Management of the patients with prolonged mechanical ventilation

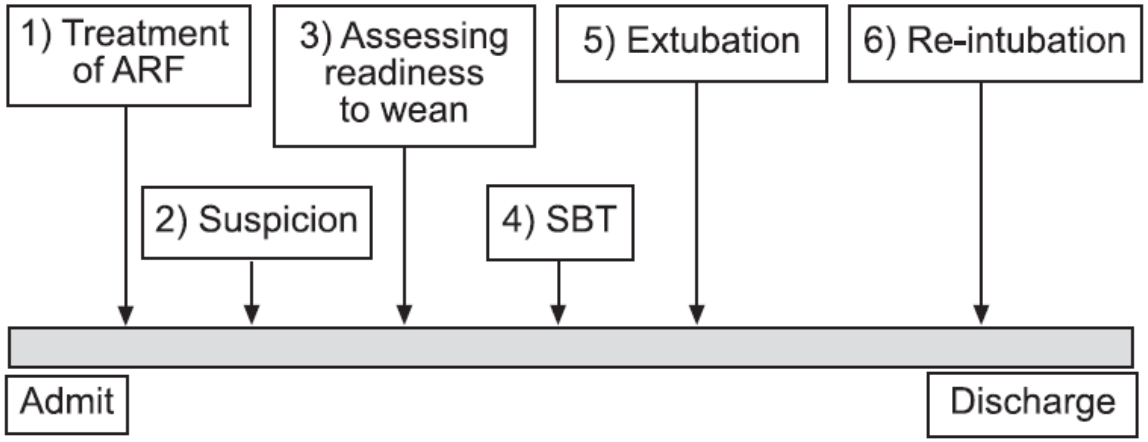
劉世豐
高雄長庚醫院胸腔科&呼吸治療科
長庚大學醫學院醫學系

高雄長庚紀念醫院
Chang Gung Memorial Hospital, Kaohsiung

Outlines

- Assessment for Readiness to Wean
- The Spontaneous Breathing Trial
- Evaluation of the Patient Who Fails a Spontaneous Breathing Trial
- Weaning Technique
- Extubation
- NIV and HFNC in weaning
- Pulmonary rehabilitation
- Sharing decision making
- Withdraw and withhold
- Tracheostomy

Schematic Representation of the Different Stages Occurring in a Mechanically Ventilated Patient

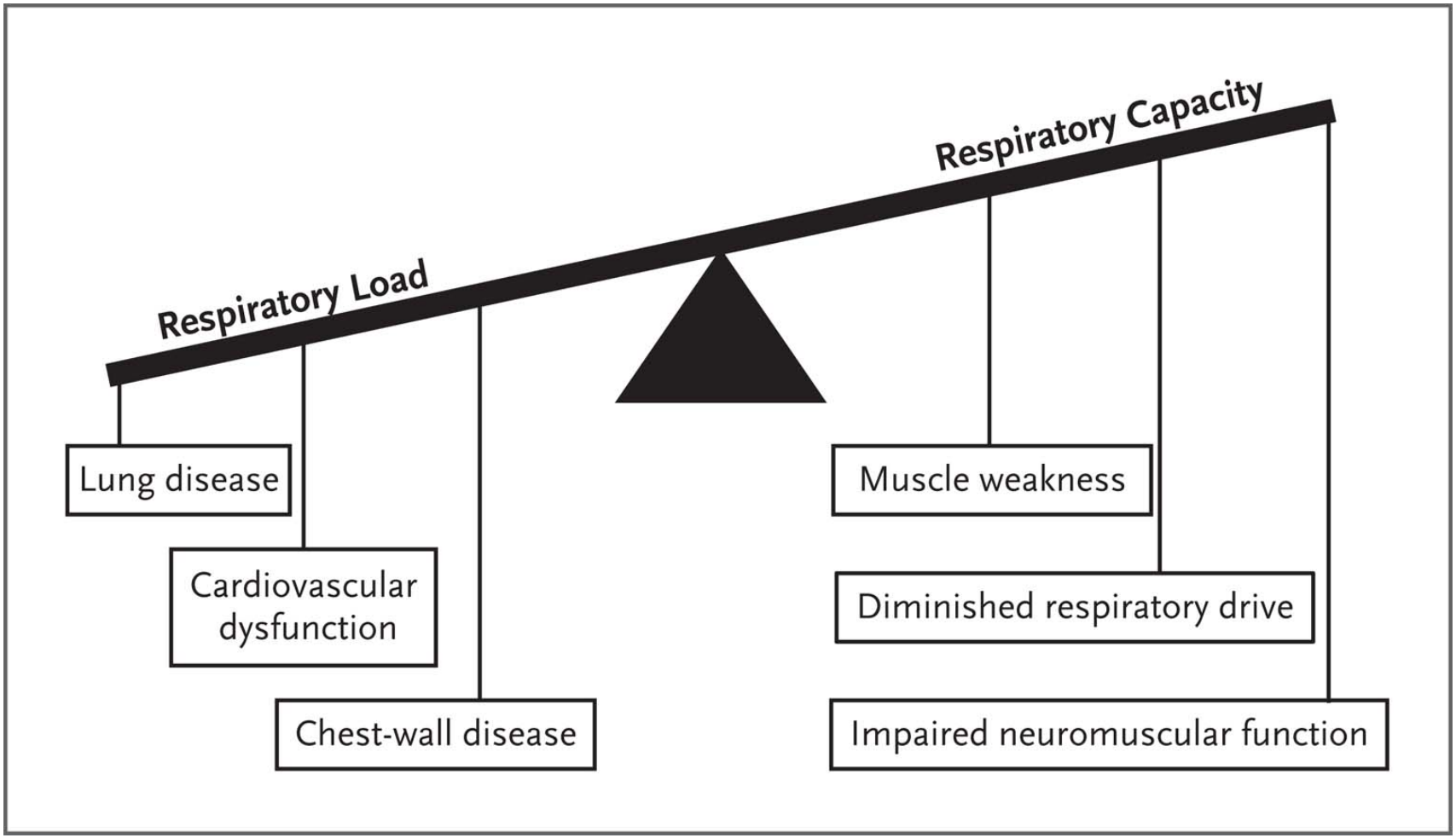


Stages	Definitions
1) Treatment of ARF	Period of care and resolution of the disorder that caused respiratory failure and prompted mechanical ventilation
2) Suspicion (懷疑)	The point at which the clinician suspects the patient may be ready to begin the weaning process（此時點，臨床醫生懷疑患者可能已經準備好開始撤機的過程）
3) Assessing readiness to wean	Daily testing of physiological measures of readiness for weaning (MIP, fR/VT) to determine probability of weaning success（要辨識出可以做脫離和不能做脫離的病人）
4) Spontaneous breathing trial	Assessment of the patient's ability to breathe spontaneously
5) Extubation	Removal of the endotracheal tube
6) Reintubation	Replacement of the endotracheal tube for patients who are unable to sustain spontaneous ventilation

ARF: acute respiratory failure, MIP: maximal inspiratory pressure, fR/VT: respiratory frequency to tidal volume ratio (rapid shallow breathing index).

Eur Respir J 2007;volume 29 number 5, 29: 1033–1056,

Pathologic States That Result in an Imbalance between Respiratory-Muscle Capacity and Respiratory Load.



McConville JF, Kress JP. N Engl J Med 2012;367:2233-2239

compared discontinuation of mechanical ventilation within 48 hours after readiness criteria had been met with more than a 48-hour delay in discontinuation

There was higher mortality, an increased risk of pneumonia, and a longer hospital stay in the group with delayed discontinuation than in the group in which ventilation was discontinued in a more timely fashion.

Coplin et al, Am J Respir Crit Care Med 2000;161:1530-6.

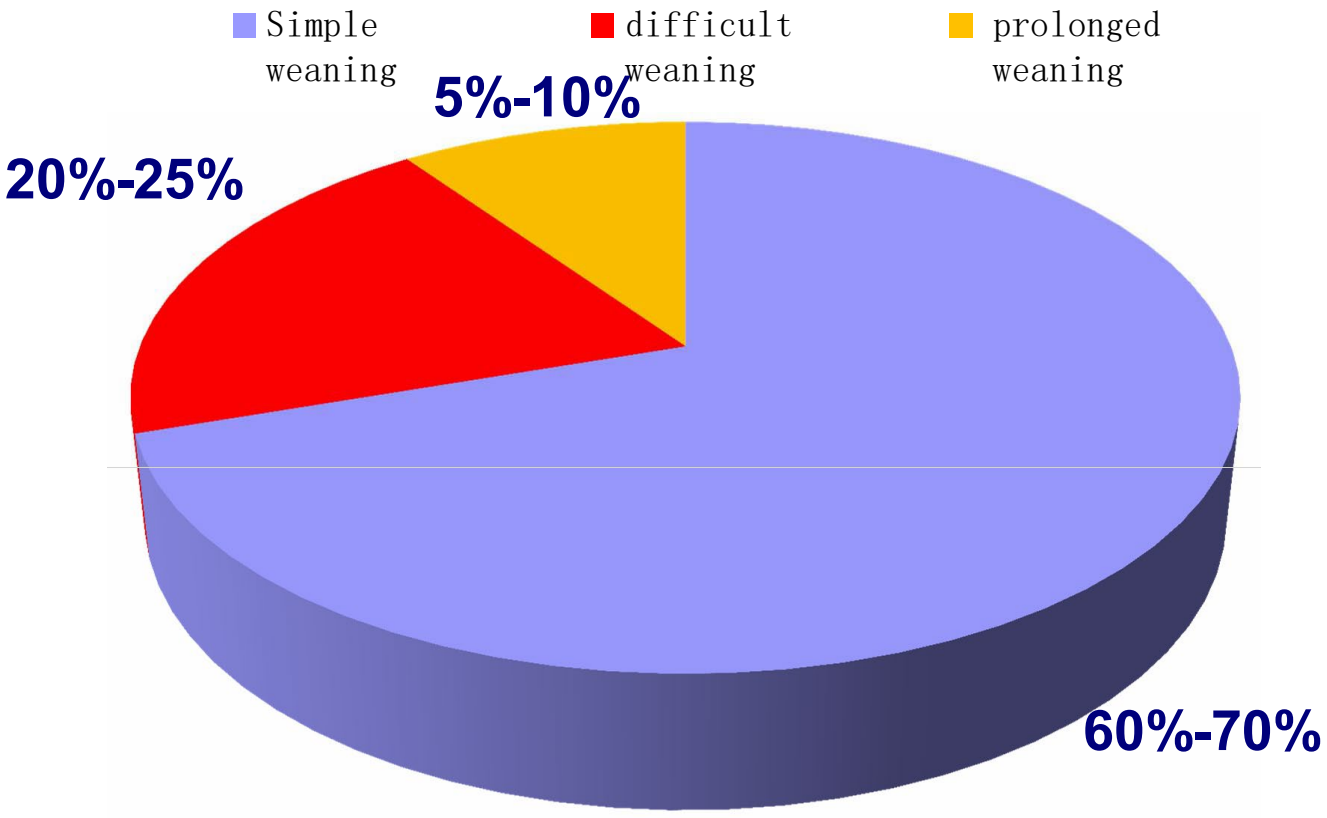
Classification of Patients According to the Weaning Process

Group/category	Definition
Simple weaning	Patients who proceed from initiation of weaning to successful extubation on the **first** attempt without difficulty
Difficult weaning	Patients who fail initial weaning and require up to three SBT or as long as **7 days** from the **first SBT** to achieve successful weaning
Prolonged weaning	Patients who fail at least three weaning attempts or require **>7 days** of weaning after the first SBT

SBT: spontaneous breathing trial.

Laurent Brochard

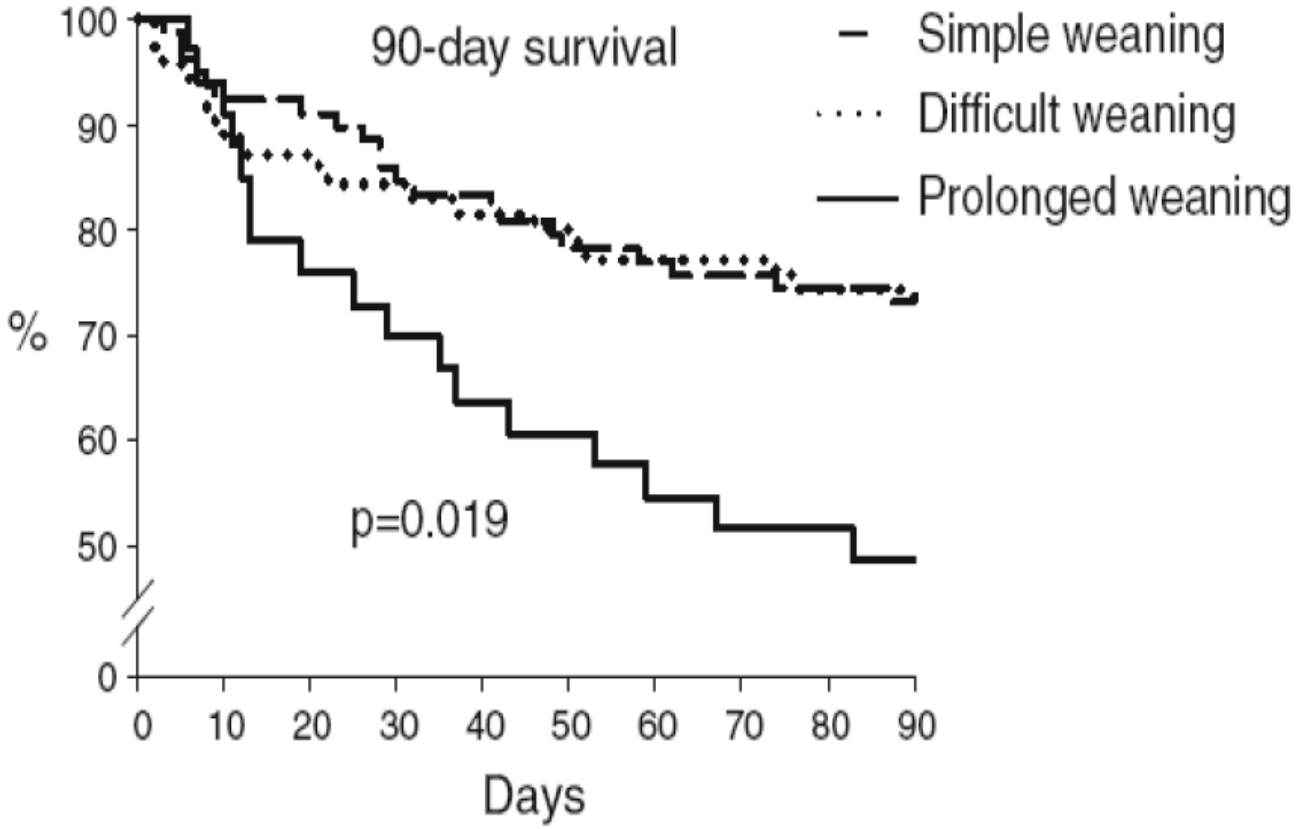
Weaning classifying



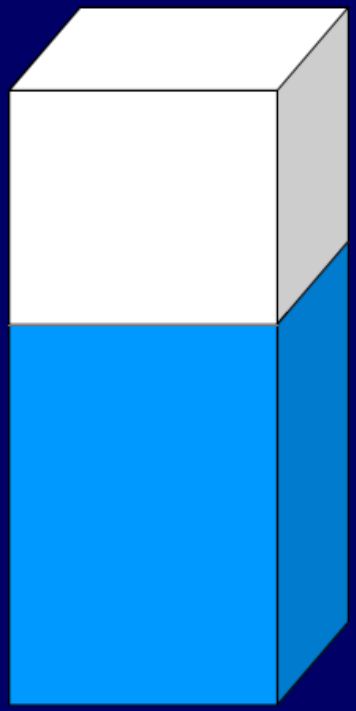
Eur Respir J 2007; 29: 1033-1056.

