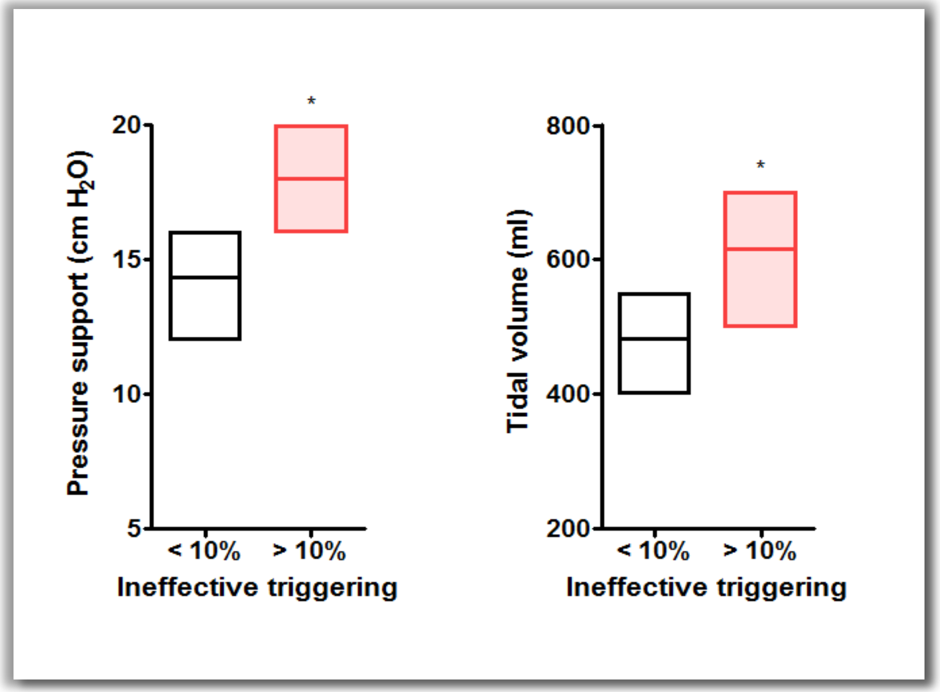
Intensive Care Med (2006) 32:1515–1522
DOI 10.1007/s00134-006-0301-8

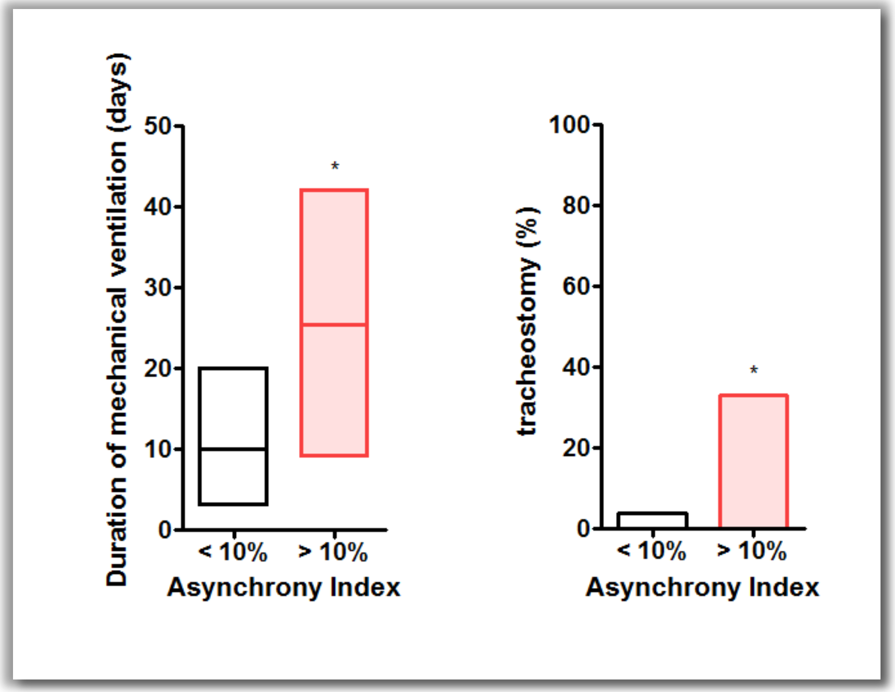
ORIGINAL

Arnaud W. Thille
Pablo Rodriguez
Belen Cabello
François Lellouche
Laurent Brochard

