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«WEANING» PROTOKOLLERİ
HANGİ STRATEJİ, NASIL YAPILMALI?

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Gazi Üniversitesi Tıp Fakültesi
Göğüs Hastalıkları Anabilim Dalı Yoğun Bakım Bilim Dalı
10.03.2025

«WEANING»

- İnvaziv mekanik ventilatörden ayırma ?
  - %80 hasta kolayca ayrılıyor

- Altta yatan hastalığı düzelmekte olan hastada ventilatör desteğinin kademeli olarak azaltılması ✔

İnvaziv Mekanik Ventilasyondan Ayırma

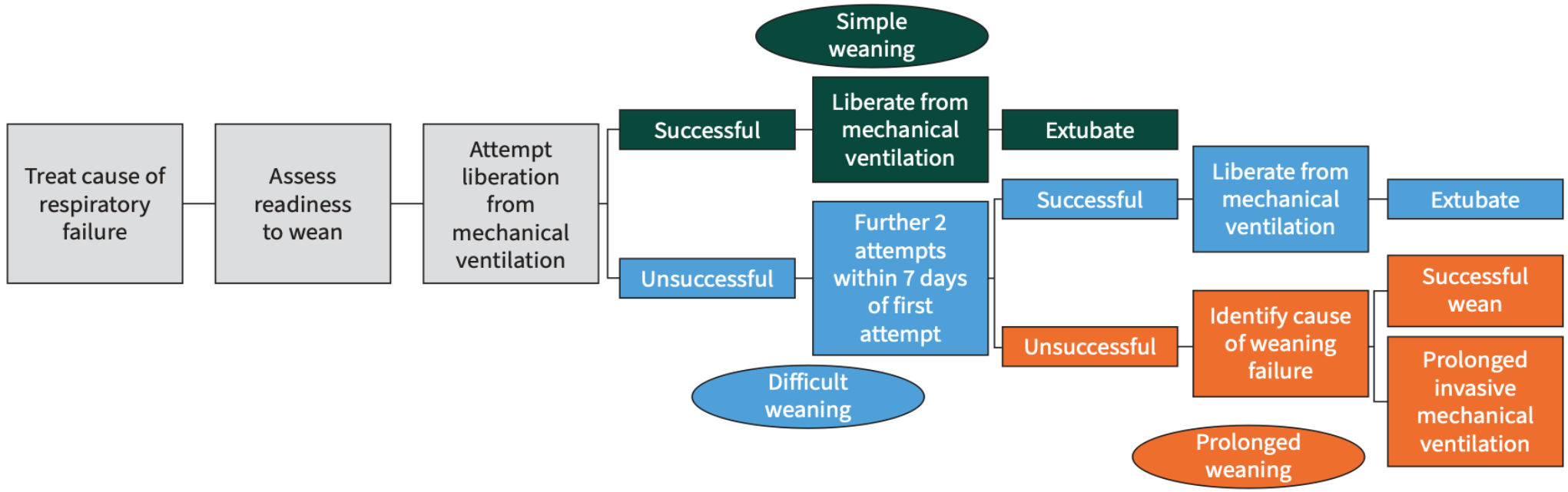


FIGURE 1 The process of weaning from invasive mechanical ventilation.

Cite this article as: Shah NM, Hart N, Kaltsakas G. Prolonged weaning from mechanical ventilation: who, what, when and how? *Breathe* 2024; 20: 240122 [DOI: 10.1183/20734735.0122-2024].

Ne Zaman Weaning?

- **'Günlük Tarama Testi' kriterleri:**

1. Hastanın spontan inspiryum çabası olmalı
2. Ajitasyonu olmamalı
3. İntrakranial basınç artışı bulgusu olmamalı
4. PaO2/FiO2 > 150-200; FiO2 <%50 ve PEEP ≤ 5-8 cmH2O, pH > 7.25 olmalı
5. Aktif miyokard iskemisi olmamalı
6. Vazopressör, inotrop kullanımı minimal olmalı (Dopamin, dobutamin ≤ 5 µg/kg/dk olmalı; NEpi ≤ 2 µg/dk, vazopressin veya milrinon olmamalı)

Ely EW, Baker AM, Evans GW, Haponik EF. Intensive Care Med 1999; 25: 581–58

Ventilator Parameters Studied in Weaning.

Parameters	Threshold Values	Range of Positive Likelihood Ratios
Ventilator Measurements		
V_E	10–15 L/min	0.81–2.37
Negative inspiratory force	–20 to –30 cm H_2O	0.23–2.45
P_{Imax}	–15 to –30 cm H_2O	0.98–3.01
$P_{0.1}/ P_{Imax}$	0.30	2.14–25.3
CROP index	13	1.05–19.74
Parameters Measured during SBT		
f/V_T	60–105 breaths/min/L	0.84–4.67

J Intensive Care Med . 2022 November ; 37(11): 1417–1425. doi:10.1177/08850666221095436.

Rapid Shallow Breathing Index

- f/VT (spontan solunum sayısı/ortalama spontan Vt)
- f/VT > 100-105 soluk sayısı/dak/L weaning başarısızlığı ile korele
  - Spontan solunumda veya 5 cmH_20 PEEP altında ölçülmesi önerilir
  - ATC açılarak PS:0, PEEP:0 altında iken de ölçülebilir
  - 7 cm endotrakeal tüpü olanlarda 8cmH_20 PS altında
  - 8 cm endotrakeal tüpü olanlarda 10cmH_20 PS altında

Yang KL, Tobin MJ. N Engl J Med. 1991; 324:1445-50

CROP İndeksi

- Compliance-Rate-Oxygenation-Pressure Index
  - « (Cd x MIPx $PaO_2/PA0_2$)/f »
  - Cd:dinamik komplians
  - MIP: maksimum inspiratuar basınç
  - f: spontan solunum sayısı/dak

- CROP indeksi > 13 başarılı weaning göstergesi

SORULAR???

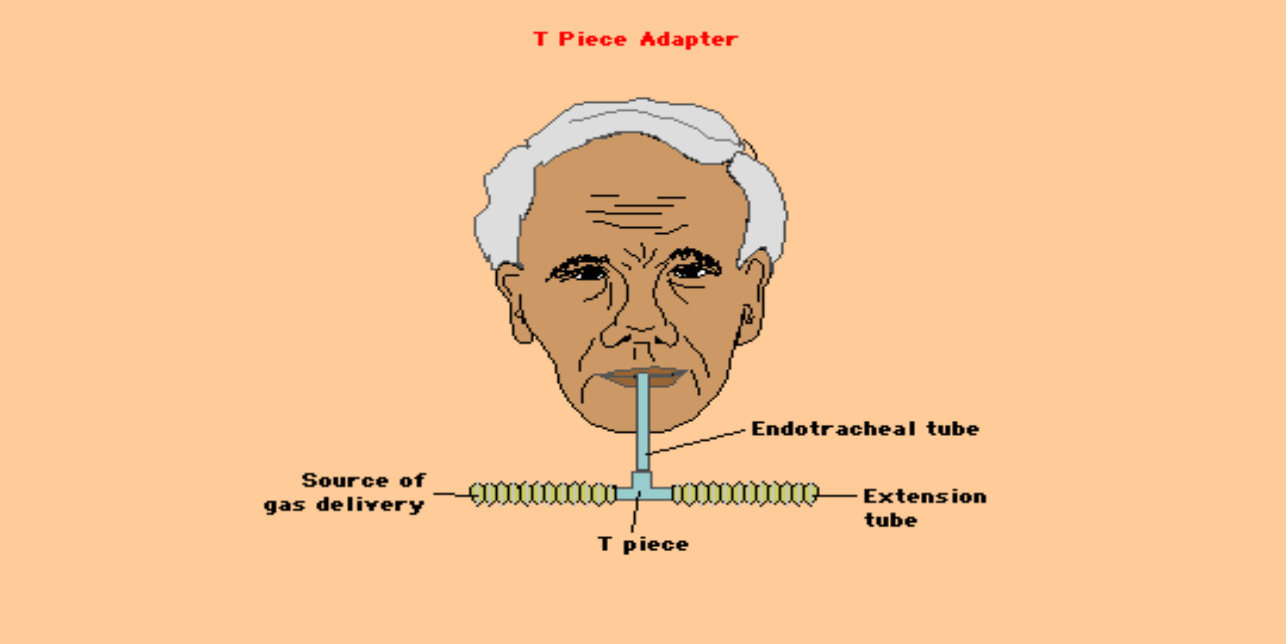
- Hangi mod, yöntem ile weaning yapalım?
- Yoğun bakım günlük işleyişinde weaning akla geliyor mu?
- Yoğun bakımların weaning protokolü olmalı mı?
- Otomatize weaning süreci kısaltır mı?