Outcome of prolonged weaning

- 181 weaning patients



Intensive Care Med. 2011; 37(5):775-84.



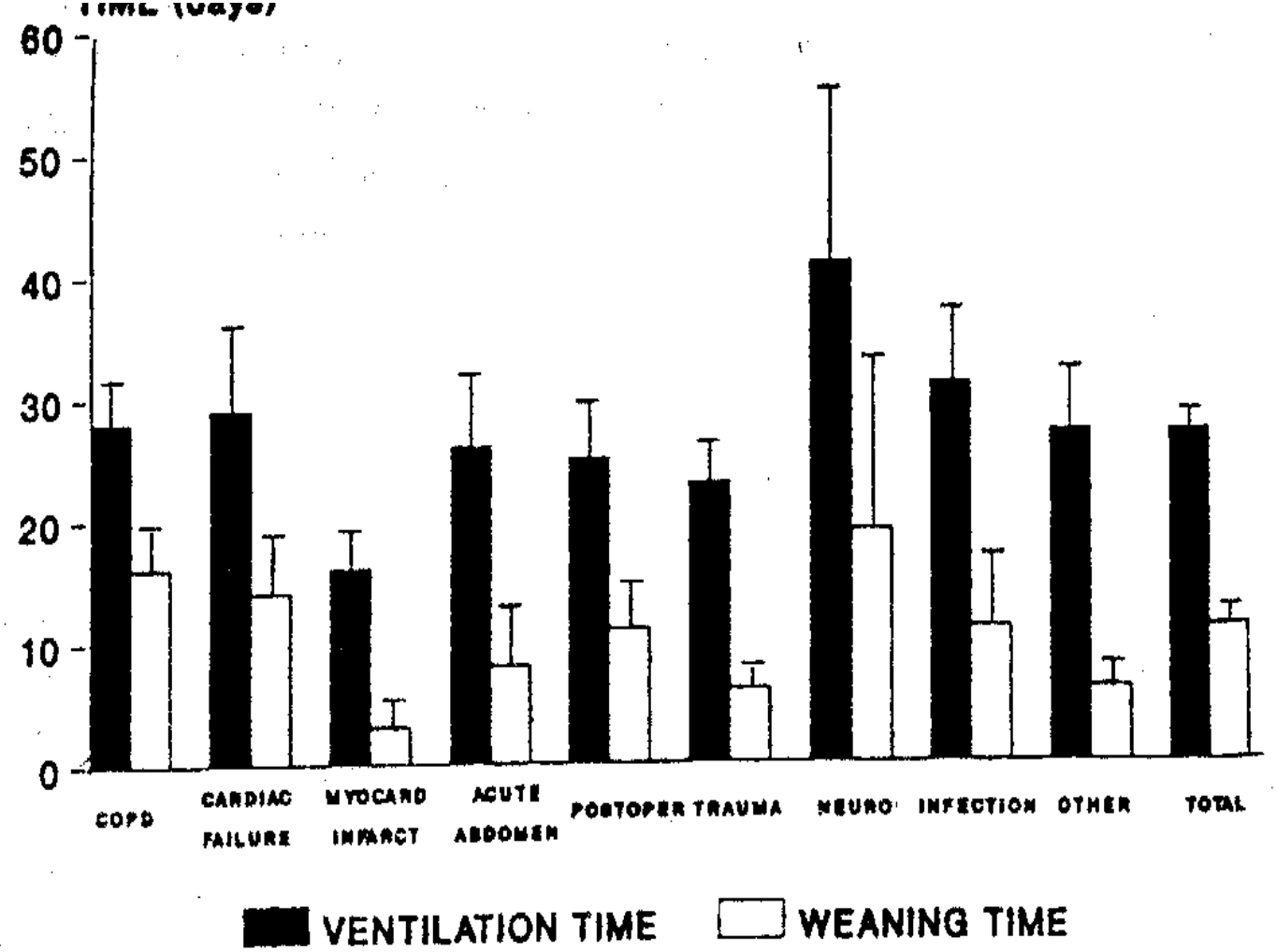
40 %

60 %

WEANING DURATION

DURATION OF VENTILATION PRIOR WEANING

A. Esteban, I. Alía, et alChest 1994;106:1186
A.Esteban,A.Anzueto,F.Frutos,et al. JAMA;287:345
A.Esteban,N.Ferguson,M.Mead,F.Frutos AJRCCM 2008;177:170



Weaning 用掉所有使用 ventilator 時間的 41%

COPD用掉所有使用 ventilator 時間的 57%

Myocardial infarction用掉所有使用 ventilator 時間的 19%

Esteban **A et al. Modes of mechanical ventilation and weaning. A national survey of Spanish hospitals.** Chest 1994

Weaning from mechanical ventilation: Readiness testing (2012.4.23 UpToDate)

- Discontinuing mechanical ventilation is a **two-step process**:
- **Readiness testing** – **clinical criteria** & weaning predictors.
- **Weaning** – is **process** of decreasing ventilator support.
  - immediate FSV →SB (SBT) or gradual reduction.
  - extubation → ability to breathe & airway patency and airway protection .
  - referred to
    discontinuation of mechanical ventilation
    liberation from the mechanical ventilator

Weaning from mechanical ventilation: Readiness testing, 2012 UpToDate

Clinical criteria used to determine readiness for trials of spontaneous breathing

Readiness testing

Required criteria
1. The cause of the respiratory failure has improved
2. $PaO_2/FiO_2 \geq 150$* or $SpO_2 \geq$ 90 % on $FiO_2 \leq$ 40% and PEEP ≤5 cmH_2O
3. pH >7.25
4. Hemodynamic stability (no or low dose vasopressor medications) ★
5. Able to initiate an inspiratory effort
Additional criteria (optional criteria)
1. Hemoglobin ≥8 to 10 mg/dL
2. Core temperature ≤38 to 38.5 degrees Centigrade
3. Mental status awake and alert or easily arousable

Weaning from mechanical ventilation: Readiness testing, 2012 UpToDate

Why obtain weaning predictors?

Clinical judgment alone had positive and negative predictive values for weaning success of only 50 and 67%

Stroetz RW et al. Tidal volume maintenance during weaning with pressure support.
Am J Respir Crit Care Med 1995

Weaning predictor 須具備特性: 準確, Noninvasive

Table 3 Accuracy of Weaning Predictors

Index	Threshold	Positive predictive value	Negative predictive value
Minute ventilation	≤15	0.55	0.38
Respiratory frequency	≤38	0.65	0.77
Tidal volume	≥325	0.73	0.94
Tidal volume/patient weight	≥4	0.67	0.85
Maximal inspiratory pressure	≤−15	0.59	1.00
Dynamic compliance	≥22	0.65	0.58
Static compliance	≥33	0.60	0.53
P_aO_2/P_AO_2 ratio	≥0.35	0.59	0.53
Frequency/tidal volume	≤105	0.78	0.95
CROP index	≥13	0.71	0.70

Source: Modified from Ref. 46.

PPV (%) = (number of true-positives) × 100/(number of true-positives + number of false-positives)

NPV (%) = (number of true-negatives) × 100 /(number of true-negatives + number of false-negatives)

Rapid Shallow Breathing Index

- Frequency / tidal volume (L)
- Young & Tobin, 1991 NEJM
- RSBI was 20% higher in first minute of spontaneous breathing than after 3-6 minutes
- Factors associated with elevated RSBI
  - Female gender
  - Older age (> 70 years old)
  - Smaller endotracheal tube (< 7.0 mm)

AUTHORS	THRESHOLD VALUE FOR f/VT RATIO	PPV (95 % CI)	NPV (95% CI)
Yang, Tobin NEJM 1991	105	(35/45) **0.78** (0.62-0.80)	(18/19) **0.95** (0.72-1.0)
Sassoon, Mahutte ARRD 1993	100	(34/40) **0.85** (0.69–0.94)	(4/5) **0.80** (0.30–0.99)
Mohsenifar et al Ann Int Med 1993	105	(18/26) **0.69** (0.48–0.85)	(3/3) **1.0** (0.29–1.0)
Lee et al Chest 1994	105	(31/39) **0.79** (0.63–0.90)	(1/13) **0.08** 0.04–0.38
Epstein AJRCCM 1995	100	(70/84) **0.83** (0.73–0.90)	(4/10) **0.40** (0.14–0.73)

AUTHORS	THRESHOLD VALUE FOR f/VT RATIO	PPV (95 % CI)	NPV (95% CI)
Epstein, Ciubutaru AJRCCM 1996	100	(163/189) **0.86** (0.80–0.91)	(8/29) **0.28** (0.13–0-47)
Kieger et al Chest 1997	105	(28/31) **0.90** (0.73–0.97)	(8/18) **0.44** (0.22–0.67)
Gandía, Blanco Int Care Med 1992	96	(23/25) **0.92** (0.72–0.99)	(10/15) **0.66** (0.39–0.87)
Chatila et al Am J. Med 1996	100	(56/78) **0.92** (0.60–0.81)	(15/22) **0.68** (0.45–0.85)
TOTAL		(458/557) **0.82** (0.79–0.85)	(71/134) **0.53** (0.44–0.61)

The NEW ENGLAND JOURNAL of MEDICINE

VOL. 357 NO. 4

ESTABLISHED IN 1812 JULY 26, 2007 WWW.NEJM.ORG

A Day in the Life of Oscar the Cat

David M. Dosa, M.D., M.P.H.

Oscar the Cat awakens from his nap, opening a single eye to survey his kingdom. From atop the desk in the doctor's charting area, the cat peers down the two wings of the nursing home's advanced dementia unit. All quiet on the western and eastern fronts. Slowly, he rises and extravagantly stretches his 2-year-old frame, first backward and then forward. He sits up and considers his next move.

In the distance, a resident approaches. It is Mrs. P., who has been living on the dementia unit's third floor for 3 years now. She has long forgotten her family, even though they visit her almost daily. Moderately disheveled after eating her lunch, half of which she now wears on her shirt, Mrs. P. is taking one decides to head down the west wing first, along the way sidestepping Mr. S., who is slumped over on a couch in the hallway. With lips slightly pursed, he snores peacefully — perhaps blissfully unaware of where he is now living. Oscar continues

down the hallway until he reaches its end and Room 310. The

Oscar takes no notice of the woman and leaps up onto the bed. He surveys Mrs. T. She is clearly in the terminal phase of illness, and her breathing is labored. Oscar's examination is interrupted by a nurse, who walks in to ask the daughter whether Mrs. T. is uncomfortable and needs more morphine. The daughter shakes her head, and the nurse retreats. Oscar returns to his work. He sniffs the air, gives Mrs. T. one final look, then jumps off the bed and quickly leaves the room. Not today.

Making his way back up the hallway, Oscar arrives at Room 313. The door is open, and he proceeds inside. Mrs. K. is resting peacefully in her bed, her breathing steady but shallow. She is surrounded by photo-

Readiness testing

高雄長庚紀念醫院　呼吸照護中心 呼吸器脫離訓練計劃評估及記錄表　P:

床號:	病歷號:	姓名:	診斷					
離機前生理評估數據	評估日期	/	/	/	/	/	/	/
	1.血液動力學穩定(HR≤120,無心率不整,無升壓劑使用)							
	2.體溫 ＜37.5 ℃, 是否有感染現象(接觸隔離中)							
	3.有無急性病症， 例:消化道出血、痙攣,血紅素是否>7mg/dl							
	4.是否有電解質不平衡的問題,但臨床已做處理							
	5.營養狀態(含血清白蛋白低下或 NPO 中，嚴重嘔吐或腹瀉)							
	6. FiO2 ≤ 50%且 SpO2 ≥ 90% ,PEEP ≤ 8 cmH2O							
	7.氣囊漏氣測驗是否通過?							
	7. weaning profile 自呼: VT: ≥ 5 cc/kg							
	自呼: RR : 6～35 次/分							
	自呼: MV< 10 L/min							
	RSBI ≤ 105							
	MIP > -20 cmH2O/ MEP>+60 cmH2O							
離機訓練時生命徵象及生理變化	R R ≤ 35 次/分 或心跳速率± 20%							
	S pO2 ≥ 90% 或減少 4%							
	BP≧90mmHg ,≦180mmHg							
	是否發生心律不整(VT、VF、Af)							
	是否意識狀態改變							
	是否冒冷汗或使用呼吸輔助肌							
	是否呼吸困難(含支氣管痙攣)							
評估者 RT 簽名								

Clinical criteria

Weaning predictors

V 代表有左述現象;　x 代表無左述現象

Weaning from mechanical ventilation: Readiness testing, 2012 UpToDate

Methods of weaning

- Synchronized Intermittent mandatory ventilation (SIMV)
- Pressure support (PSV)
- Spontaneous breathing trial with T piece

Ideally, a trial of spontaneous breathing is initiated while the patient is awake and not receiving sedative infusions.