Patient-ventilator asynchrony during assisted mechanical ventilation

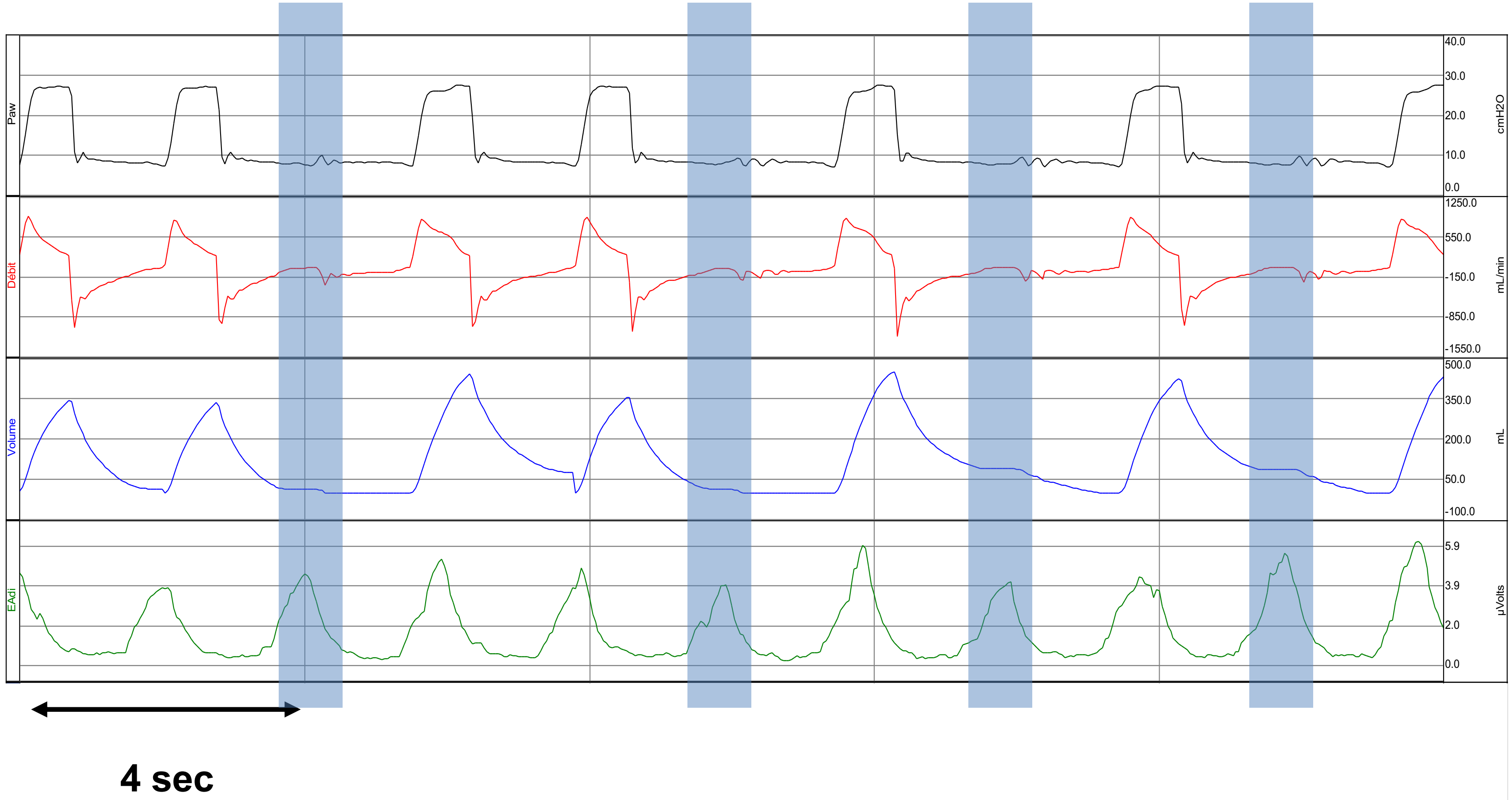
62 patients under mechanical ventlation: 24% presented an asynchrony index higher than 10%





Over-Assistance

PSV 160%



Mechanical Ventilation–induced Diaphragm Atrophy Strongly Impacts Clinical Outcomes