Weaning Sırasında Kullanılan Ventilatör Modları

1. **SBT (Spontaneous Breathing Trials)-** Spontan solunum denemeleri
   - T- tüp solunumu
   - Düşük destekle CPAP
   - Düşük destekle PSV
2. **PSV (Pressure Support Ventilation)**
3. **SIMV (Synchronized Intermittent Mandatory Ventilation)**
4. **Otomatik weaning; otomatik tüp kompanzasyon, PAV, servo kontrollü ventilasyon (ASV/Smartcare)**

SBT

- Klasik yaklaşım; hasta ventilatörden ayrılır ve T-tüp yardımıyla nemlendirilmiş oksijen solutulur.



SBT:

- SBT hasta ventilatörden ayrılmadan da yapılabilir.
- **Yöntemleri;**
  - Pozitif basınç ayarlanmadan, akım-tetikleme ayarlanarak yapılabilir
  - Düşük düzeyde CPAP ile uygulanabilir (5 cmH_2O)
  - Düşük düzeyde PSV ile uygulanabilir (5-8 cmH_2O)

PSV ile Weaning;

- Basınç desteği hasta tarafından tolere edilebilen düzeye kadar kademeli olarak 2-4 cmH_20 azaltılır.
- Genellikle ekstübasyon öncesi PS ≤ 8 cmH_20'nun tolere edilmesi gerekir

SIMV ile Weaning:

- Kısa dönem MV uygulamalarının sonlandırılmasında yararlı (post op, ilaç aşırı dozu)
- Yapılan iki çalışmada 14-21 günden daha uzun süreli MV'den weaningde;
  - SIMV'nin PSV ve T-tüple karşılaştırıldığında weaning süresi ve başarısı açısından daha kötü performans gösterdiği bulunmuştur

Brochard L. ve ark., Am J Respir Crit Care Med 1994; 150: 896-903

Esteban A ve ark, N Engl J Med 1995; 332:345-350

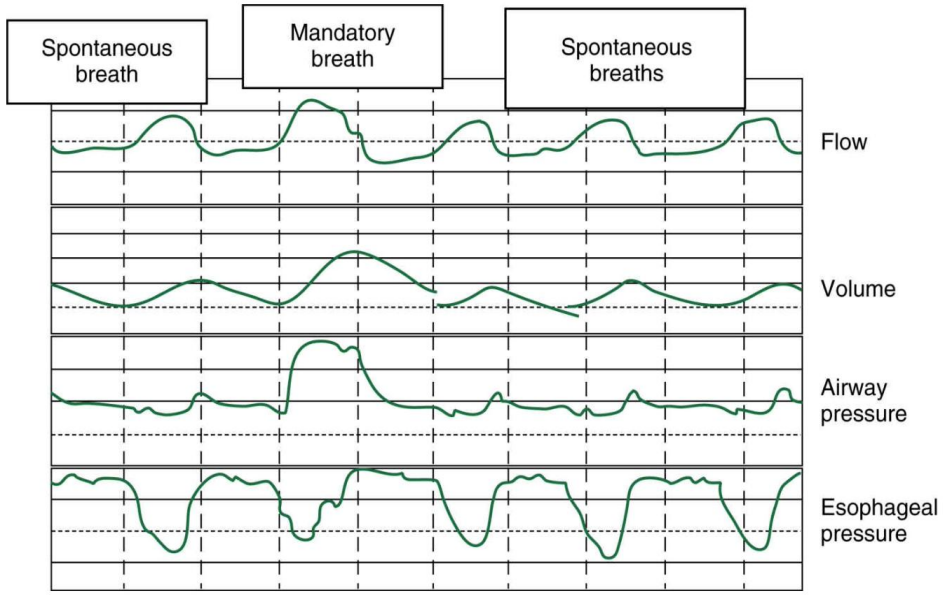
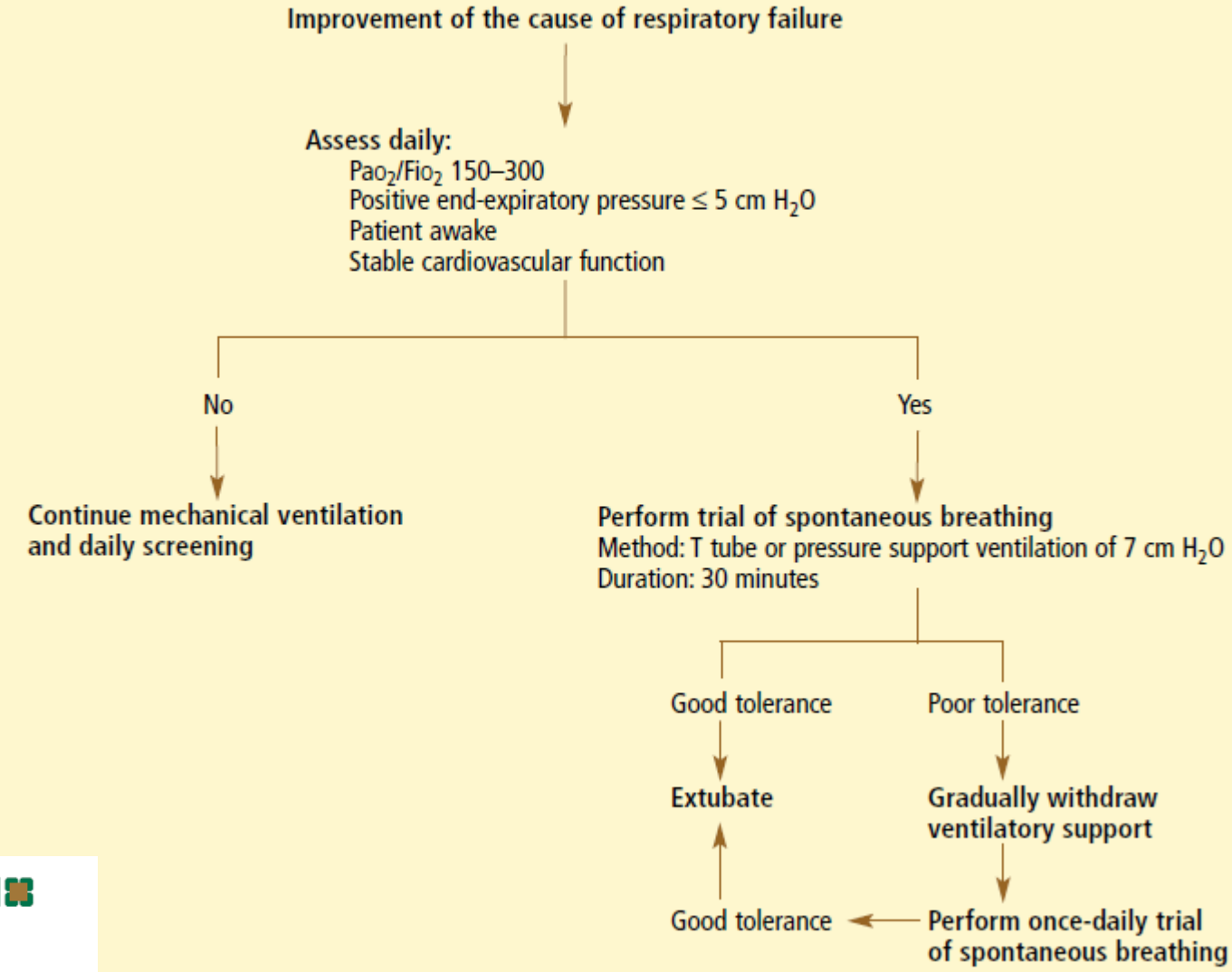


FIG. 20.3 Measurements of flow, volume, airway pressure, and esophageal pressure in a patient ventilated with synchronized intermittent mandatory ventilation (IMV). The esophageal pressure swings reflect the changes in pleural pressure and are the result of respiratory muscle contraction. These pressure swings are nearly as large during a mandatory breath as during spontaneous breaths. From Hess DR. Mechanical ventilation strategies: what's new and what's worth keeping? *Respir Care*. 2002;47:1007-1017.

PROTOKOLLÜ WEANİNG GEREKLİ Mİ?