Mode	優點	缺點
T-Piece	• 自行呼吸管路阻力較小 • 為一種休息/作工的訓練方式 • 可測試病人完全自行呼吸狀況	•所花費的人力較多 •病人呼吸作工變化大
IMV/SIMV	• 病人可慢慢適應 • 所花人力較少	•為高p/△v作工方式需克服demand valve, 管路及人工氣道阻力較不舒適 • 會延長脫離時間 • 也許造成永久的肌肉疲勞
P.S. (Pressure Support)	• 為低p/△v作功方式較舒適, 可為一種耐訓練 • 病人自行調整流速, 吸氣時間及潮器量 • 所花人力較少	•無呼吸時,無法給予機械通氣
MMV (Mandatory minute volume)	• 病人最易適應 • 所花人力最少	•對呼吸淺快者可能不適 •可能造成病人依賴呼吸器

Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation

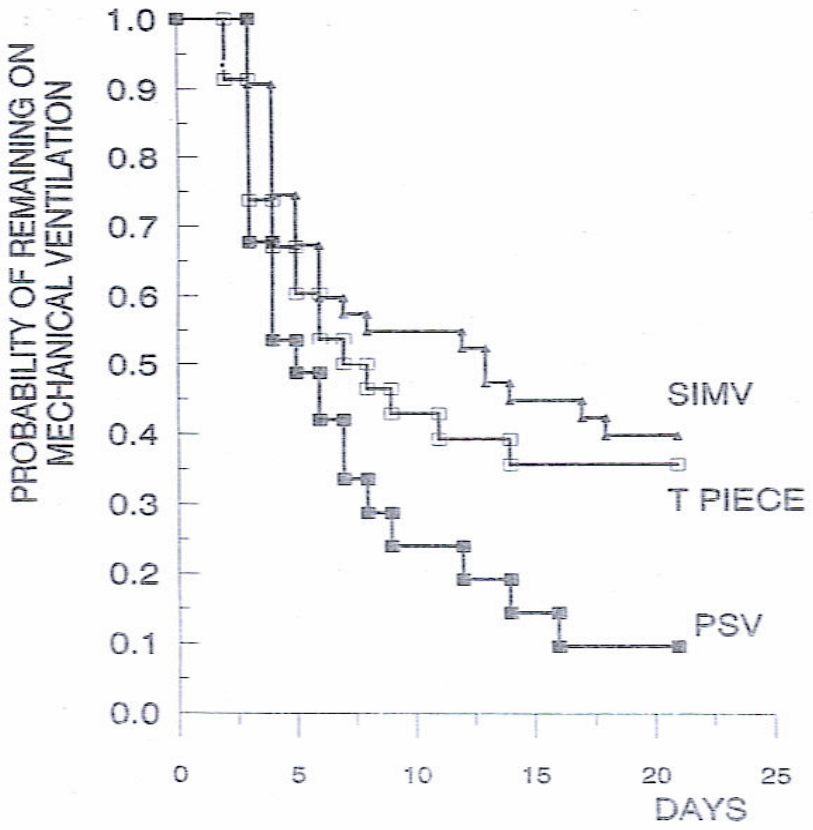


Figure 1. Probability of remaining on mechanical ventilation in patients with prolonged difficulties in tolerating spontaneous breathing. This probability was significantly lower for pressure support ventilation (PSV) than for T piece or synchronized intermittent ventilation (SIMV) (cumulative probability for 21 d, $p < 0.03$ with the log-rank test).

TABLE 3

CAUSES OF FAILURE AND EARLY TERMINATION IN THE THREE GROUPS OF PATIENTS ASSIGNED TO A MODALITY OF GRADUAL WITHDRAWAL FROM VENTILATORY SUPPORT

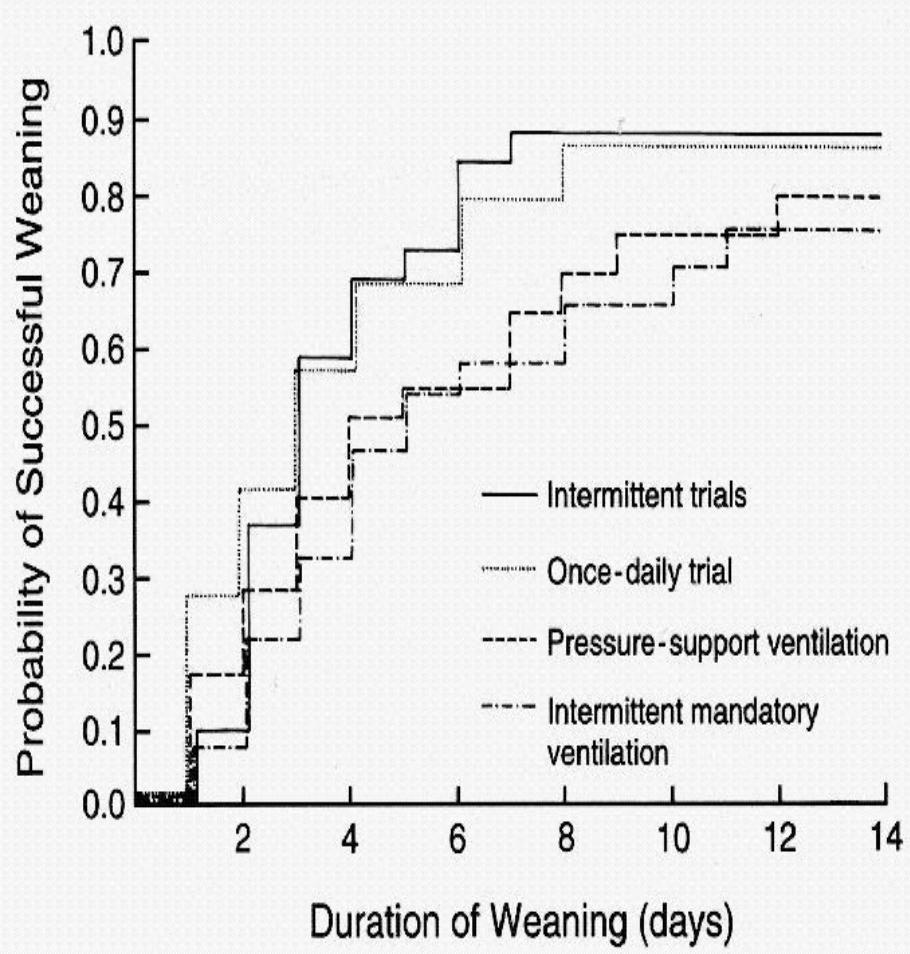
Cause	T Piece (*n* = 35)	Synchronized Intermittent Mandatory Ventilation (*n* = 43)	Pressure Support Ventilation (*n* = 31)
Events unrelated to the weaning process			
Laryngeal edema needing reintubation	1	1	2
Tracheoesophageal fistula	0	0	1
Stroke	2	0	1
Peritonitis	1	1	0
Septic shock without pneumonia	1	0	1
Events considered as failures of the weaning process			
Nosocomial pneumonia > 72 h after start of weaning	3	3	0
Ischemic heart failure during weaning	1	3	1
Reintubation (< 48 h)*	2	5	1
Impossibility of weaning after 21 d	4	5	0
Number of failures	10 (33%)	16 (39%)	2 (8%)
Total number of events	15	18	7

* Other than for laryngeal edema.

Conclusion: PSV is superior to others

Brochard L et al Am J Respir Crit Care Med 1994

A comparison of four methods of weaning patients from MV



Weaning Technique	Successful Weaning and Extubation	Continued Mechanical Ventilation after 14 Days	
		Reintubation	
		no. of patients (%)	
Intermittent mandatory ventilation	20 (69.0)	4 (13.8)	5 (17.2)
Pressure-support ventilation	23 (62.2)	7 (18.9)	4 (10.8)
Intermittent trials of spontaneous breathing	27 (81.8)	5 (15.2)	1 (3.0)
Once-daily trial of spontaneous breathing	22 (71.0)	7 (22.6)	1 (3.2)

*The percentages do not total 100 percent in the groups that received pressure-support ventilation and a once-daily trial of spontaneous breathing because one patient died in each group and weaning was interrupted because of an intercurrent illness in two patients in the pressure-support group.

Conclusion: spontaneous breathing trials leading to earlier extubation

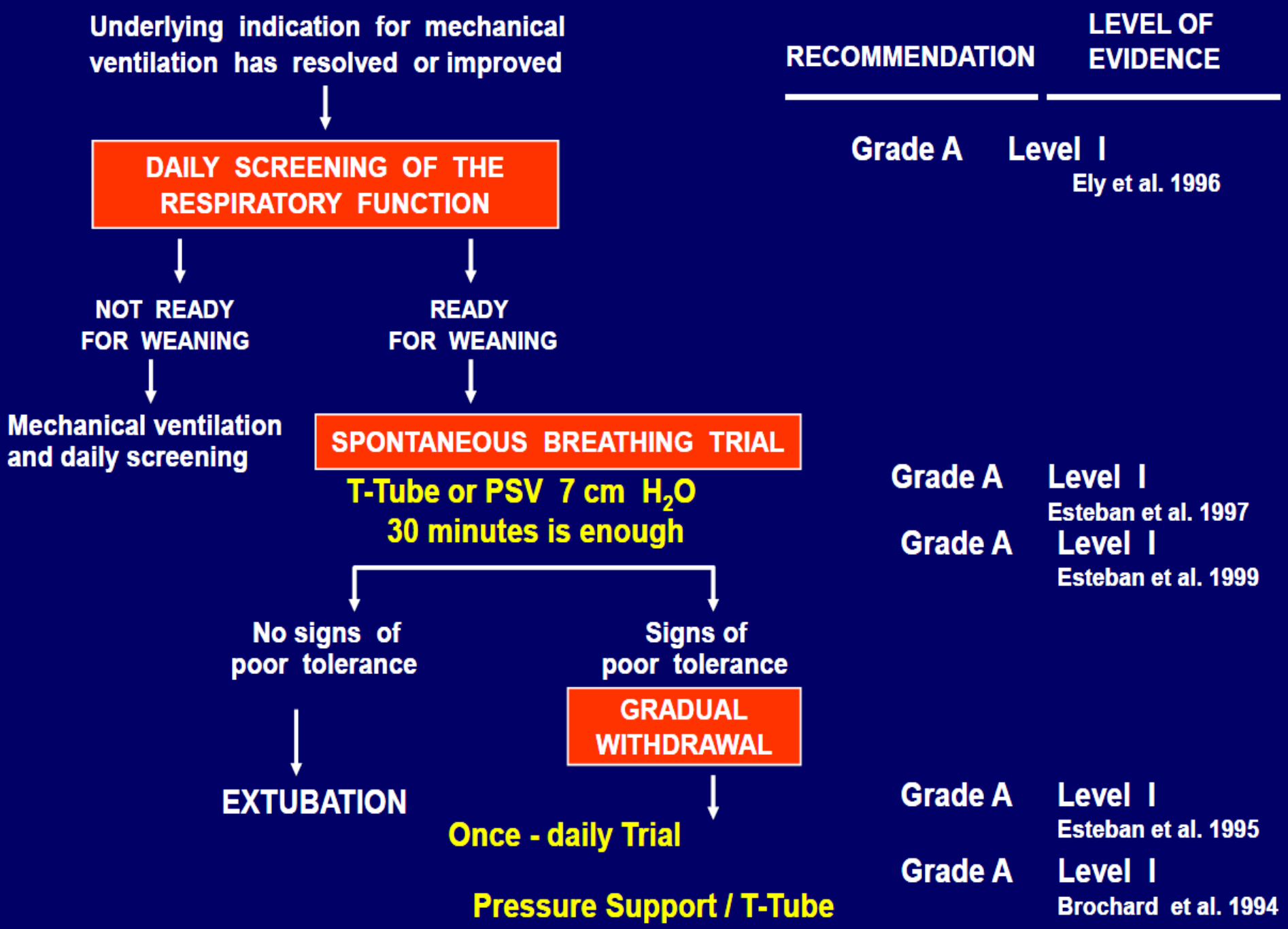
Esteban et al. N Engl J Med 1995

	T - Tube (n = 246)		PS (7 cm H_2O) (n = 238)
SUCESSFULLY EXTUBATED	63 %	(p = 0.14)	70 %
REINTUBATED WITHING 48 hr	18.7 %	(p = 0.94)	18,5 %