Gohliger et al. AJRCCM (2018) 197; 204-213

Over assistance – Diaphragm atrophy

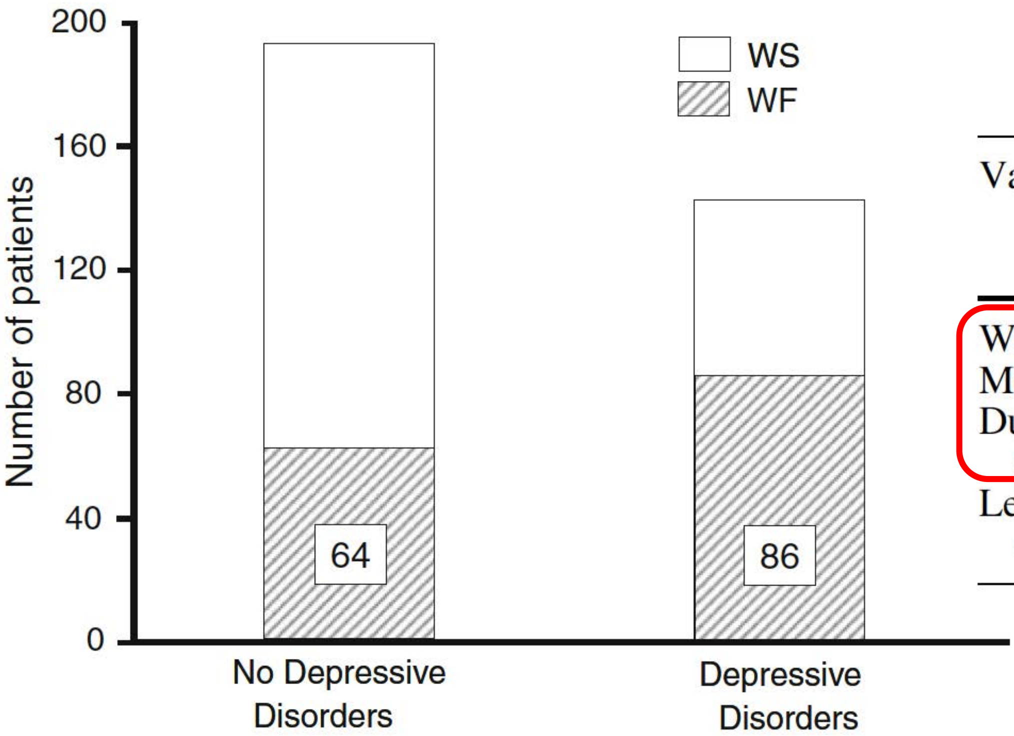
Under-assistance – Strong effort

Outcome	Initial Change in Diaphragm Thickness during First Week of Ventilation Patients with ⩾2 Measurements (*n* = 191)			Statistical Comparisons Adjusted Count Ratio or Adjusted Odds Ratio (95% CI)*	
	⩾10% Decrease in Thickness (*n* = 78; 41%)	<10% Change in Thickness (*n* = 66; 35%)	⩾10% Increase in Thickness (*n* = 47; 24%)	⩾10% Decrease in Thickness vs. <10% Change in Thickness	⩾10% Increase in Thickness vs. <10% Change in Thickness
Ventilator-free days to Day 60	46 (0–53)	51 (0–55)	37 (0–51)	0.77 (0.59–1.00)	0.91 (0.67–1.22)
Duration of ventilation (in ICU survivors), d	9 (5–17)†	5 (4–9)	10 (6–22)†	1.69 (1.28–2.24)	1.38 (1.00–1.90)
Duration of ICU admission (in ICU survivors), d	12.5 (7–21)†	8 (5–12)	14 (7–24)†	1.71 (1.29–2.27)	1.31 (0.94–1.83)
Duration of hospitalization (in hospital survivors), d	29 (16–58)†	22 (11–51)	30 (17–65)	1.44 (1.01–2.05)	1.23 (0.71–1.60)
Complications of acute respiratory failure, *n* (%)‡	49 (64)†	31 (48)	31 (67)†	3.00 (1.34–6.72)	1.84 (0.77–4.43)
Reintubation, *n* (%)	16 (21)†	5 (8)	12 (26)†	3.55 (1.14–11.05)	3.24 (0.97–10.88)
Tracheostomy, *n* (%)	20 (26)†	7 (11)	11 (23)	3.58 (1.29–9.97)	2.11 (0.66–6.70)
Mechanical ventilation >14 d, *n* (%)	27 (35)†	14 (21)	20 (43)†	2.97 (1.26–6.97)	2.16 (0.87–5.40)
Readmission to ICU during same hospital admission, *n* (%)	5 (7)	9 (15)	9 (20)	0.78 (0.21–2.84)	2.32 (0.70–7.67)
Death in ICU, *n* (%)	19 (24)	12 (18)	11 (23)	1.55 (0.61–3.95)	1.28 (0.45–3.65)
Death in hospital, *n* (%)	28 (37)	21 (3)	17 (37)	1.66 (0.73–3.76)	0.94 (0.38–2.34)