Is the patient ready to be weaned from the ventilator? An algorithm



REVIEW

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When to wean from a ventilator: An evidence-based strategy

CLEVELAND CLINIC JOURNAL OF MEDICINE VOLUME 70 • NUMBER 5 MAY 2003

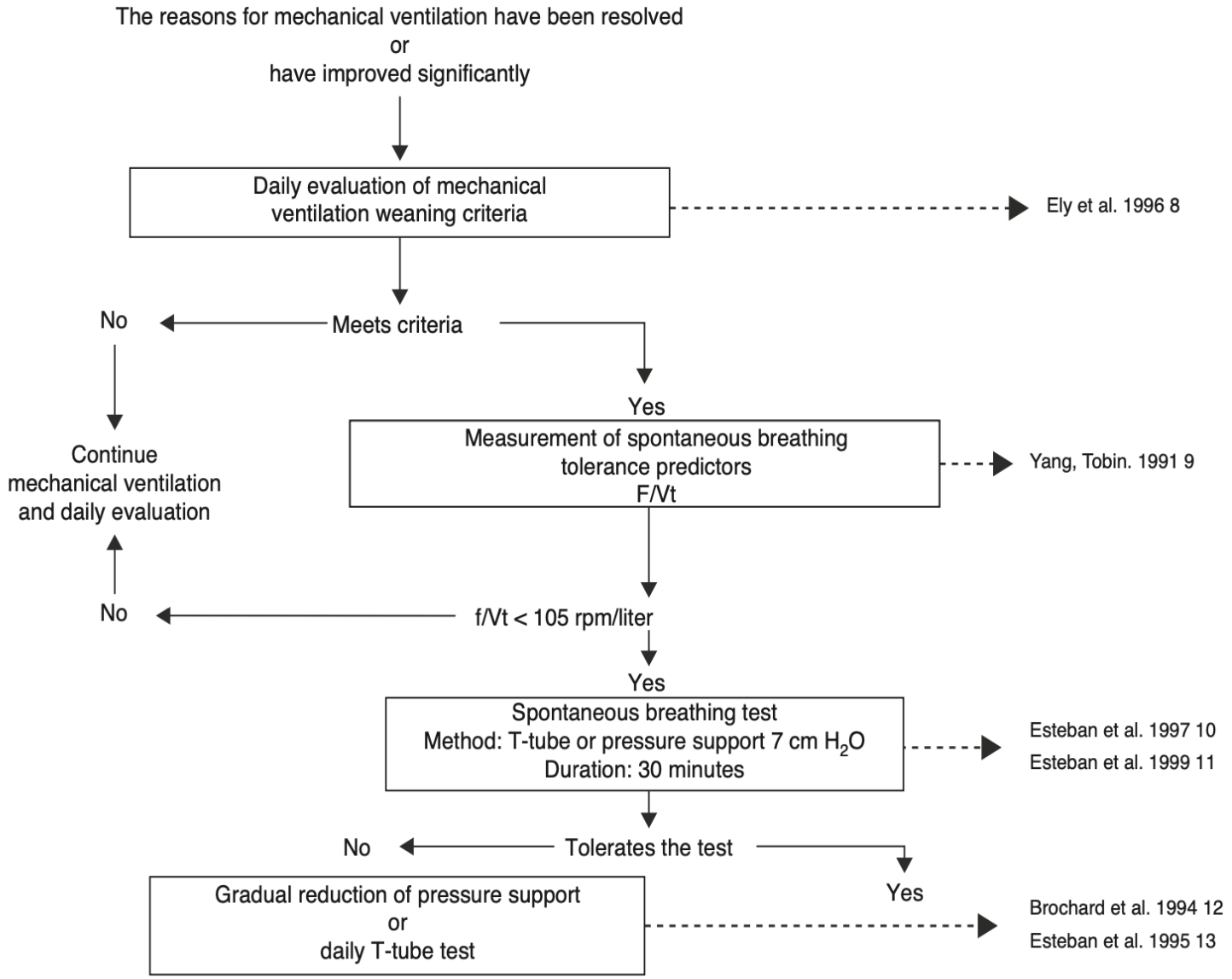


Figure 1 Mechanical ventilation weaning algorithm.[8–11]

Med Intensiva. 2013;**37(9)**:605-617

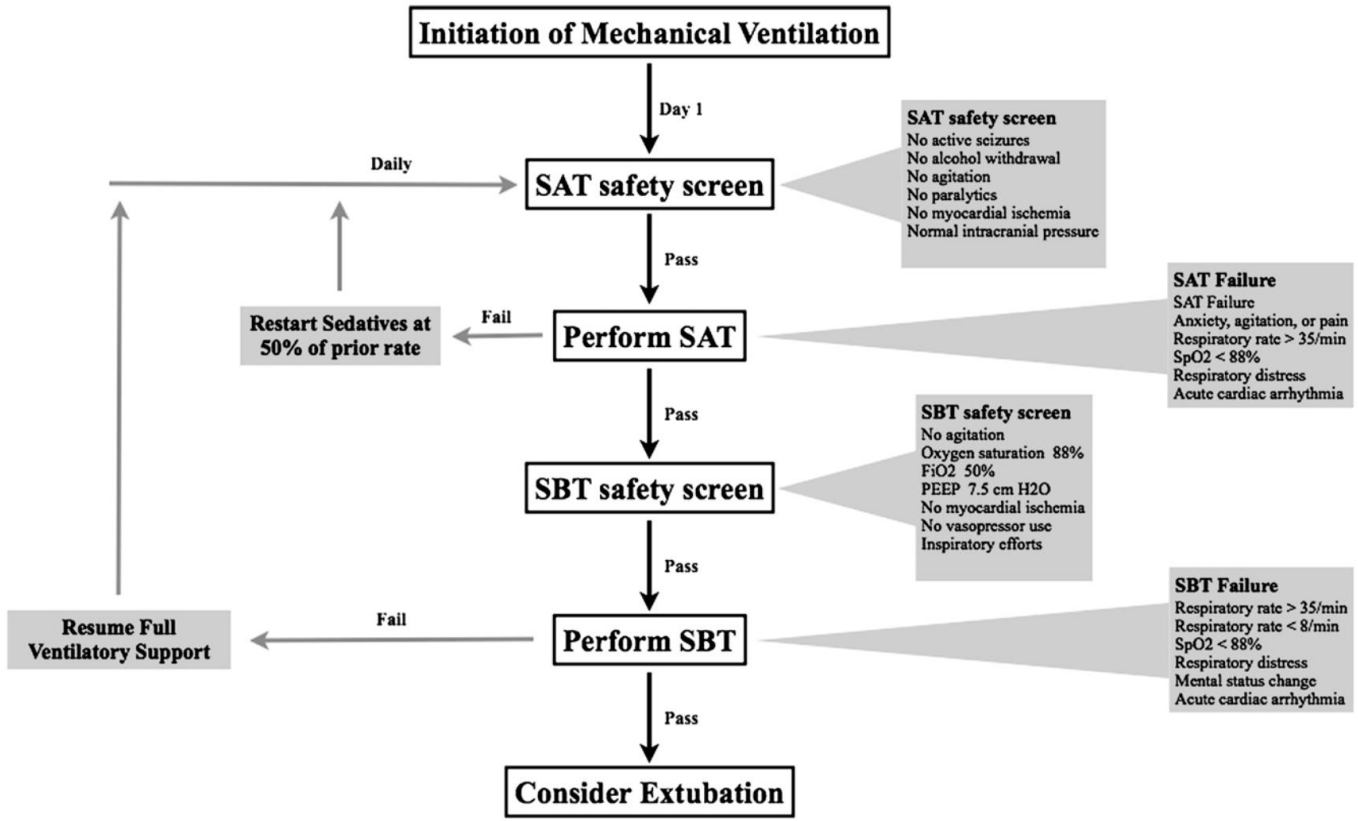


Fig. 2. Overview of a wake-up and breathe protocol. Includes criteria for passing the safety screens that were implemented before spontaneous awakening trials and spontaneous breathing trials. Also includes criteria for failing a spontaneous awakening trial or spontaneous breathing trial.

Anesthesiology Clin 29 (2011) 651–661
doi:10.1016/j.anclin.2011.09.005
anesthesiology.theclinics.com
1932-2275/11/$ – see front matter

Box 3. "Wake up and breathe" protocol

Spontaneous awakening trial safety screen

If the patient has no evidence of the following criteria, proceed with SAT. Otherwise, reassess the next day.

- Active seizures or alcohol withdrawal requiring a sedative infusion
- Ongoing agitation requiring escalating sedative doses
- Active treatment with neuromuscular blockers
- Myocardial ischemia in the previous 24 hours
- Increased intracranial pressure

Spontaneous awakening trial

Discontinue sedatives and analgesics used for sedation and monitor for the following failure criteria. If observed, restart sedatives at half the previous dose, titrate to achieve patient comfort, and restart protocol the next day.