A. Esteban, I. Alía, et al
ARJCCM 1997;156:459-465

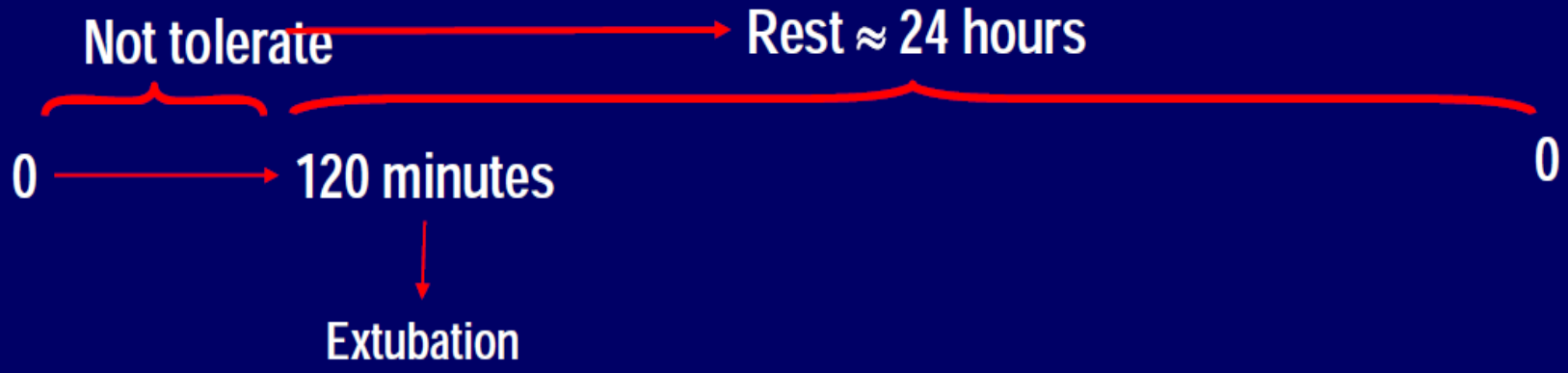
	30 minutes (n = 270)	120 minutes (n = 256)	p
SUCESSFULLY EXTUBATED	205 (78 %)	187 (73 %)	0.43
REINTUBATED WITHING 48 hr	32 (13 %)	29 (13 %)	0.91
SB TRIAL FAILURE	33 (12 %)	40 (16 %)	0.32

A. Esteban, I. Alía, et al
ARJCCM 1999;159:512-518


Underlying indication for mechanical ventilation has resolved or improved
DAILY SCREENING OF THE RESPIRATORY FUNCTION
NOT READY FOR WEANING
READY FOR WEANING
Mechanical ventilation and daily screening
SPONTANEOUS BREATHING TRIAL
T-Tube or PSV 7 cm H_2O
30 minutes is enough
No signs of poor tolerance
Signs of poor tolerance
GRADUAL WITHDRAWAL
EXTUBATION
Once - daily Trial
Pressure Support / T-Tube
RECOMMENDATION
LEVEL OF EVIDENCE
Grade A Level I
Ely et al. 1996
Grade A Level I
Esteban et al. 1997
Grade A Level I
Esteban et al. 1999
Grade A Level I
Esteban et al. 1995
Grade A Level I
Brochard et al. 1994

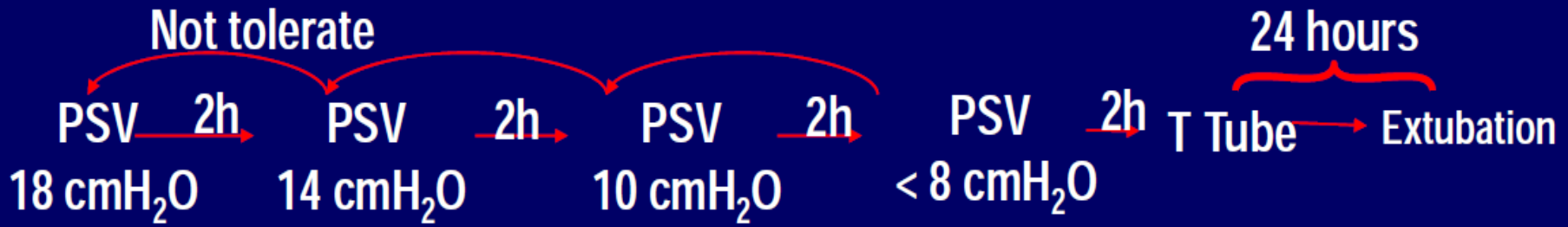
Daily Trial of Spontaneous Breathing

Esteban et al. N Engl J Med 1995



Gradual reduction of Pressure Suport

Brochard et al. Am J Respir Crit Care Med 1994



A randomized, controlled trial of protocol- directed versus physician-directed weaning from mechanical ventilation

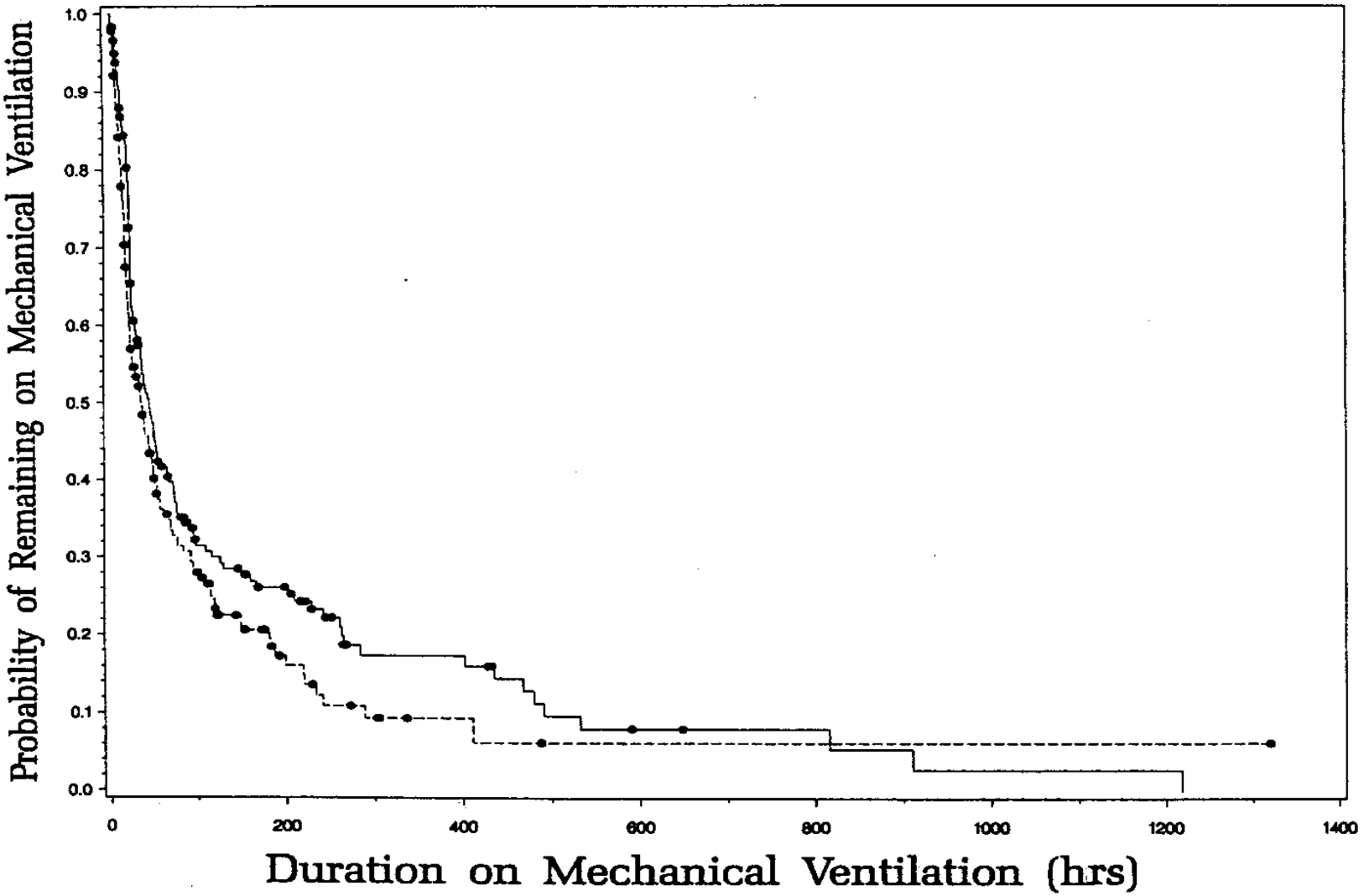
- **Physician directed group**
  - Onset of weaning and progression of the weaning determined by physician
- **protocol directed group**
  - Underlying problem resolve or significant improve
  - Meet the criteria:
  - Pao2/FiO2>200
  - PEEP≦5 cmH2O
  - Heart rate<140/ min
  - Respiratory rate<35/ min
  - Awake and oriented mental status
  - No vasopressor

Crit Care Med 1997; 25:567-574

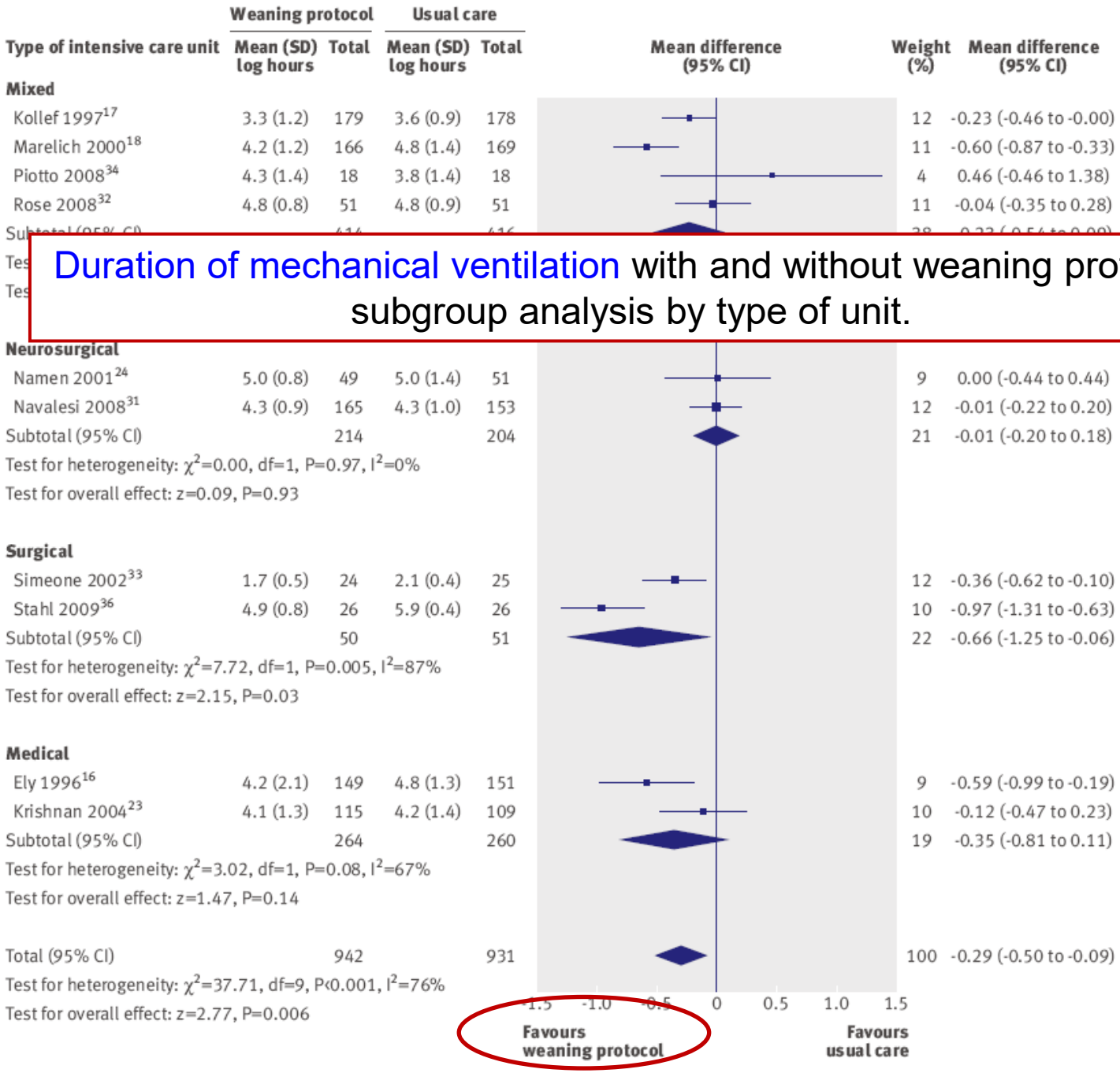
Weaning failure criteria:

- Respiratory rate>35/ min
- Oxygen saturation<90%
- Heart rate>140/min
- Systolic BP>180 or <90
- Presence of somnolence, diaphoresis ,or anxiety
- Require vasopressors
- Chest pain

Crit Care Med 1997; 25:567-574



•Conclusion: Conclusion: Protocol-guided weaning of mechanical ventilation, as performed by nurses and respiratory therapists, is safe and led to extubation more rapidly than physician-directed weaning. (Crit Care Med 1997; 25:567-574)



Duration of mechanical ventilation with and without weaning protocol; subgroup analysis by type of unit.

BMJ 2011; 342: c7237 doi:10.1136/bmj.c7237

Fig 3 | Duration of mechanical ventilation with and without weaning protocol; subgroup analysis by type of unit. Mean difference calculated with fixed effects model

Duration of mechanical ventilation with and without weaning protocol; subgroup analysis by type of approach.