Optimal assistance

Depressive disorders during weaning from prolonged mechanical ventilation

Intensive Care Med (2010) 36:828–835



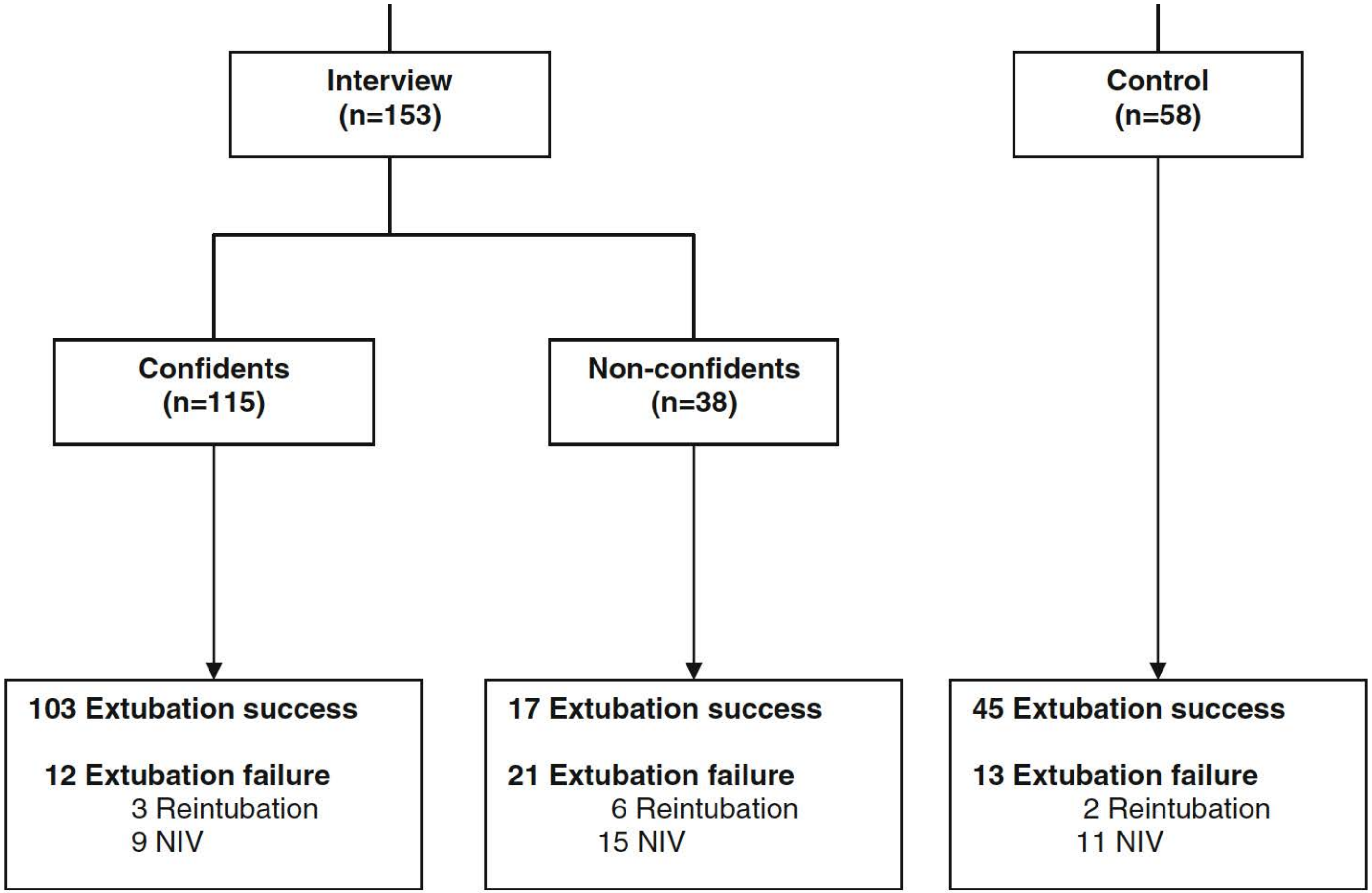
N=336

Variable	No depressive disorders (n = 194)	Depressive disorders (n = 142)	P value
Weaning failure (%)	33.0	60.6	0.0001
Mortality (%)	10.3	23.9	0.0008
Duration of MV at RMLH, days, median (IQR)	13 (5–38)	24 (8–41)	0.007
Length of stay at RMLH, days, median (IQR)	33 (24–42)	35 (23–46)	0.55