- Sustained anxiety, agitation, or pain.
- Respiratory rate greater than 35/min for at least 5 minutes
- SpO_2 less than 88% for at least 5 minutes
- Acute cardiac dysrhythmia
- Two or more signs of respiratory distress, including tachycardia, bradycardia, accessory muscle use, abdominal paradox, diaphoresis, or marked dyspnea

Spontaneous breathing trial safety screen

If the patient passes the SAT and has no evidence of the following criteria, proceed with SBT. Otherwise, reassess the next day.

- SpO_2 less than 88% or FiO_2 greater than 50% or PEEP greater than 8 cm H_2O
- Lack of spontaneous inspiratory efforts
- Agitation
- Myocardial ischemia in the previous 24 hours
- Dopamine or dobutamine greater than or equal to 5 μg/kg per minute, norepinephrine greater than or equal to 2 μg/min, or any vasopressin or milrinone at any dose
- Increased intracranial pressure

Spontaneous breathing trial

Discontinue ventilatory support, placing patient on T-piece or PSV less than 8 cm H_2O, and monitor for the following criteria. If observed, restart full support using previous ventilator settings, titrate as needed, and restart protocol the next day.

- Respiratory rate greater than 35/min or less than 8/min for at least 5 minutes
- SpO_2 less than 88% for at least 5 minutes
- Abrupt changes in mental status
- Acute cardiac dysrhythmia
- Two or more signs of respiratory distress, including tachycardia, bradycardia, accessory muscle use, abdominal paradox, diaphoresis, or marked dyspnea

If the patient does not develop any failure criteria during a 120-min trial, consider extubation.

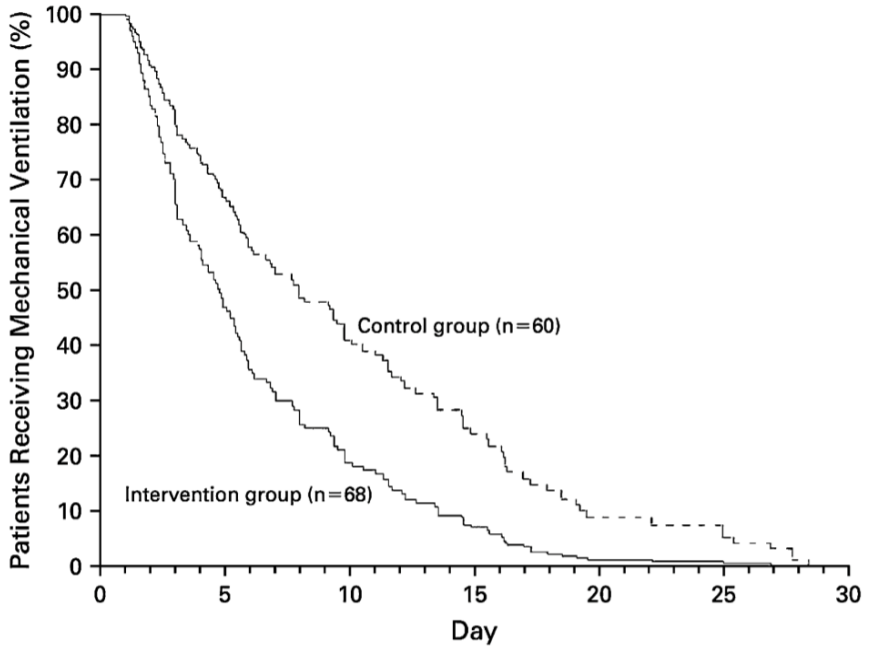


Fig. 1. Effect of daily interruption of sedative infusions on the duration of mechanical ventilation in medical ICU patients receiving sedatives. After adjustment for age, sex, weight, acute physiology and chronic health enquiry II (APACHE II) score, and type of respiratory failure, mechanical ventilation was discontinued earlier in the intervention group than in the control group (relative risk of extubation, 1.9; 95% confidence interval [CI], 1.3–2.7; *P*<.001). (*From* Kress JP, Pohlman AS, O'Connor MF, et al. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. N Engl J Med 2000;342(20):1474; with permission.)

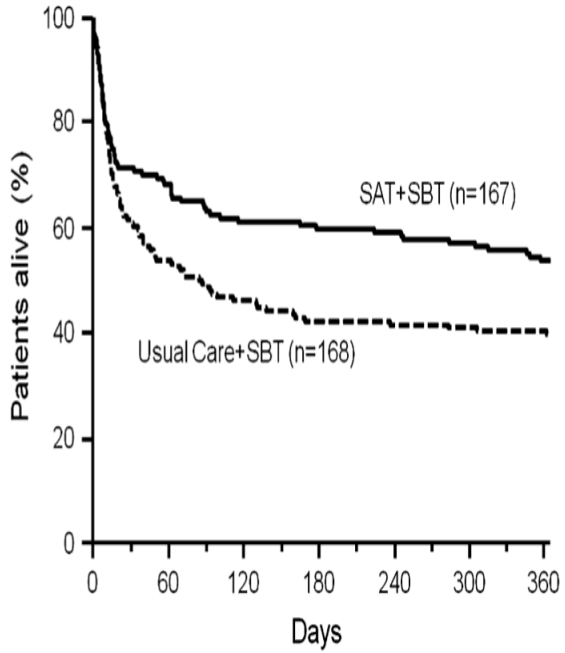


Fig. 3. Effect of paired sedation and ventilator weaning protocol on 1-year survival in medical ICU patients receiving mechanical ventilation. An unadjusted Cox proportional hazard analysis showed that patients in the SAT + SBT group were 32% less likely to die at any instant during the year after enrollment than patients in the usual care + SBT group (hazard ratio for death, 0.68; 95% CI, 0.50–0.92; *P* = .01). (*From* Girard TD, Kress JP, Fuchs BD, et al. Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial):

Anesthesiology Clin 29 (2011) 651–661
doi:10.1016/j.anclin.2011.09.005
1932-2275/11/$ – see front matter