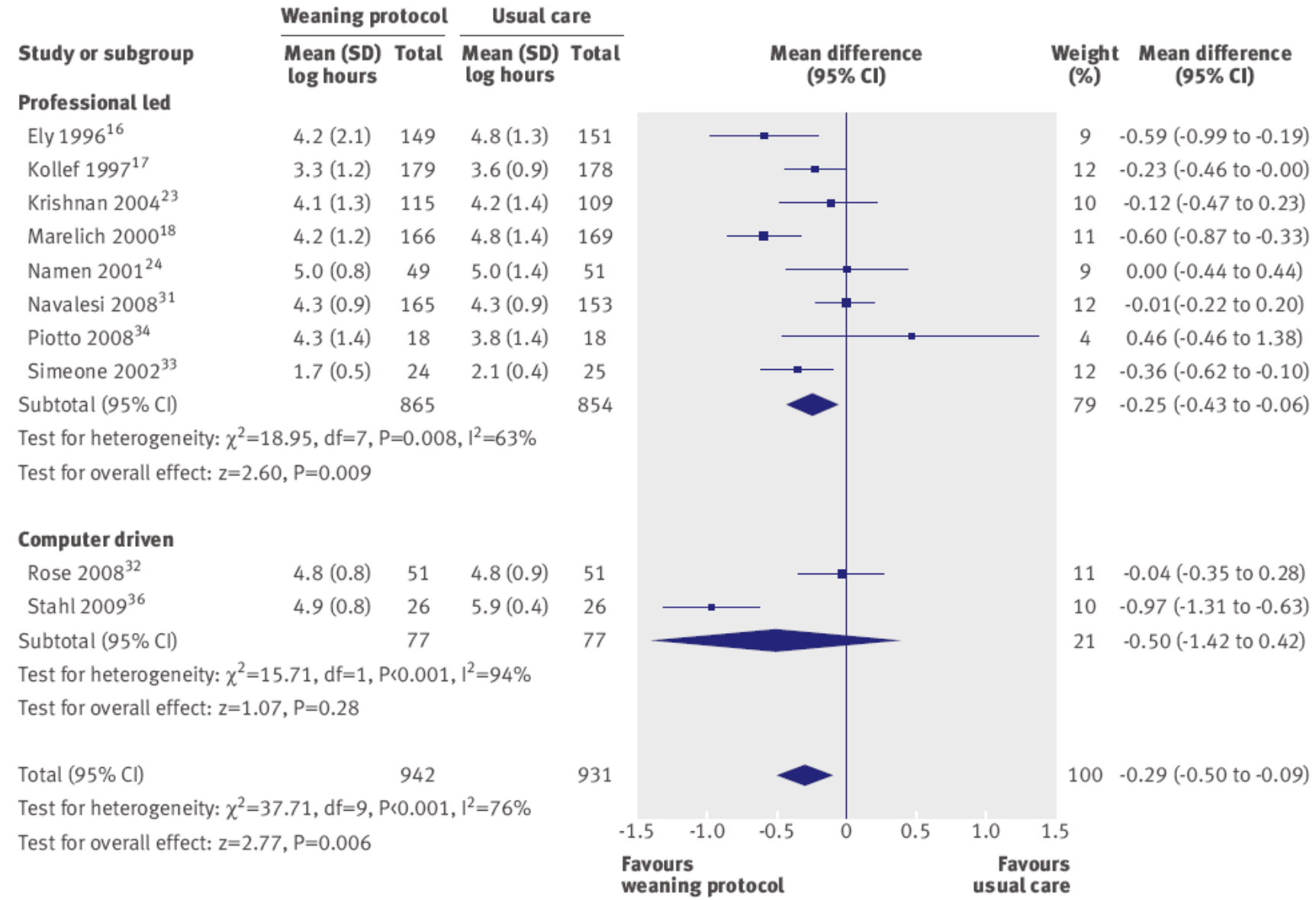


Fig 4 | Duration of mechanical ventilation with and without wea
difference calculated with fixed effects model

BMJ 2011;342:c7237 doi:10.1136/bmj.c7237

Mortality in hospital and intensive care unit according to weaning with and without protocol. Odds ratio calculated with fixed effects model

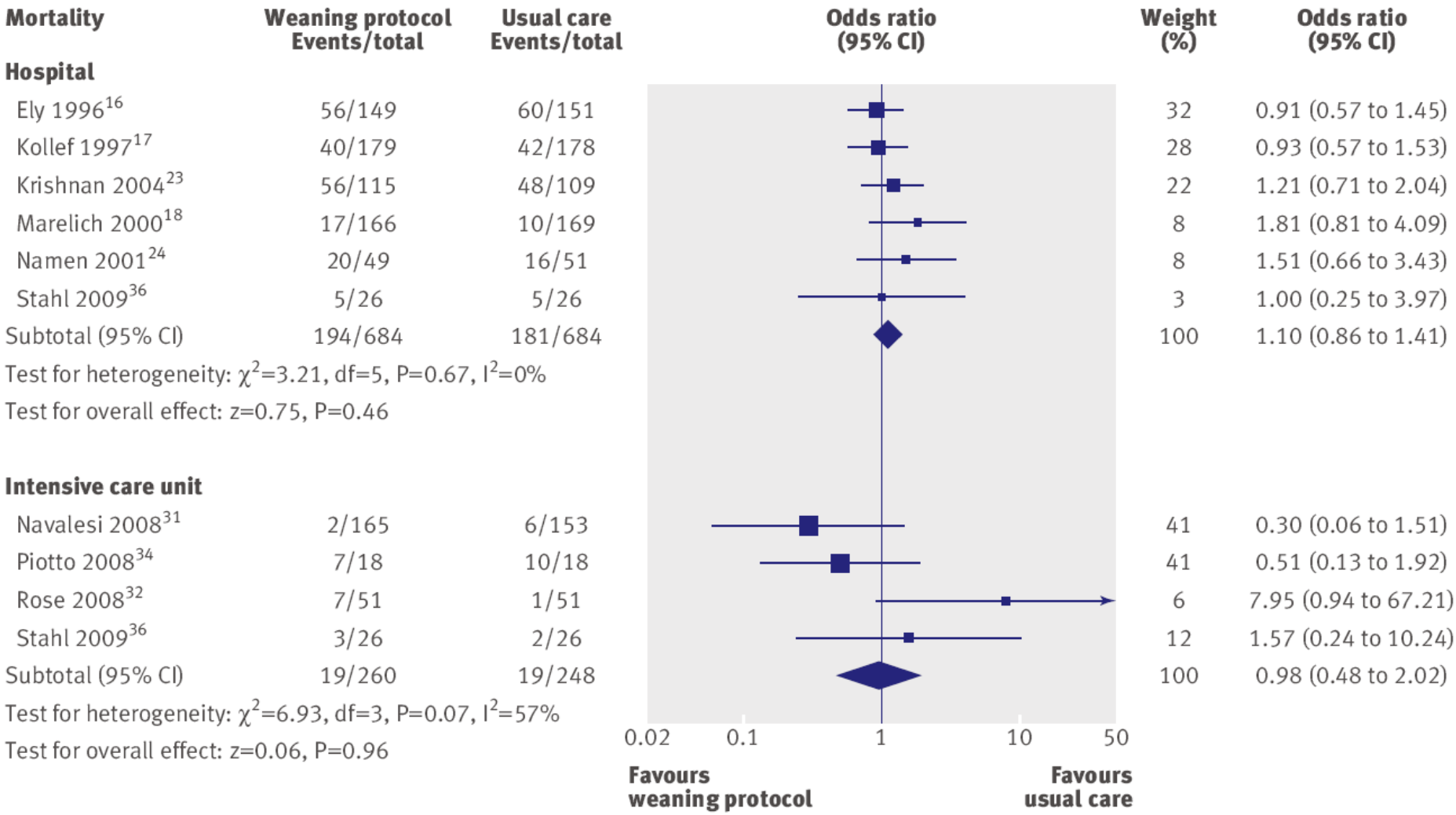


Fig 5 | Mortality in hospital and intensive care unit according to weaning with and without protocol. Odds ratio calculated with fixed effects model

BMJ 2011;342:c7237 doi:10.1136/bmj.c7237

Duration of weaning with and without weaning protocol. Mean difference calculated with fixed effects model

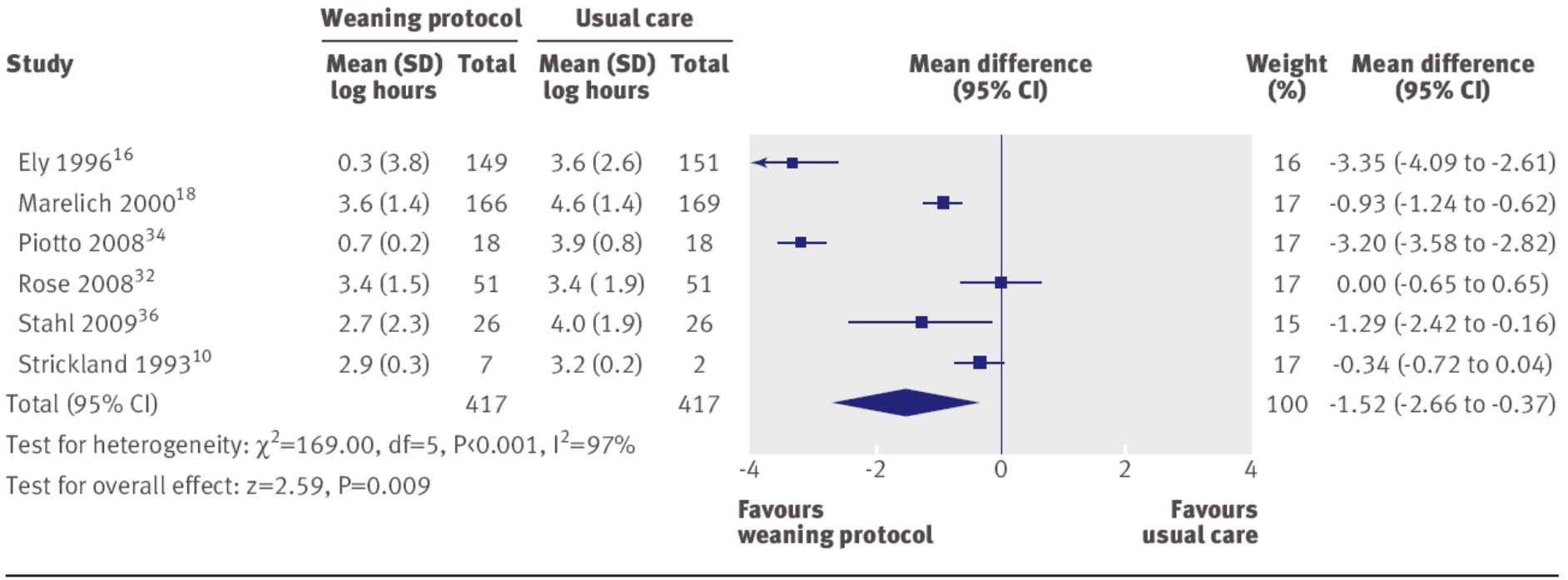


Fig 6 | Duration of weaning with and without weaning protocol. Mean difference calculated with fixed effects model

BMJ 2011;342:c7237 doi:10.1136/bmj.c7237

Weaning protocols in clinical practice

- 研究顯示 weaning protocols ，在臨床實踐中可安全和有效減少機械通氣的時間。但在不同族群的其他研究中，沒有顯示效益。
- 研究結果不一致，可能各協定中，個別的方式各有不同。
- 許多protocols ，包括準備撤機(readiness to wean)和減少呼吸機支援的指引標準(guidelines for reducing ventilator support)，但具體標準和指導原則，不盡相同。
- 並非所有的協議包括拔管標準。
- protocols是在不同的環境中實施，醫療人員（包括護士，呼吸治療師，醫生等）和自動化（電腦）系統。
- 對protocols的堅持性，有限證據表明，護士和專業醫療人員(RT)可能比醫生更會堅持protocols 。

BMJ 2011;342:c7237 doi:10.1136/bmj.c7237

A **protocol**, defined by Merriam-Webster :

- 一個科學或醫學實驗、治療或過程的詳細計畫。
- 在臨床實踐中，一個決策支援的工具。
- 它是介於完全臨床自主使用和全面電腦自動化的頻譜治療間的醫療實踐的方法。

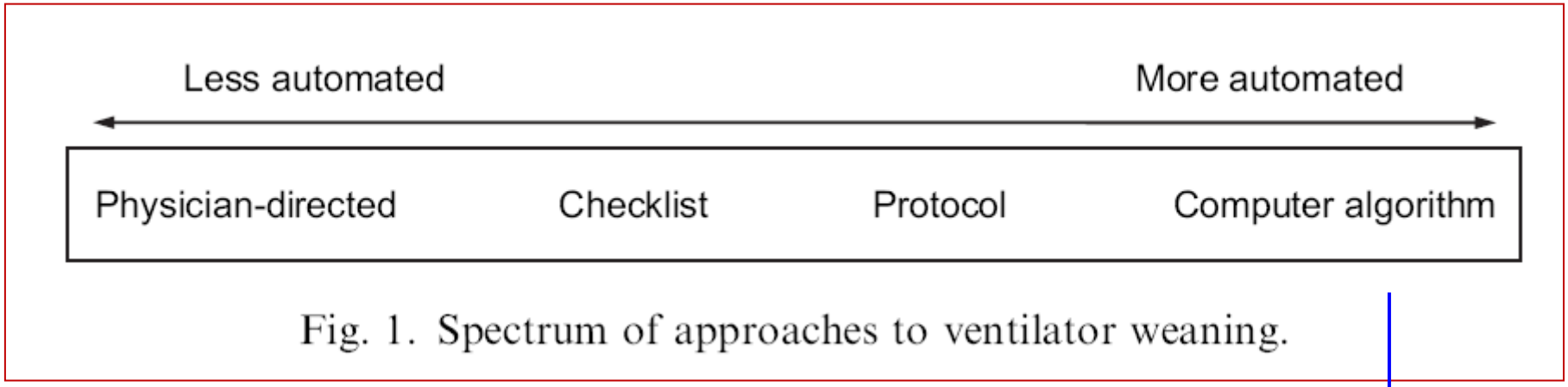


Fig. 1. Spectrum of approaches to ventilator weaning.

Closed loop ventilator systems

Computer driven weaning

144 patients were enrolled before weaning initiation - randomly allocated to computer-driven weaning (CDW, n=74) or to physician-controlled weaning (PCW, n=70)

Weaning duration was reduced in the CDW group from a median of 5 to 3 d (p = 0.01) and total duration of mechanical ventilation from 12 to 7.5 d (p = 0.003). Reintubation rate did not differ (23 vs. 16%, p = 0.40). CDW also decreased median ICU stay duration from 15.5 to 12 d (p = 0.02) and caused no adverse events

Lellouche F. Am J Respir Crit Care Med 2006; 174:894-900

A Multicenter Randomized Trial of Computer-driven Protocolized Weaning from Mechanical Ventilation

A Prospective, Controlled Trial of a Protocol-based Strategy to Discontinue Mechanical Ventilation

Jerry A. Krishnan, Dana Moore, Carey Robeson, Cynthia S. Rand, and Henry E. Fessler

Department of Medicine; and Department of Medical Nursing, Division of Pulmonary and Critical Care Medicine, Johns Hopkins Medical Institutions, Baltimore, Maryland

Am J Respir Crit Care Med Vol 169. pp 673–678, 2004

Weaning protocols can improve outcomes, but their efficacy may vary with patient and staff characteristics. In this prospective, controlled trial, we compared protocol-based weaning to usual, physician-directed weaning in a closed medical intensive care unit (ICU) with high physician staffing levels and structured, system-based rounds.