Depressive disorders= 42%

Jubran et al. ICM 2010

Patients' prediction of extubation success



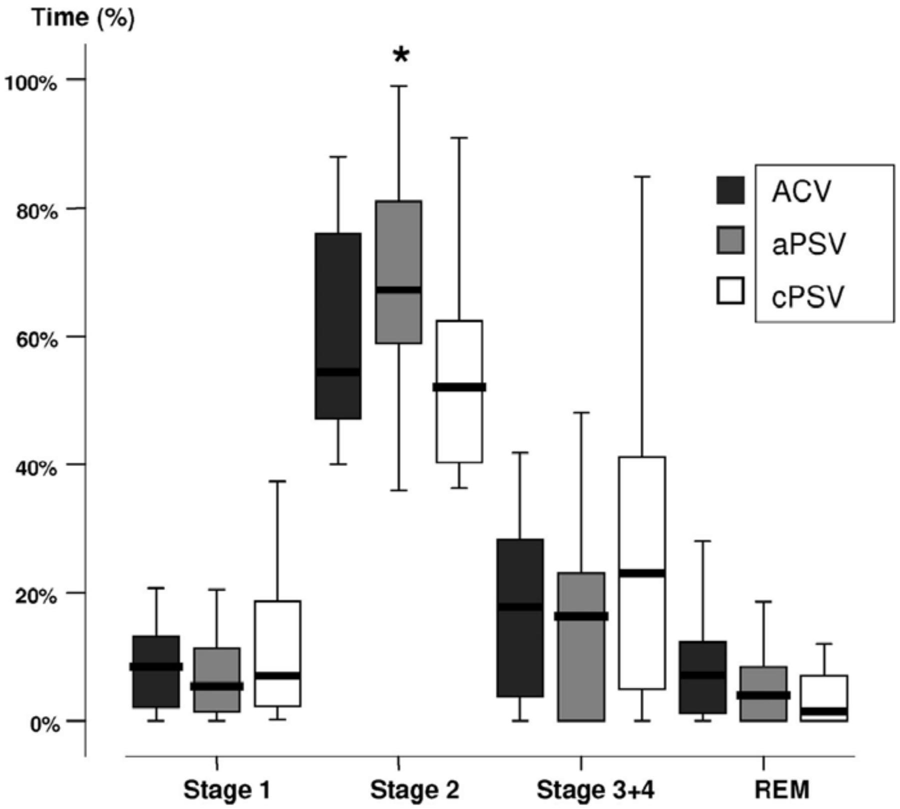
Perren A et al. ICM 2010

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

Cabello B et al. CCM 2008

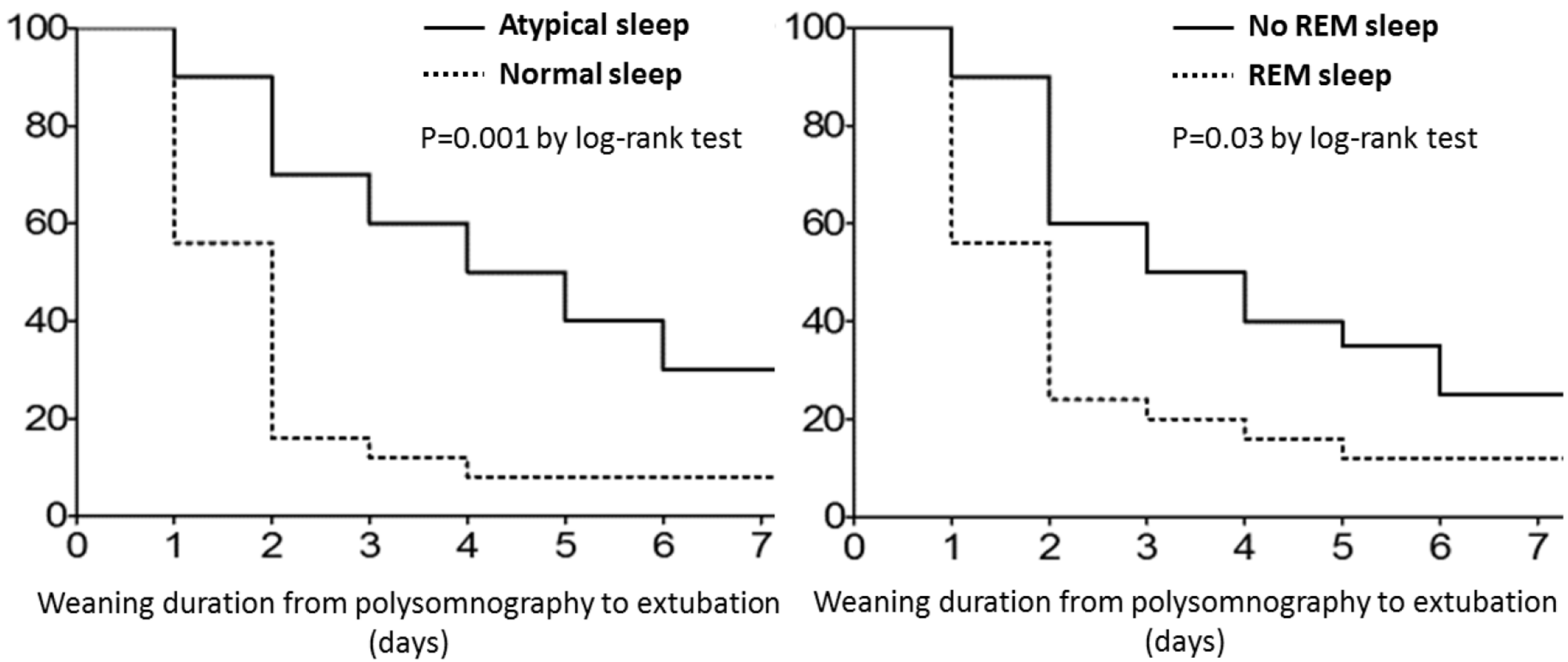
Table 2. Sleep architecture and fragmentation during the study (18 hours)

Patient, N	Stage 1, %	Stage 2, %	Stage 3 and 4, mins	Rapid Eye Movement, %	Fragmentation Index
1	2	83	102	1	15
2	1	64	119	18	25
3	5	57	246	10	35
4	8	68	73	0	41
5	10	66	98	7	41
6	7	64	67	13	53
7	8	48	91	7	37
8	1	51	178	13	67
9	17	49	63	15	20
10	10	47	119	12	19
11	4	49	300	11	29
12	3	88	54	0	11
13	15	41	151	11	51
14	16	74	31	5	14
15	8	79	35	2	23
Median [25–75th percentiles]	8 [3–11]	63 [48–74]	98 [63–151]	10 [2–13]	29 [19–41]



Impact of sleep alterations on weaning duration in mechanically ventilated patients: a prospective study

Thille AW et al. ERJ 2018



Impact of sleep alterations on weaning duration in mechanically ventilated patients: a prospective study