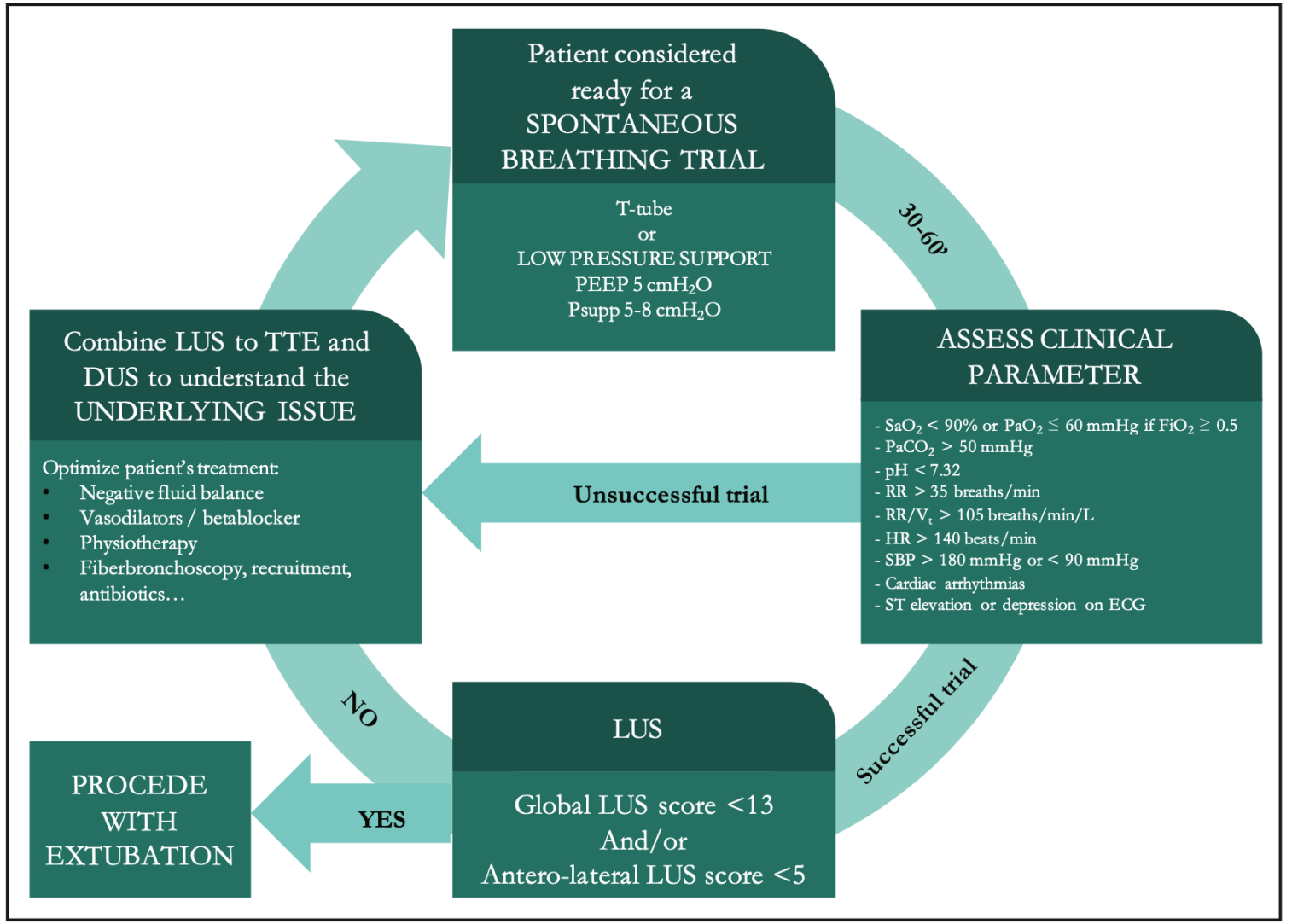


FIGURE 2. Combined clinical and ultrasound algorithm for weaning assessment. PEEP, positive end expiratory pressure; Psupp, pressure support; SaO_2, arterial oxygen saturation; PaO_2, arterial partial pressure of oxygen; $PaCO_2$, arterial partial pressure carbon dioxide; RR, respiratory rate; Vt, tidal volume; HR, heart rate; SBP, systolic blood pressure; LUS, lung ultrasound score; TTE, trans-thoracic echocardiography; DUS, diaphragm ultrasound.

Curr Opin Crit Care 2022, 28:322–330
DOI:10.1097/MCC.0000000000000941

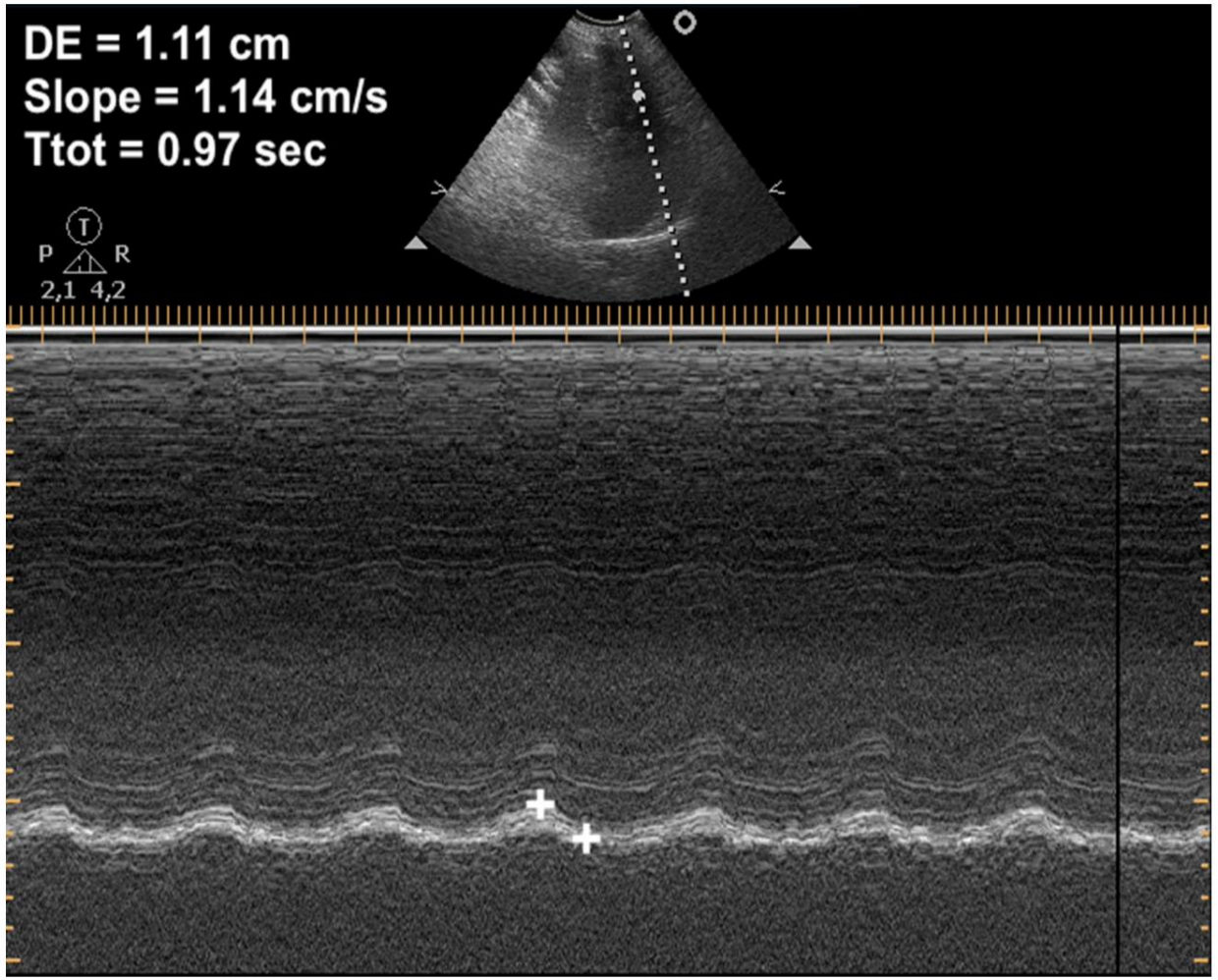


Fig. 4 Diaphragm excursion. *DE* diaphragmatic excursion, *Slope* diaphragmatic contraction speed, *Ttot* inspiration + expiration time

Vetrugno *et al. Ultrasound J (2020) 12:9*
https://doi.org/10.1186/s13089-020-00161-y

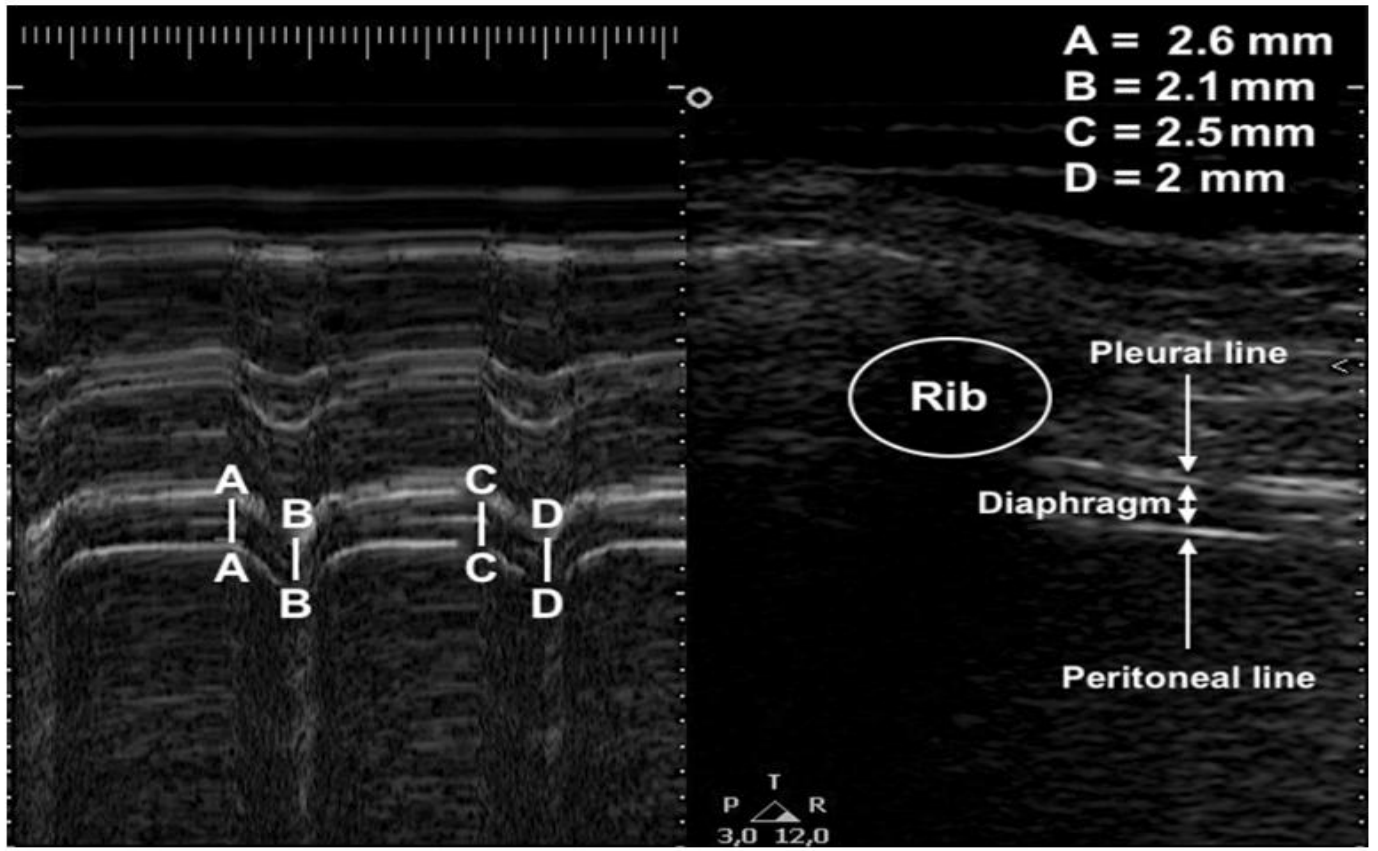


Fig. 5 Diaphragm thickening fraction assessment. **a**, **c** End of inspiration thickness; **b**, **d** End of expiration thickness