Conclusion: The protocol-directed weaning may be unnecessary in a closed ICU with generous physician staffing and structured rounds. (在封閉式ICU與充足醫師人力及結構性查房下，protocols 撤機可能是不必要的)。

Failure Criteria of Spontaneous Breathing Trials

Clinical assessment and subjective indices	**Agitation and anxiety**
	Depressed mental status
	Diaphoresis
	Cyanosis
	Evidence of increasing effort
	Increased accessory muscle activity
	Facial signs of distress
	Dyspnoea
Objective measurements	**PaO_2 ≤50–60 mmHg on FIO_2 ≥0.5 or SaO_2 <90%**
	$PaCO_2$ >50 mmHg or an increase in $PaCO_2$ >8 mmHg
	pH<7.32 or a decrease in pH≥0.07 pH units
	fR/VT>105 breaths/min/L
	fR>35 breaths/min or increased by≥50%
	fC>140 beats/min or increased by≥20%
	Systolic BP>180 mmHg or increased by≥20%
	Systolic BP<90 mmHg
	Cardiac arrhythmias

Eur Respir J 2007;volume 29 number 5, 29: 1033–1056,

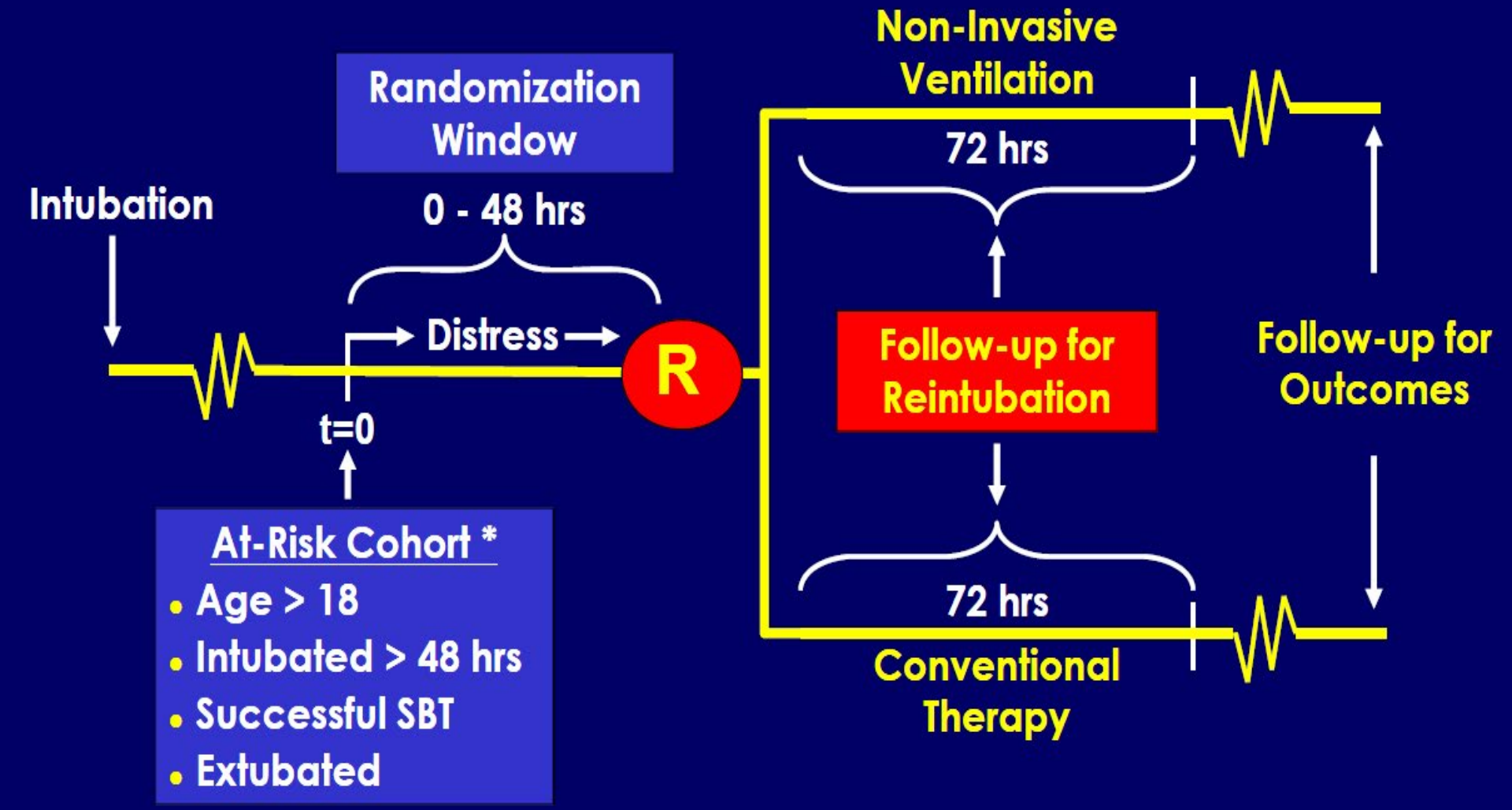
PaO_2: arterial oxygen tension; FIO_2: inspiratory oxygen fraction; SaO_2: arterial oxygen saturation; $PaCO_2$: arterial carbon dioxide tension; fR: respiratory frequency; VT: tidal volume; fC: cardiac frequency; BP: blood pressure. 1 mmHg=0.133 kPa.

Should NIPPV be routinely used for weaning from MV?

Weaning patients off invasive ventilation. [Editorial]

Non-invasive ventilation may improve outcomes in selected patients, but **the evidence is weak ?????????**

Study Overview



* Excluded:
- Prior tracheostomy
- No informed consent

A. Esteban, F. Frutos, ND Ferguson, et al
N Engl J Med 2004;350:2452

Results - Outcomes

	Mortality	Reintubation
Non-Invasive Ventilation	25 %	49 %
Conventional Therapy	14%	49%
Relative Risk (95% CI)	1.75 (0.99-3.09)	0.99 (0.76-1.30)
Absolute Risk Difference	10.5% (0.00-20.75)	0%
p-value	0.0517	ns

A. Esteban, F. Frutos, ND Ferguson, et al
N Engl J Med 2004;350:2452

97 patients

Mechanical ventilation ≥ 48 h.

Extubated

Risk of developing post-extubation failure

- > 1 failure of weaning trial
- Chronic Heart Failure
- PCO_2 > 45 mmHg after extubation
- > 1 co-morbidities
- Weak cough
- Upper airwais obstruction

S. Nava, C. Gregoretti, et al
Crit Care Med 2005;33:2461

	NIV	Standard treatment	P value
Intention-to-treat			
Re-intubated	4 /48 (8 %)	12 / 49 (24 %)	0.03
ICU mortality	3 /48 (6 %)	9 /49 (18 %)	0.07
Hosp. mortality	6 /48 (12 %)	9 / 49 (18 %)	0.42
ICU length of stay (days)	8.86 ± 5.67	11.60 ± 14.94	0.25
Hosp. length of stay (days)	23.26 ± 16.44	25.46 ± 21.43	0.60

S. Nava, C. Gregoretti, et al

Crit Care Med 2005;33:2461

	NIV	Stand. Treat.	p
Time in ICU (d.)	8.9 ± 5.7	11.6 ± 14.9	
Time in Hosp. (d.)	23.3 ± 16.4	25.5 ± 21.4	
Mortality ICU	3/48 (6 %)	9 /49 (18 %)	0.07
Mortality Hosp.	12 %	18 %	0.23
Reintubation	4/48 (8%)	12/49 (24 %)	0.027
Mort. ICU Reint.	**10/16 (63%)**		
Mort. ICU No Reint.	**2/81 (3%)**		

S. Nava, C. Gregoretti, et al
Crit Care Med 2005;33:2461

Risk difference of univariate and multivariate equations calcutated with the generalized linear models

Response Variable Y	Predictor Variable X, n (%)		Risk Difference, %	95 %	p value
UNIVARIATE Reintubation	NIV 4/48 (8)	No NIV 12/49 (24)	-16	(-2, -31)	.027
ICU mortality	NIV 3/48 (6)	No NIV 9/49 (18)	-12	(-25, +0.7)	.064
ICU mortality	Reintubation 10/16 (63)	No reintubation 2/81 (3)	+60	(+36, +84)	<.001
MULTIVARIATE Reintubation	NIV 4/48 (8)	No NIV 12/49 (24)	-16	(-2, -31)	.027
ICU mortality	NIV 6/48 (12)	No NIV 6/49 (13)	-1	(-8, +6)	.845
ICU mortality	Reintubation 10/16 (62)	No reintubation 2/81 (3)	+60	(+37, +83)	<.001

S. Nava, et al.
Crit Care Med 2005;33:2461

133 ventilated patients
Tolerated a T-piece trial, but had increased risk for extubation failure

- Age > 65
- Cardiac failure
- APACHE II ±12

Inmediatelly after extubation

- NIV for 24 hours (66)
- Conventional management (67)

M. Ferrer, M. Valencia, et al.
AJRCCM 2004; 173:164

	NIV Group (n=79)	Control Group (n=83)	p
Respiratory failure	13 (16%)	27 (33%)	0.029
Reintubation	9 (11 %)	18 (22 %)	0.12
ICU stay, d.	11 ± 8	13 ± 11	0.14
Hospital stay, d.	30 ± 23	29 ± 18	0.65
ICU mortality	2 (3 %)	12 (14 %)	0.015
Hospital mortality	13 (16 %)	19 (23 %)	0.41

M. Ferrer, M. Valencia et al.
AJRCMM 2006;173:164

Patients with and without hypercapnia during SBT

	WITH			WITHOUT		
	NIV (n=27)	Control (n=22)	p	NIV (n=52)	Control (n=61)	p
PCO_2 during SBT	55 ± 7	53 ± 5	0.36	38 ± 5	37 ± 5	0.61
COPD	100 %	95 %		27 %	33 %	
Resp. Failure after extubation	4 (15 %)	9 (41 %)	0.08	9 (17)	18 (30%)	0.20
Reintubation	3 (11 %)	6 (27 %)	0.27	6 (12 %)	12 (20%)	0.36
ICU mortality	0 (0 %)	4 (18 %)	0.03	2 (4 %)	8 (13 %)	0.11
Hosp. mortality	1 (4 %)	9 (41 %)	0.03	10 (23%)	10 (16%)	0.51

M. Ferrer, M. Valencia et al.
AJRCMM 2006;173:164

NIV to prevent the post-extubation respiratory failure

	Overall	% COPD	Reintubatión (COPD)	
			NIV	Conventional
Nava et al. Crit Care Med 2005	97	33%	6%	27%
Ferrer et al. AJRCCM 2006	162	51%	22%	44%

NIV for treatment of post-extubation respiratory failure

	Overall	% COPD	Reintubation (COPD)	
			NIV	Conventional
Esteban,Frutos, et al N Engl J Med 2004	221	10%	50%	67%

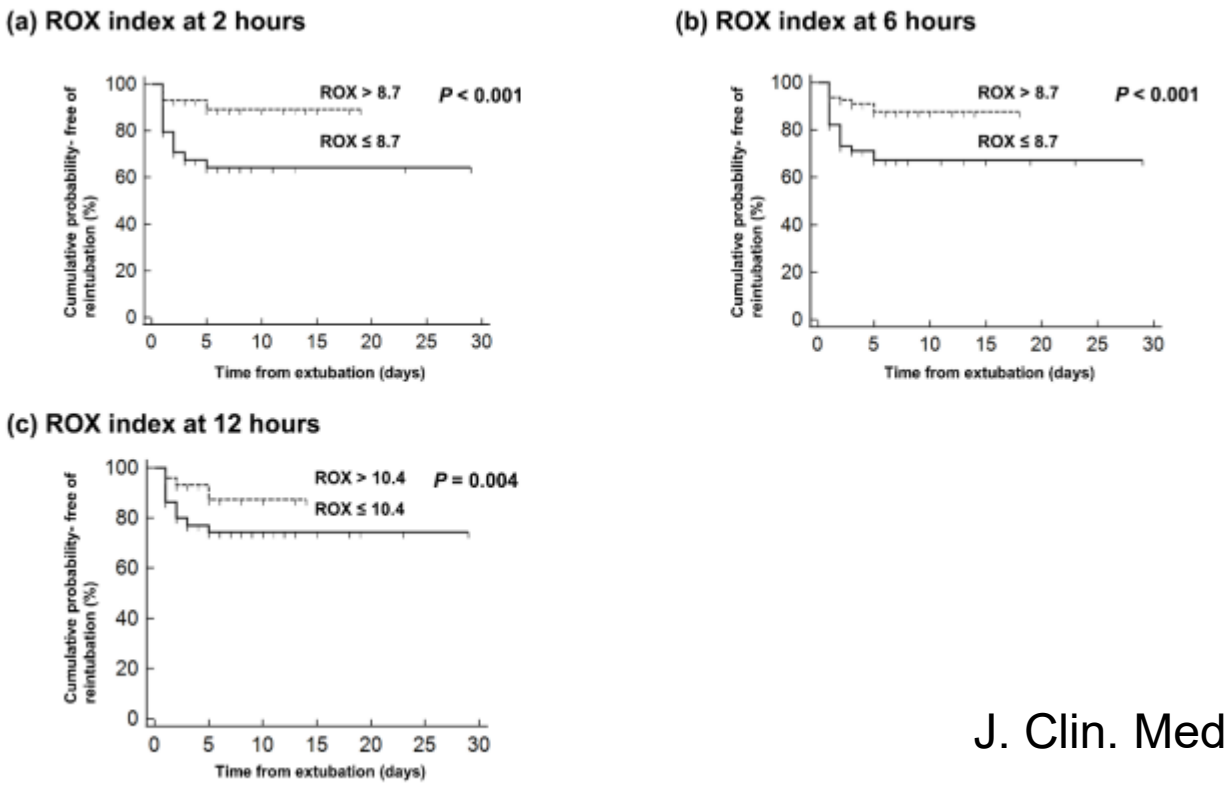
Journal of *Clinical Medicine*

MDPI

Article

An Integrated Model including the ROX Index to Predict the Success of High-Flow Nasal Cannula Use after Planned Extubation: A Retrospective Observational Cohort Study