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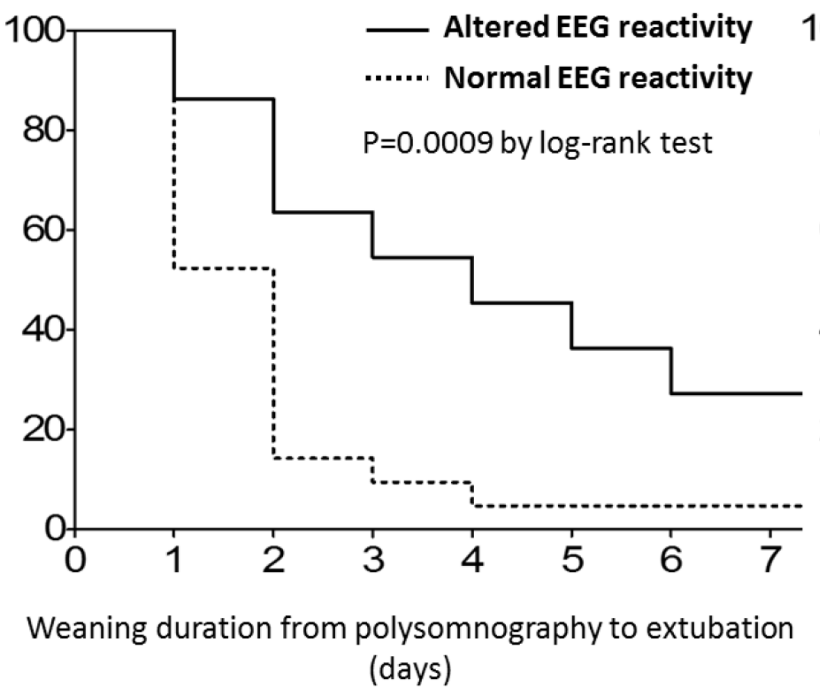
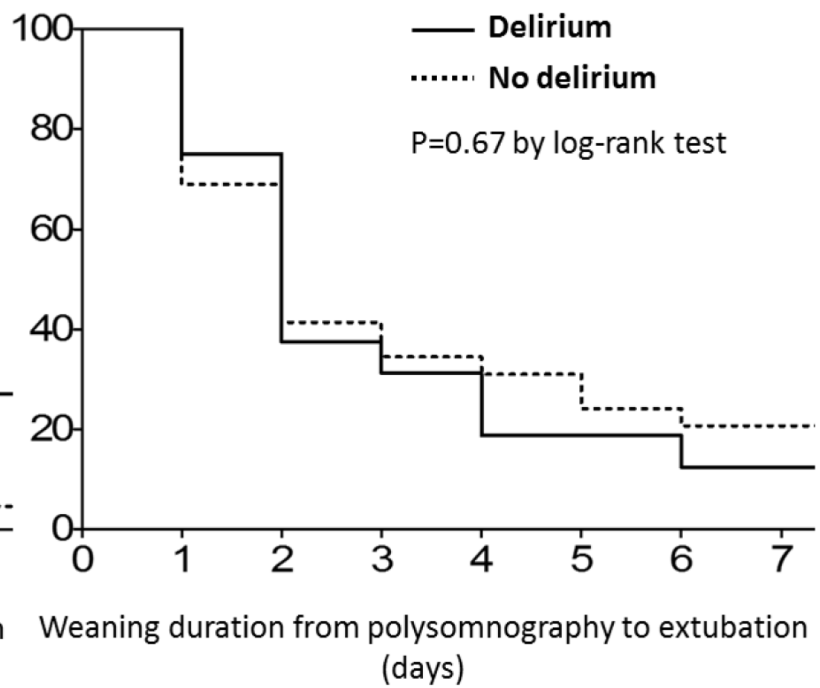




Delirium and Circadian Rhythm of Melatonin During Weaning From Mechanical Ventilation

An Ancillary Study of a Weaning Trial

Mekontso Dessap *et al.* Chest 2015

Outcome	Mental Status at Initiation of Weaning[a]		*P* Value
	Normal (n = 24)	Delirious (n = 43)	
Time to first extubation, h			.086
Median (IQR)	27.5 (21.7-62.0)	49.7 (21.4-137.6)	
Mean (SD)	43.0 (29.6)	111.7 (176.6)	
Time to successful extubation, h			.086
Median (IQR)	27.4 (21.1-72.2)	51.0 (21.9-143.5)	
Mean (SD)	56.4 (59.3)	164.8 (255.3)	
Ventilator-free days from randomization to d 28			.044
Median (IQR)	26.6 (23.7-27.1)	23.1 (0.8-27.1)	
Mean (SD)	23.5 (7.6)	17.7 (11.5)	
Ventilator-free days from randomization to d 60			.027
Median (IQR)	58.6 (55.7-59.1)	54.4 (25.2-58.9)	
Mean (SD)	52.9 (16.4)	41.7 (23.8)	

Delirium and Circadian Rhythm of Melatonin During Weaning From Mechanical Ventilation

An Ancillary Study of a Weaning Trial

Mekontso Dessap *et al.* Chest 2015

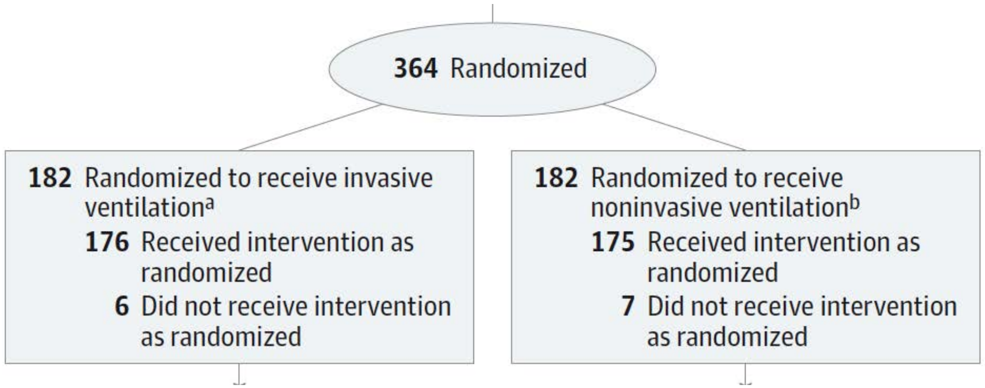
Respiratory function			
Respiratory worsening requiring a return to assist-control ventilation	5 (20.8)	21 (48.8)	.024
Ventilator-associated pneumonia	2 (8.3)	13 (30.2)	.039
Ventilator-associated complication	1 (4.2)	11 (25.6)	.044
Need for noninvasive ventilation after extubation	11 of 23 (47.8)	16 of 38 (42.1)	.663
Reintubation within 72 h after extubation	3 of 23 (13.0)	6 of 38 (15.8)	> .99
Tracheostomy	1 (4.2)	5 (11.6)	.408
Cardiovascular function			
Need for fluid loading	7 (29.2)	23 (53.5)	.055
Need for catecholamine infusion	9 (37.5)	21 (48.8)	.371
Neurologic function			
Need for continuous sedation because of clinical worsening	2 (8.3)	30 (69.8)	< .001
Need for continuous analgesia because of clinical worsening	1 (4.2)	24 (55.8)	< .001