Vetrugno *et al. Ultrasound J (2020) 12:9*
https://doi.org/10.1186/s13089-020-00161-y

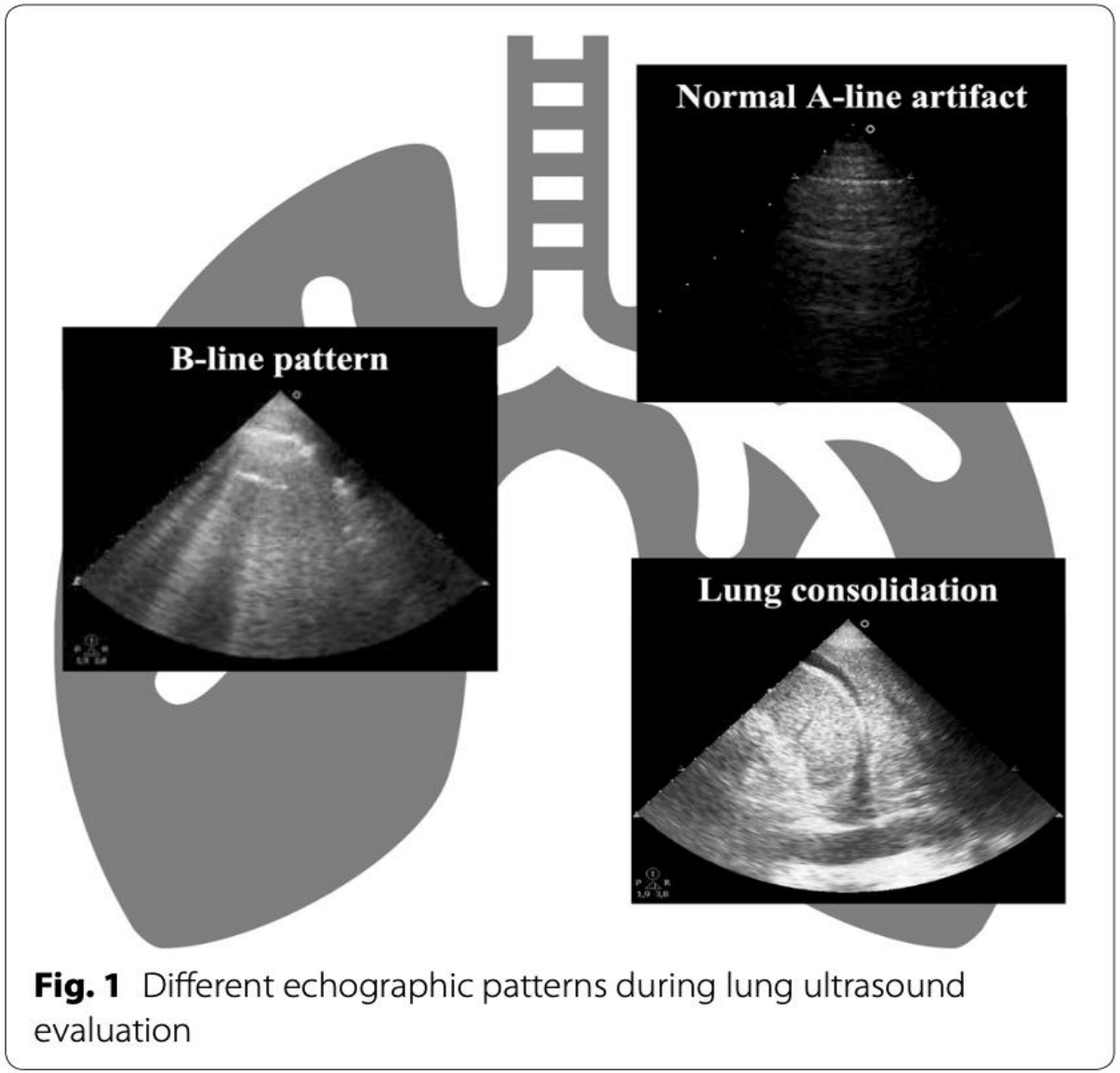


Fig. 1 Different echographic patterns during lung ultrasound evaluation

Vetrugno *et al. Ultrasound J (2020) 12:15*
https://doi.org/10.1186/s13089-020-00160-z

methods and protocols

MDPI

Study Protocol

MUltiparametric Score for Ventilation Discontinuation in Intensive Care Patients: A Protocol for an Observational Study

Iacopo Cappellini [1,*], Andrea Cardoni [2], Lorenzo Campagnola [1] and Guglielmo Consales [1]

Methods Protoc. **2024**, *7*, 45. https://doi.org/10.3390/mps7030045

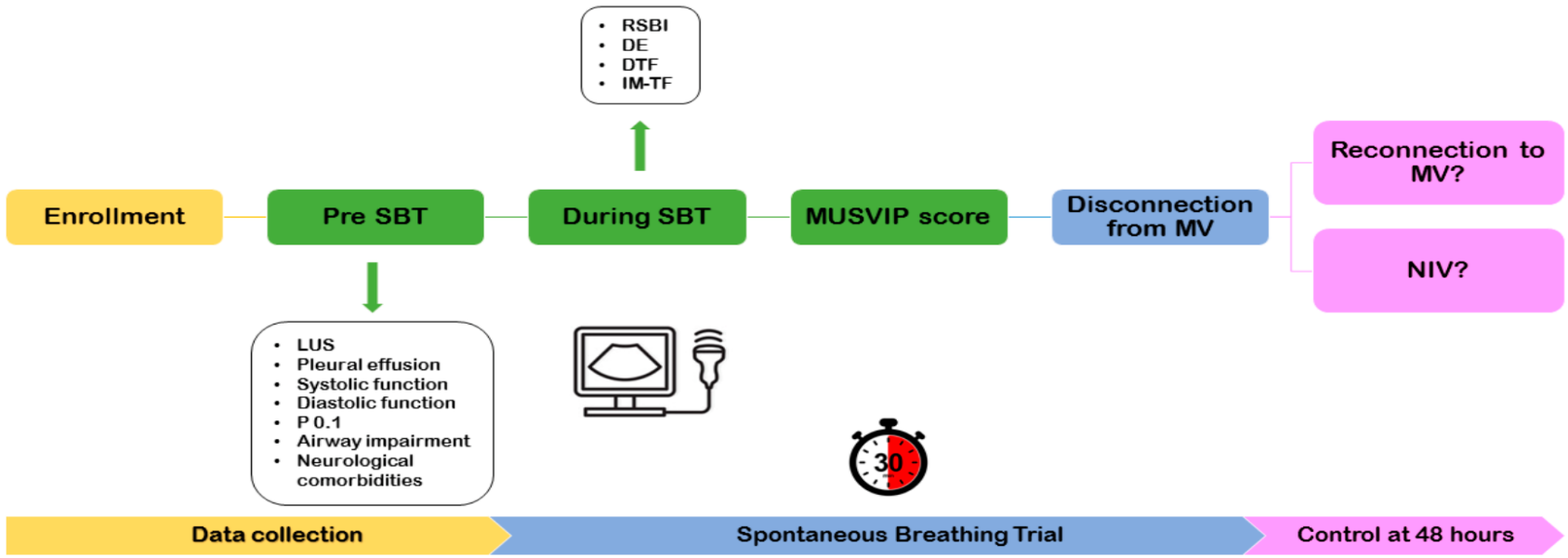


Figure 1. Timeline of the study.

Table 1. Evaluation before SBT.

Variable	Assessment	Partial MUSVIP
LUS	<13 13–17 >17	12 6 0
Pleural effusion	Absent or <2 cm 2–4 cm >4 cm	12 6 0
Systolic function	Normal Abnormal	12 0
Diastolic function	Normal Abnormal	12 0
Neurological comorbidities	Absent Present	12 0
Airway protection impairment	Absent Present	12 0
P 0.1	≥1 but <5 cmH_2O <1 or ≥5 cmH_2O	12 0

Table 2. Evaluation during SBT.