Young Seok Lee [1], Sung Won Chang [2], Jae Kyeom Sim [1], Sua Kim [3] and Je Hyeong Kim [3,*]



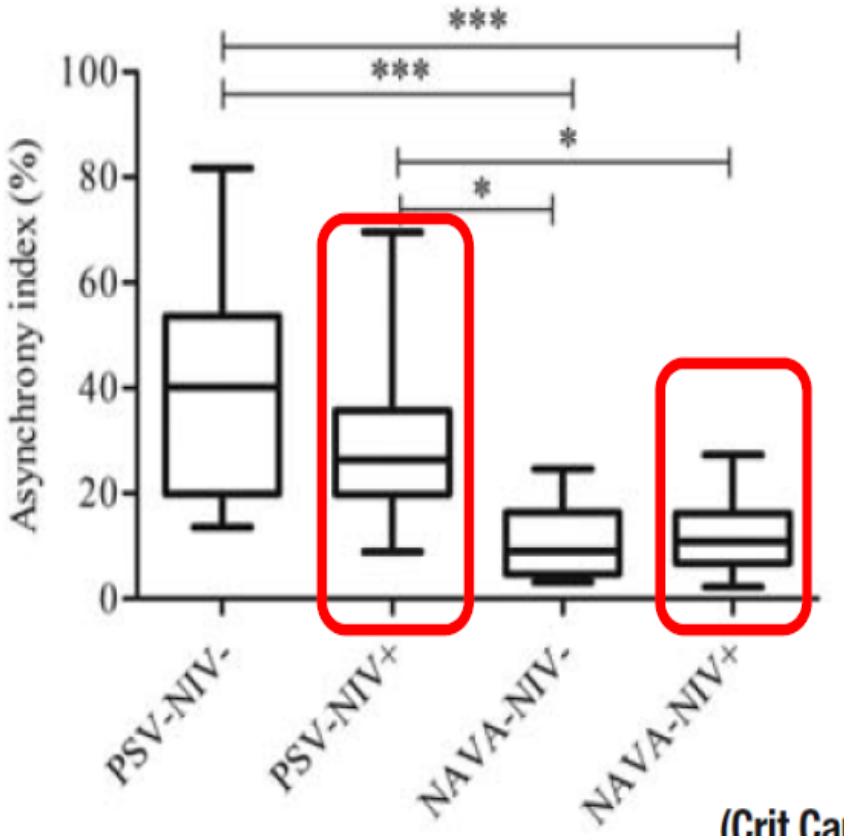
J. Clin. Med. 2021, 10, 3513

Figure 2. Kaplan–Meier plots showing the cumulative probability of remaining free of reintubation according to the cut-off ROX index value at (**a**) 2 h, (**b**) 6 h, and (**c**) 12 h after the commencement of HFNC therapy in extubated patients.

Neurally adjusted ventilatory assist improves patient–ventilator interaction during postextubation prophylactic noninvasive ventilation*

Matthieu Schmidt, MD; Martin Dres, MD; Mathieu Raux, MD, PhD; Emmanuelle Deslandes-Boutmy, MD; Felix Kindler, MD; Julien Mayaux, MD; Thomas Similowski, MD, PhD; Alexandre Demoule, MD, PhD

17 patients receiving a prophylactic postextubation noninvasive mechanical ventilation



(Crit Care Med 2012; 40:1738–1744)

Table 2. Risk Factors for Unsuccessful Discontinuation of Mechanical Ventilation.

Failure of two or more consecutive spontaneous-breathing trials
Chronic heart failure
Partial pressure of arterial carbon dioxide >45 mm Hg after extubation
More than one coexisting condition other than heart failure
Weak cough
Upper-airway stridor at extubation
Age ≥65 yr
APACHE II score >12 on day of extubation*
Patient in medical, pediatric, or multispecialty ICU
Pneumonia as cause of respiratory failure

* Scores on the Acute Physiology and Chronic Health Evaluation (APACHE II) range from 0 to 71, with higher scores indicating greater impairment.

FAILURE TO WEAN OFF VENTILATOR

"ABCDE"

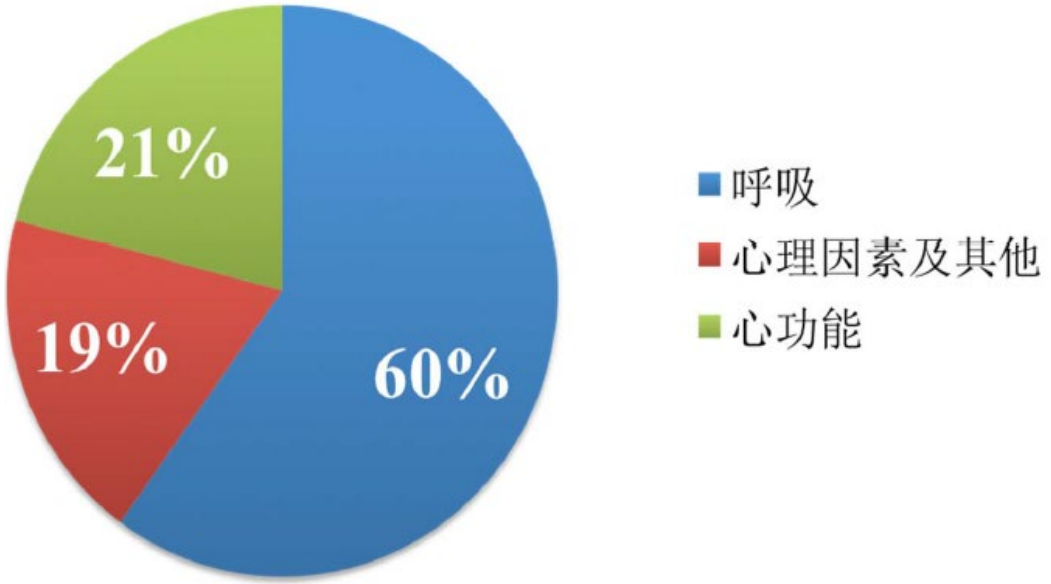
Airway / lung
Resistance Complance Gas exchange

Brain
Delirium Other cognitive dysfunction

Cardiac

Diaphragm

Endocrine
Endocrine Metabolic



FAILURE TO WEAN OFF VENTILATOR: CAUSES - 1

Respiratory:

- Use wider bore artificial airway –
  ET tube / tracheostomy
- Treat bronchospasm adequately
- Improve lung compliance by removing excess fluid ("wet lungs") by using diuretics if volume overloaded / congestive cardiac failure is the cause.
- Improve diaphragmatic function by using xanthines.

Cardiovascular:

left ventricular dysfunction

- pulmonary oedema (backward failure)
- inability of the cardiovascular system to provide the increase in delivery of oxygen needed by the respiratory muscles during weaning (forward failure)

Appropriate therapy (diuretics / vasodilators / inotropes)

Wean the inotropes only after successful weaning from mechanical ventilatory support.

Haemoglobin must also be optimized

> 8g%

> 10g% with myocardial ischemia / cerebral ischemia

FAILURE TO WEAN OFF VENTILATOR: CAUSES - 2

Neurological:

-brain stem dysfunction due to trauma, hypoxia or infection, critical illness polyneuropathy

-intermediate syndrome due to organophosphorus insecticides

Fluid Balance:

Positive cumulative fluid balance is associated with failure to wean and a negative fluid balance was predictive of a successful weaning in a recent study.

Infection:

體溫每升高1℃會增加 CO_2 production 和 O_2 consumption 約 5 % ，使 ventilatory requirement 增加。

any sepsis and/or respiratory infection should have resolved

FAILURE TO WEAN OFF VENTILATOR: CAUSES - 3

Drugs

- stop sedatives and drugs likely to impair neuromuscular function.
- give antidotes (flumazenil, nalorphine, neostigmine) as indicated

Electrolytes - maintain normal serum potassium 、phosphorous 、calcium、and magnesium

Alkalosis

- respiratory – don't chase the $PaCO_2$
- metabolic – reduce base excess (?acetazolamide)

PaO_2

Endocrine – hypothyroidism**, Adrenal insufficiency**

Psychological Factor

- 使用呼吸器是可怕的經驗，但若能改善呼吸困難則會受病人歡迎，因此少數病人會對呼吸器產生心理上的依賴。
- 患者主要焦慮來源：
  - 害怕呼吸器故障
  - 工作人員疏忽
  - 不能與人口頭溝通

Post Extubation Stridor

- **The Cuff leak test:**

  The ventilator is used in Assist Control mode with a tidal volume of 10-12ml/kg.

  The expired tidal volume is measured with the cuff inflated. The cuff is then deflated and after elimination of artefacts due to cough, four to six consecutive breaths are used to compute the average value for the expiratory tidal volume. The difference in the tidal volumes with the cuff inflated and deflated is the leak. A value of 130ml (12% of inspiratory tidal volume) gave a sensitivity of 85% and a specificity of 95% to identify patients with an increased risk of post extubation stridor.

- **Cough / Leak test:** In spontaneously breathing patients

the tracheal cuff is deflated and monitored for the first 30 seconds for cough. Only cough associated with respiratory gurgling (heard without a stethoscope and related to secretions) is taken into account.

The tube is then obstructed with a finger while the patient continues to breath. The ability to breathe around the tube is assessed by the auscultation of a respiratory flow.

The approach to discontinuing invasive mechanical ventilation--from "predicting" to "checking."

in fact, breathe fine without assistance if simply taken off ventilatory support. This led to the recommendation that, rather than attempting to predict when patients were ready for weaning, clinicians should simply "check," both early and repeatedly, to determine whether they were, in fact, ready.

肺復原訓練

依意識、肌力及呼吸器脫離狀態執行個別化肺復原訓練

RESEARCH Critical Care Open Access

Effect of abdominal weight training with and without cough machine assistance on lung function in the patients with prolonged mechanical ventilation: a randomized trial

Tsai-Yi Hung[1†], Wen-Lan Wu[2], Ho-Chang Kuo[1,3,4], Shih-Feng Liu[1,4,5*†], Chia-Ling Chang[1], Hui-Chuan Chang[1], Yuh-Chyn Tsai[1] and Jui-Fang Liu[6,7]

Abstract

Purpose: The patients with prolonged mechanical ventilation (PMV) have the risk of ineffective coughing and infection due to diaphragm weakness. This study aimed to explore the effect of abdominal weight training (AWT) intervention with/without cough machine (CM) assistance on lung function, respiratory muscle strength and cough ability in these patients.

Methods: Forty patients with PMV were randomly assigned to three groups: AWT group ($n=12$), AWT + CM group ($n=14$) and control group ($n=14$). Change of maximum inspiratory pressure (MIP), Maximum expiratory pressure (MEP) and peak cough flow (PCF) between 1 day before and 2 weeks after the intervention were compared among these three groups.

Results: MIP before and after intervention in AWT group (30.50 ± 11.73 vs. 36.00 ± 10.79; $p<0.05$) and AWT + CM group (29.8 ± 12.14 vs. 36.14 ± 10.42; $p<0.05$) compared with control group (28.43 ± 9.74 vs 26.71 ± 10.77; $p>0.05$) was significantly improved. MEP before and after intervention in AWT group (30.58 ± 15.19 vs. 41.50 ± 18.33; $p<0.05$) and AWT + CM group (27.29 ± 12.76 vs 42.43 ± 16.96; $p<0.05$) compared with control group (28.86 ± 10.25 vs. 29.57 ± 14.21; $p>0.05$) was significantly improved. PCF before and after intervention in AWT group in AWT group (105.83 ± 16.21 vs. 114.17 ± 15.20; $p<0.05$) and AWT + CM group (108.57 ± 18.85 vs. 131.79 ± 38.96; $p<0.05$) compared to control group (108.57 ± 19.96 vs. 109.86 ± 17.44; $p>0.05$) showed significant improvements. AWT + CM group had significantly greater improvements than control group in MIP and peak cough flow than control group (13.71 ± 11.28 vs 19.64 ± 29.90, $p<0.05$).

Conclusion: AWT can significantly improve lung function, respiratory muscle strength, and cough ability in the PMV patients. AWT + CM can further improve their expiratory muscle strength and cough ability.