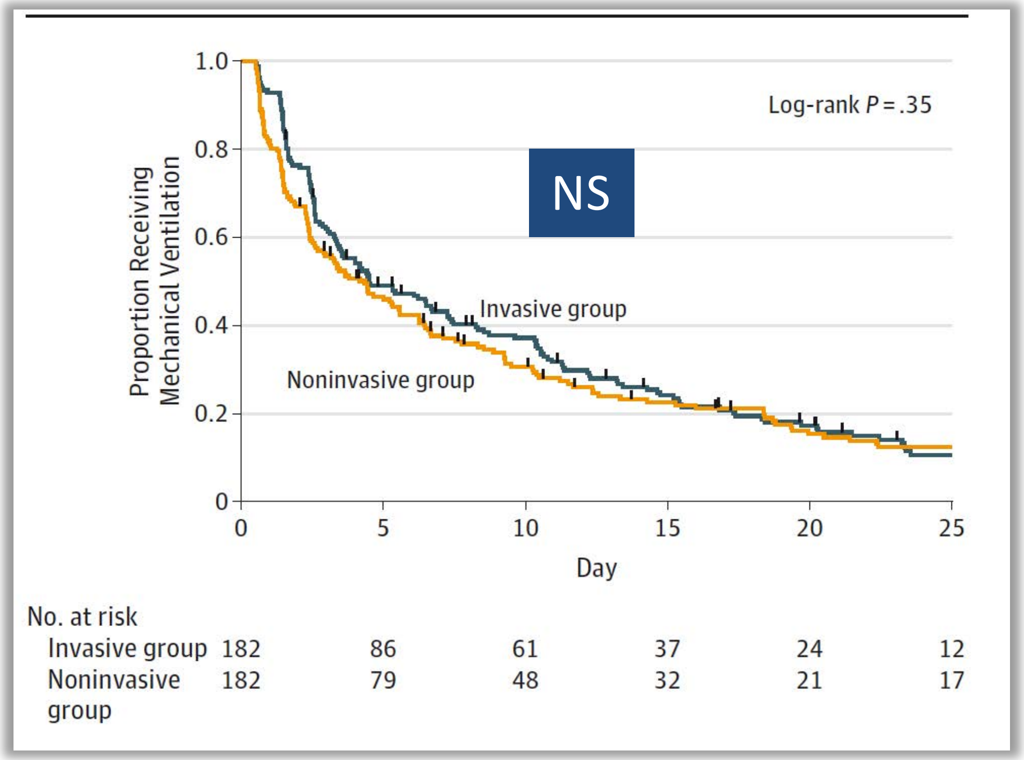
Effect of Protocolized Weaning With Early Extubation to Noninvasive Ventilation vs Invasive Weaning on Time to Liberation From Mechanical Ventilation Among Patients With Respiratory Failure