Variable	Assessment	Partial MUSVIP
RSBI	<105 ≥105	12 0
DE	≥11 mm <11 mm	12 0
DTF	≥30% <30%	12 0
IM-TF	<10% ≥10%	12 0

MUSVIP: MUltiparametric Score for Ventilation Discontinuation in Intensive Care Patients

- Hala devam eden bir çalışma,
- İlk değerlendirmede MUSVIP skoru için Area Under the Curve (AUC) of 0.815
- Bu skorun YBÜ yatış süresini ve maliyeti azaltması öngörülüyor

Weaning Protokolleri

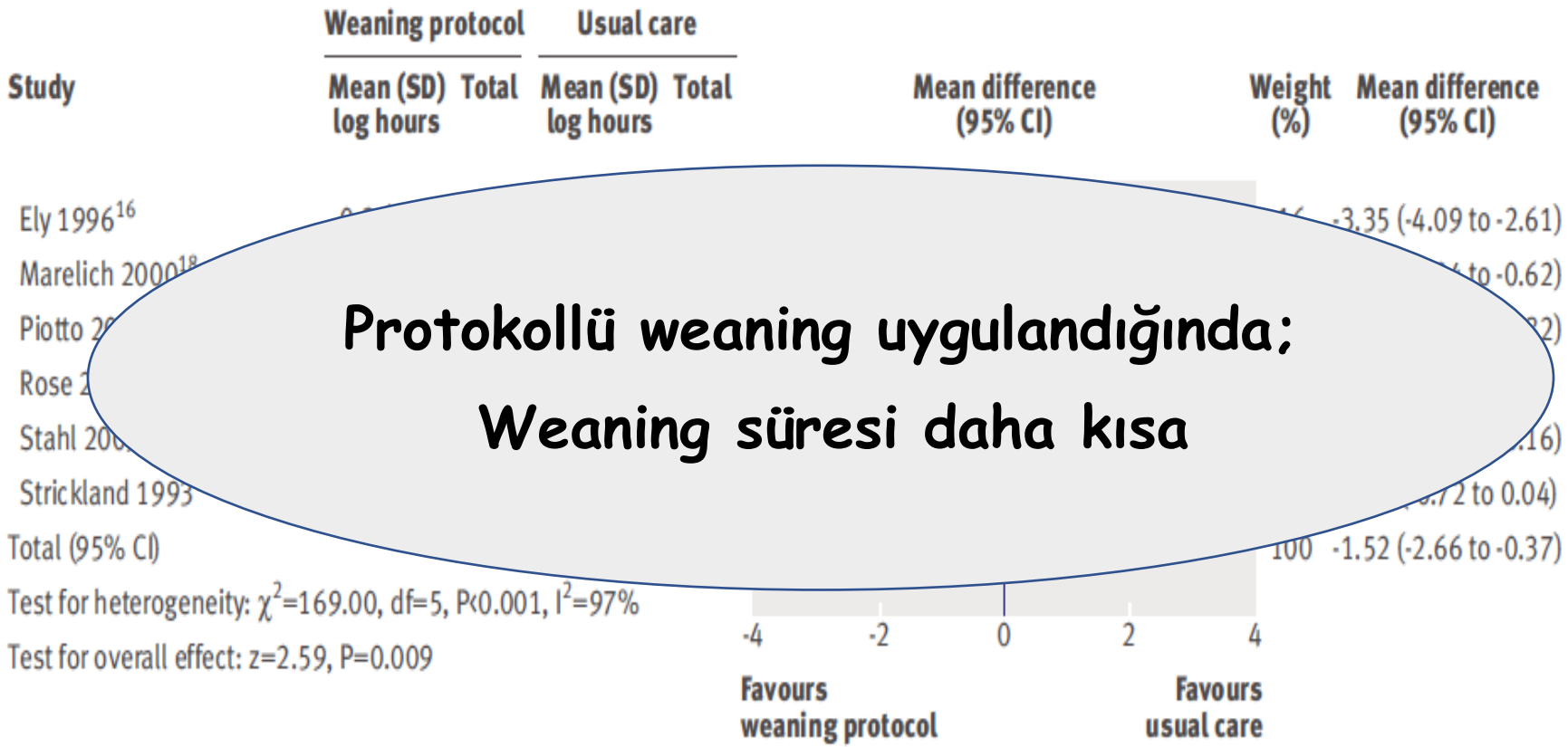
BMJ

RESEARCH

Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane systematic review and meta-analysis

Bronagh Blackwood, lecturer in nursing,[1] Fiona Alderdice, director,[1] Karen Burns, clinician scientist,[2] Chris Cardwell, lecturer in medical statistics,[3] Gavin Lavery, consultant in intensive care medicine,[4] Peter O'Halloran, lecturer in nursing[1]

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237

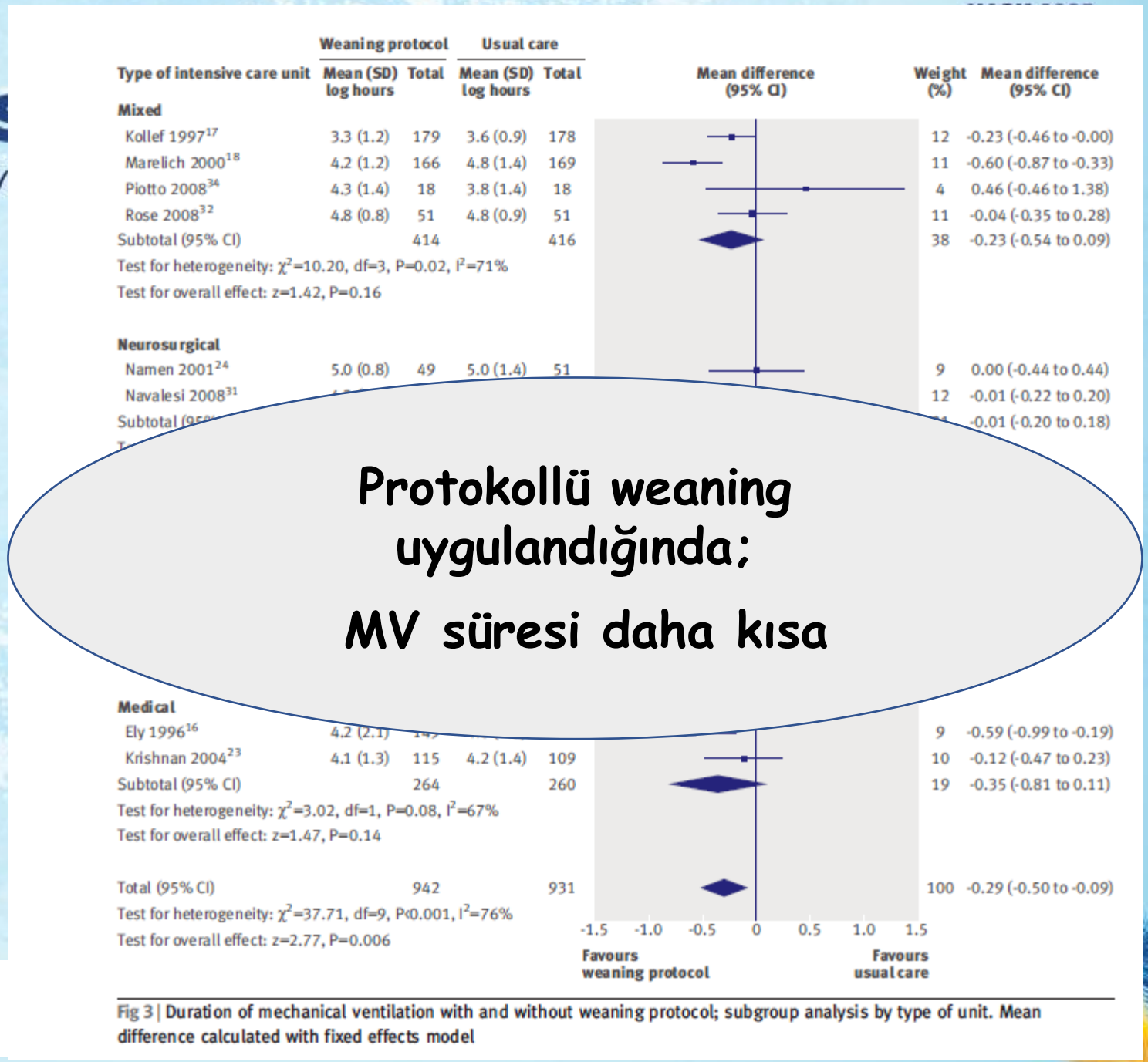


Protokollü weaning uygulandığında;
Weaning süresi daha kısa

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

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237

- Protokollü weaning uygulanan hastalara 25 saat daha az MV uygulanmış (95% CI, 12.5–35.5)