Table 2 Comparison of lung function and respiratory muscle strength and coughing ability of various groups

Variable	Group	Pre Mean ± SD	Post Mean ± SD	*p* value
RR (bpm)	A	24.25 ± 5.63	25.17 ± 4.06	0.503
	B	25.79 ± 5.37	23.00 ± 4.57	0.131
	C	26.14 ± 7.21	25.00 ± 6.84	0.550
RSBI	A	82.50 ± 39.87	70.25 ± 27.10	**0.034***
	B	90.14 ± 36.20	70.29 ± 26.46	0.055
	C	97.79 ± 44.88	89.36 ± 38.60	0.730
TV (ml)	A	343.50 ± 132.90	404.58 ± 138.35	**0.012***
	B	315.21 ± 99.81	359.79 ± 104.27	0.167
	C	278.07 ± 73.09	302.07 ± 73.14	0.258
VC (ml/kg)	A	9.95 ± 4.18	10.80 ± 3.36	0.433
	B	10.88 ± 7.19	13.86 ± 7.63	**0.023***
	C	9.42 ± 6.34	9.38 ± 5.40	0.646
MIP (cmH_2O)	A	30.50 ± 11.73	36.00 ± 10.79	**0.011***
	B	29.86 ± 12.14	36.14 ± 10.42	**0.011***
	C	28.43 ± 9.74	26.71 ± 10.77	0.666
MEP (cmH_2O)	A	30.58 ± 15.19	41.50 ± 18.33	**0.033***
	B	27.29 ± 12.76	42.43 ± 16.96	**< 0.001***
	C	28.86 ± 10.25	29.57 ± 14.21	0.900
PEFR(L/min)	A	61.67 ± 15.72	62.92 ± 16.85	0.276
	B	57.86 ± 10.51	72.14 ± 35.72	0.080
	C	58.57 ± 16.10	61.07 ± 19.82	0.680
PCF (L/min)	A	105.83 ± 16.21	114.17 ± 15.20	**0.011***
	B	108.57 ± 18.85	131.79 ± 38.96	**< 0.001***
	C	108.57 ± 19.96	109.86 ± 17.44	0.753

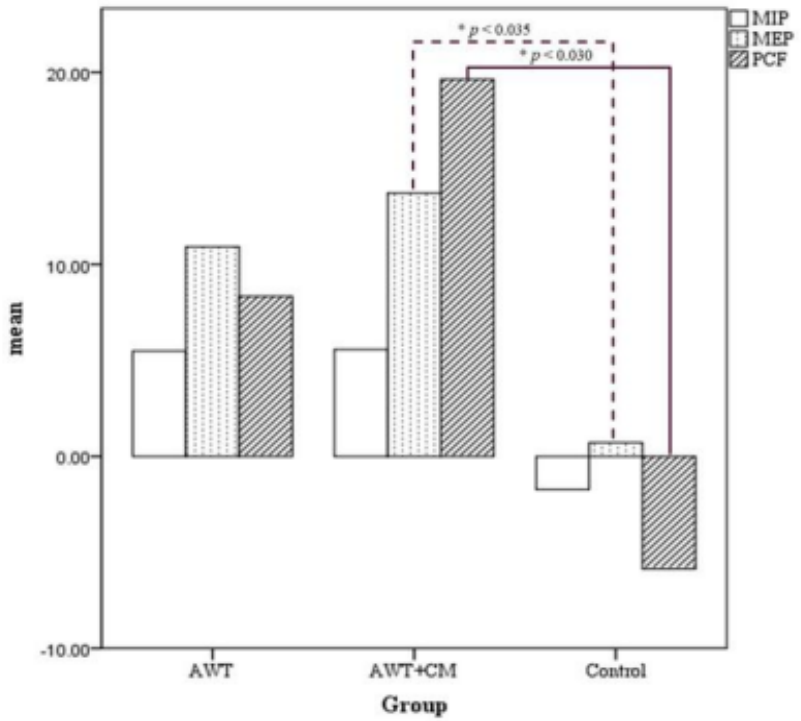


Figure 2. Maximal inspiratory, expiratory pressure and peak cough flow before and after intervention tween the exercise training and control groups

JAMA Intern Med. 2015;175(3):363-371.
doi:10.1001/jamainternmed.2014.7386
Published online January 12, 2015.

Original Investigation

Withholding and Withdrawal of Life-Sustaining Treatments in Intensive Care Units in Asia

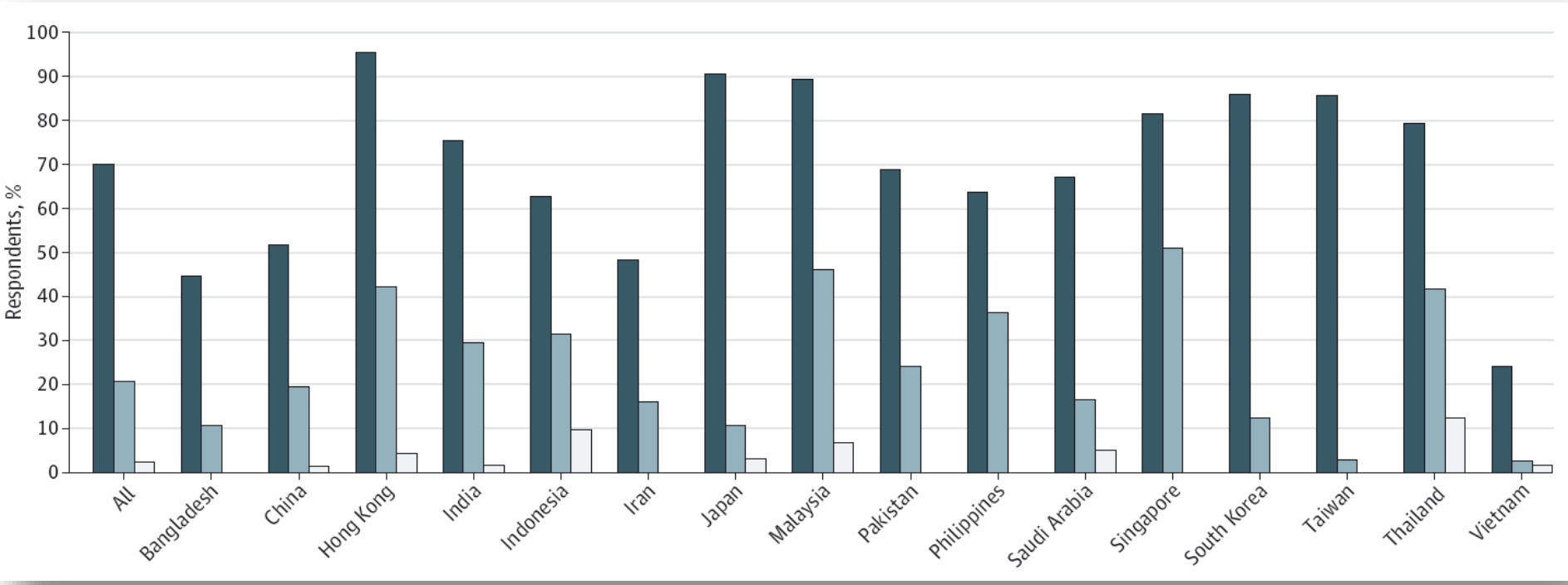
Jason Phua, FRCP; Gavin M. Joynt, FRCP; Masaji Nishimura, MD; Yiyun Deng, MD; Sheila Nainan Myatra, MD; Yiong Huak Chan, PhD; Nguyen Gia Binh, MD; Cheng Cheng Tan, MBBS; Mohammad Omar Faruq, MD; Yaseen M. Arabi, MD; Bambang Wahjuprajitno, MD; Shih-Feng Liu, MD; Seyed Mohammad Reza Hashemian, MD; Waqar Kashif, MD; Dusit Staworn, MD; Jose Emmanuel Palo, MD; Younsuck Koh, MD; for the ACME Study Investigators and the Asian Critical Care Clinical Trials Group

目的：描述現況醫師在生命末期照護上，對生命維持治療的 withholding (不給) 和withdrawal (撤除) 態度傾向，和評價相關的因素與觀察到的態度。

The Asian Collaboration for Medical Ethic (ACME)'s Study.

JAMA Intern Med. 2015;175(3):363-371

總是或經常 withheld (深藍), withdrew (淺藍), 積極用 藥縮短死亡過程(白色)



Proportion of Respondents Who Almost Always or Often Withheld and Withdrew Life-Sustaining Treatments, and Actively Shortened the Dying Process for Patients With No Chance of Recovering a Meaningful Life
Respondents were asked, “For patients with no real chance of recovering a meaningful life, how often have you (A) withheld further active therapy, but continued current therapy (such as not starting vasopressors and hemodialysis); (B) withdrawn active therapy (such as stopping vasopressors and hemodialysis); (C) deliberately given large doses of drugs intentionally (eg, barbiturates or morphine) until death ensues?” Bars refer to percentages of respondents who chose almost always or often withheld (dark blue), withdrew (light blue), and actively shortened the dying process with drugs (white).

Table 2. Treatments That Can Usually Be Withheld or Withdrawn

Treatment	Respondents, Overall % (Range Between Countries)[a]	
	Withheld	Withdrawn
Hemodialysis	71.3 (20.0-100)	72.9 (6.5-100)
Cardiopulmonary resuscitation	69.7 (11.6-100)	73.1 (3.2-100)
Tracheotomy	64.5 (14.3-93.9)	57.1 (3.2-86.4)
Vasopressors or inotropes	64.6 (25.0-95.9)	63.6 (26.8-91.3)
Broad-spectrum antibiotics	59.4 (19.4-90.9)	60.8 (6.5-95.5)
Mechanical ventilation	57.4 (9.4-95.9)	46.7 (0-86.4)
Total parenteral nutrition	55.6 (33.9-87.5)	54.6 (33.9-100)
Endotracheal intubation	51.6 (6.5-95.9)	41.5 (0-81.8)
Diuretics	46.6 (19.4-90.9)	50.6 (25.2-86.4)
Enteral feeding	35.6 (0-88.6)	31.5 (0-62.1)
Intravenous fluid therapy	33.9 (3.2-71.4)	27.9 (3.2-42.0)
Oral suctioning	24.4 (3.6-80.0)	19.2 (2.7-45.6)

a Respondents who strongly agreed or agreed that specific treatments can usually be withheld or withdrawn as part of limitation of life-sustaining therapy in end-of-life care. Range is from the country or region with the lowest percentage to the country or region with the highest percentage.

Table 5 Independent predictors of withholding and withdrawing of life-sustaining treatments in case scenario

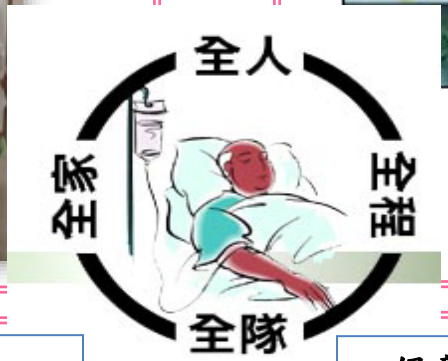
Variables[a]	AOR, 95% CI	P Value
Countries' and regions' characteristics		
Low-middle income country	5.05, 2.69-9.51	<0.001
Hospitals' characteristics		
<250 compared to ≥750 beds	3.07, 1.22-7.75	0.02
Respondents' characteristics		
Islam versus no religion	0.24, 0.13-0.46	<0.001
Hinduism versus no religion	0.09, 0.04-0.21	<0.001
Protestantism versus no religion	0.29, 0.10-0.81	0.02
Shintoism versus no religion	0, 0-0	<0.001

Abbreviations: AOR, adjusted odds ratio; CI, confidence intervals.
[a] Only variables with a P value of <0.05 using a generalised linear mixed model are shown.

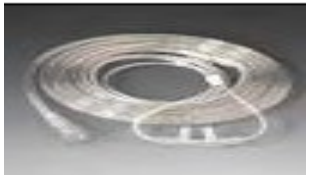
I am not sure but as shown in Table 5 below, respondents who believed Islam, Hinduism, Protestantism, and Shintoism were LESS likely to withhold/withdraw treatments in this case. I cannot see how this should affect the responses in Korea, Japan, and Taiwan?

共享決策(Shared Decision Making, SDM)
COPD安寧緩和

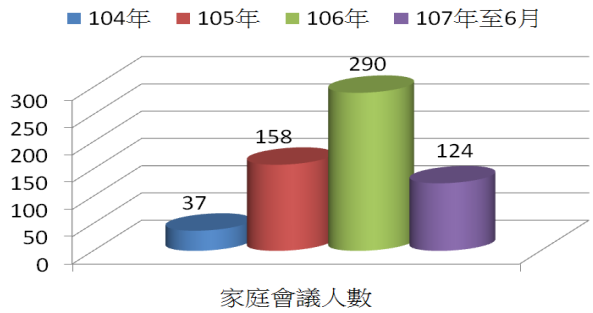
家庭緩和及安寧會議



氧氣治療



胸腔科104-107年家庭會議人數



侵襲性呼吸器

非侵襲性呼吸器

亞急性呼吸照護病房(RCC)之醫療品質適當(SDM)

本院病人轉入RCC無氣切者，於第二週召開氣切執行討論會，每月一次與所有家屬舉辦氣切說明會

氣切衛教包

氣切衛教手冊

氣切討論會

氣切衛教專欄

醫療決策共享

<醫病溝通及醫療決策共享>

1. 對象： 病患之太太、兒子
2. 參加之醫護人員：主治醫師, 住院醫師, 護理師, 呼吸治療師
3. 討論事項：

#目前疾病狀況：

(1). 氣管內管放置且呼吸器使用超過一個月，目前使用T型管訓練，但病人因腦幹中風無自主意識且自咳功能不佳

#建議：

(1). 氣管切開術(氣切)：在頸部氣管處切開一小洞插入氣切管, 以幫助病人呼吸

(一)益處：1. 減少呼吸功並改善患者的舒適度, 提早脫離呼吸器
2. 置換氣切管較容易 3. 意識清楚病患可以說話和吞嚥
4. 較容易抽痰 5. 可在加護病房外照顧
6. 口腔容易維持清潔, 降低吸入性肺炎可能性

(二)缺點：1. 手術風險：氣管造廔和大量出血發生不到1%。其他併發症，包括皮下肺氣腫，氣胸，氣管狹窄和氣管環破裂。 2. 傷口照護感染

(2). 繼續放置氣管內管, 繼續呼吸器訓練, 轉至普通病房照護

(一)益處：1. 不需承受手術風險 2. 無造口併發症

(二)缺點：1. 病人比較不舒服 2. 置換困難 3. 較容易引起相關肺炎

(3)脫離呼吸器並移除氣管內管#若拔管失敗，可供選擇之醫療項目：

a. 視狀況選擇非侵襲性呼吸器治療或重插氣管內使用 b. 考慮氣切手術

c. 選擇安寧緩和治療 ，不再重新插管

#家屬提問：1. 無

4. 家屬決議：1. 家屬決定要讓病人做氣切 2. 若病況惡化，家屬決定不要再電擊、心外按摩，已簽署不施行心肺復甦術同意書(DNR)

Home message

- Assessment for Readiness to Wean
- The Spontaneous Breathing Trial
- Evaluation of the Patient Who Fails a Spontaneous Breathing Trial
- Weaning Technique
- Extubation
- NIV and HFNC in weaning
- Pulmonary rehabilitation
- Sharing decision making
- Withdraw and withhold
- Tracheostomy

可以下課了~~~~ 感謝聆聽!