The Breathe Randomized Clinical Trial

Perkins et al. 2018

JAMA | Original Investigation

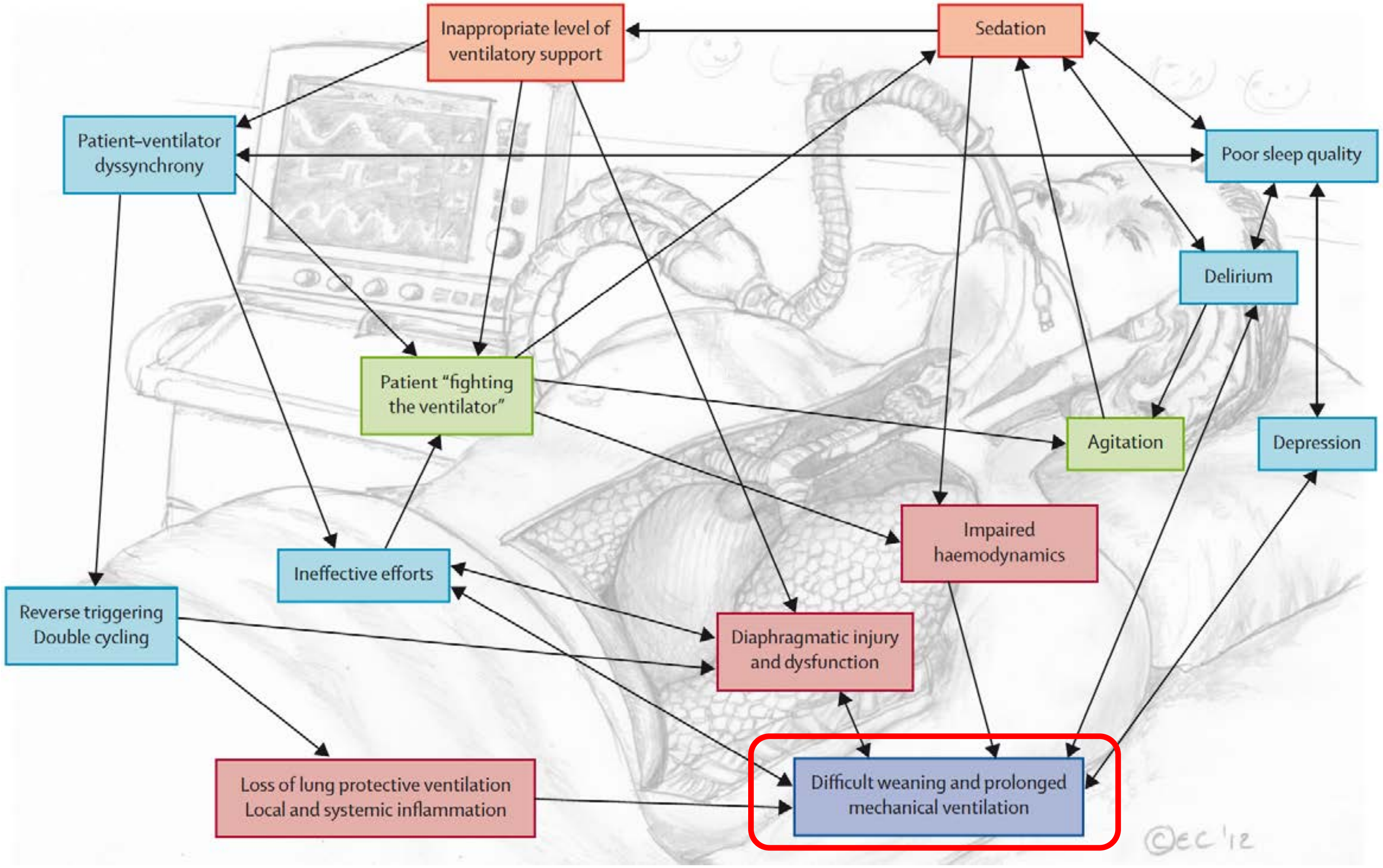


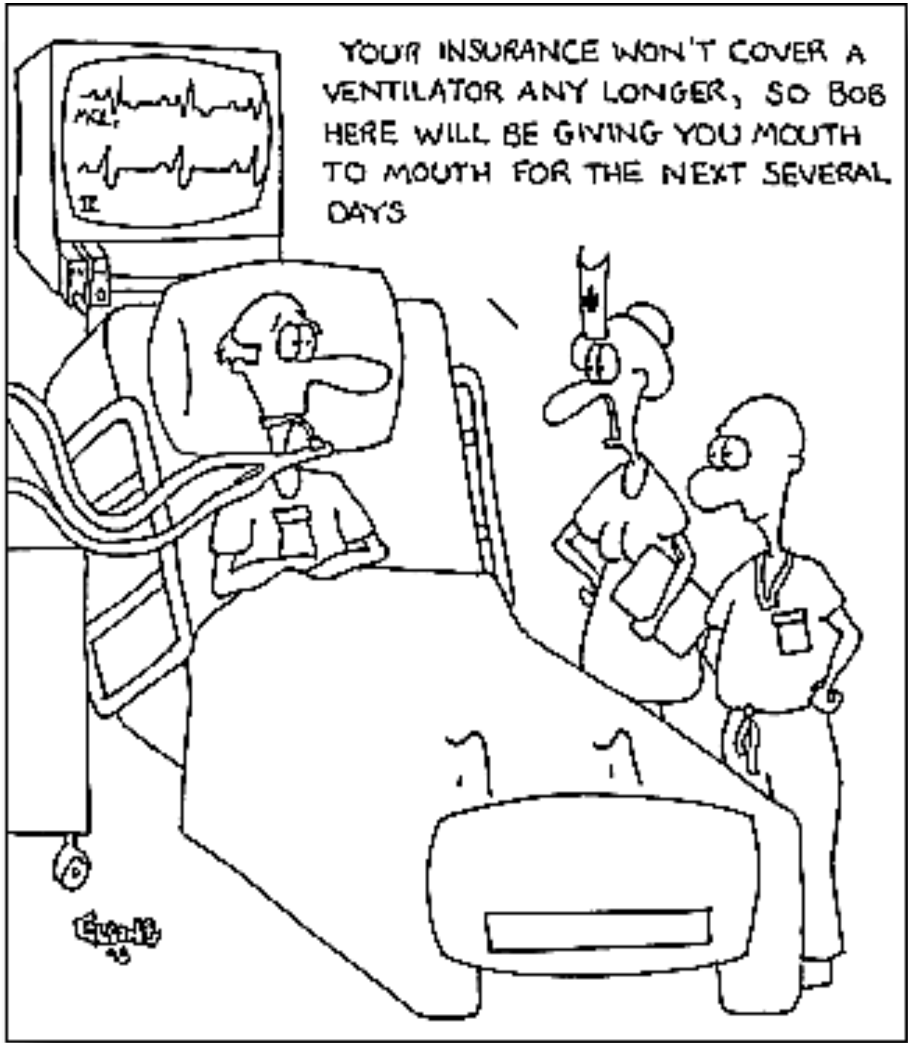


Clinical challenges in mechanical ventilation

Ewan C Goligher, Niall D Ferguson, Laurent J Brochard

Lancet 2016




YOUR INSURANCE WON'T COVER A VENTILATOR ANY LONGER, SO BOB HERE WILL BE GIVING YOU MOUTH TO MOUTH FOR THE NEXT SEVERAL DAYS