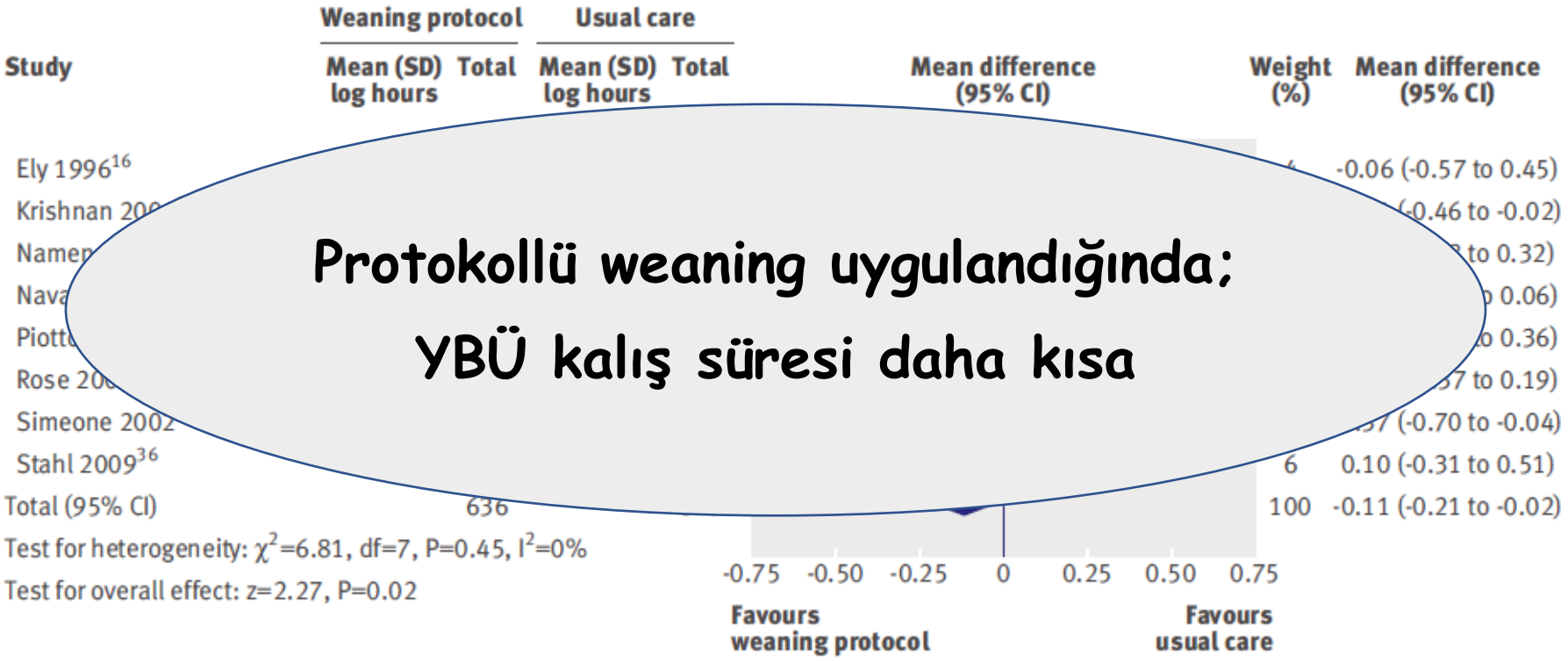


Protokollü weaning uygulandığında;

MV süresi daha kısa

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

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237



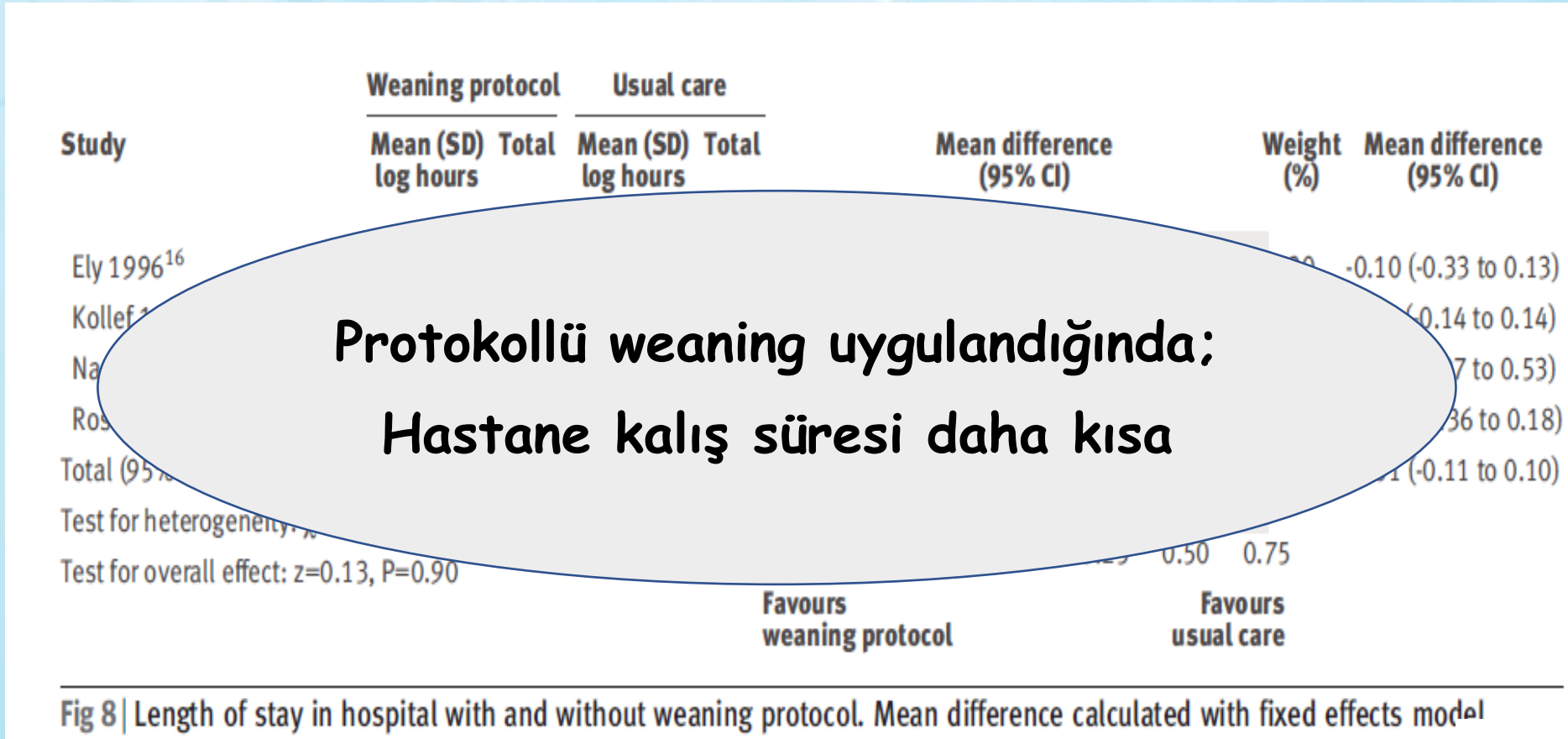
Protokollü weaning uygulandığında;

YBÜ kalış süresi daha kısa

Fig 7| Length of stay in intensive care unit with and without weaning protocol. Mean difference calculated with fixed effects model

Protokol uygulanan hastalar yoğun bakımdan 0.96 gün (1 gün) daha erken taburcu edilmiş. (95% CI, 0.24–1.7 d)

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237



Protokollü weaning uygulandığında;
Hastane kalış süresi daha kısa

Fig 8 | Length of stay in hospital with and without weaning protocol. Mean difference calculated with fixed effects model

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237

Table 5 | Summary of adverse events associated with weaning from mechanical ventilation with and without weaning protocol in critically ill adults on mechanical ventilation

Adv		
Self e		
Tracheostomy[17]		1.22), P=0.24
Protracted weaning (days):		
>21[16]	300	0.42 (0.19 to 0.96), P=0.04
>21[24]	100	0.18 (0.02 to 1.63), P=0.21
>14[32]	102	0.68 (0.20 to 2.31), P=0.54
>7[17]	357	0.63 (0.35 to 1.15), P=0.13

Protokollü weaning uygulandığında;

Komplikasyon gelişim riskinde fark yok

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237

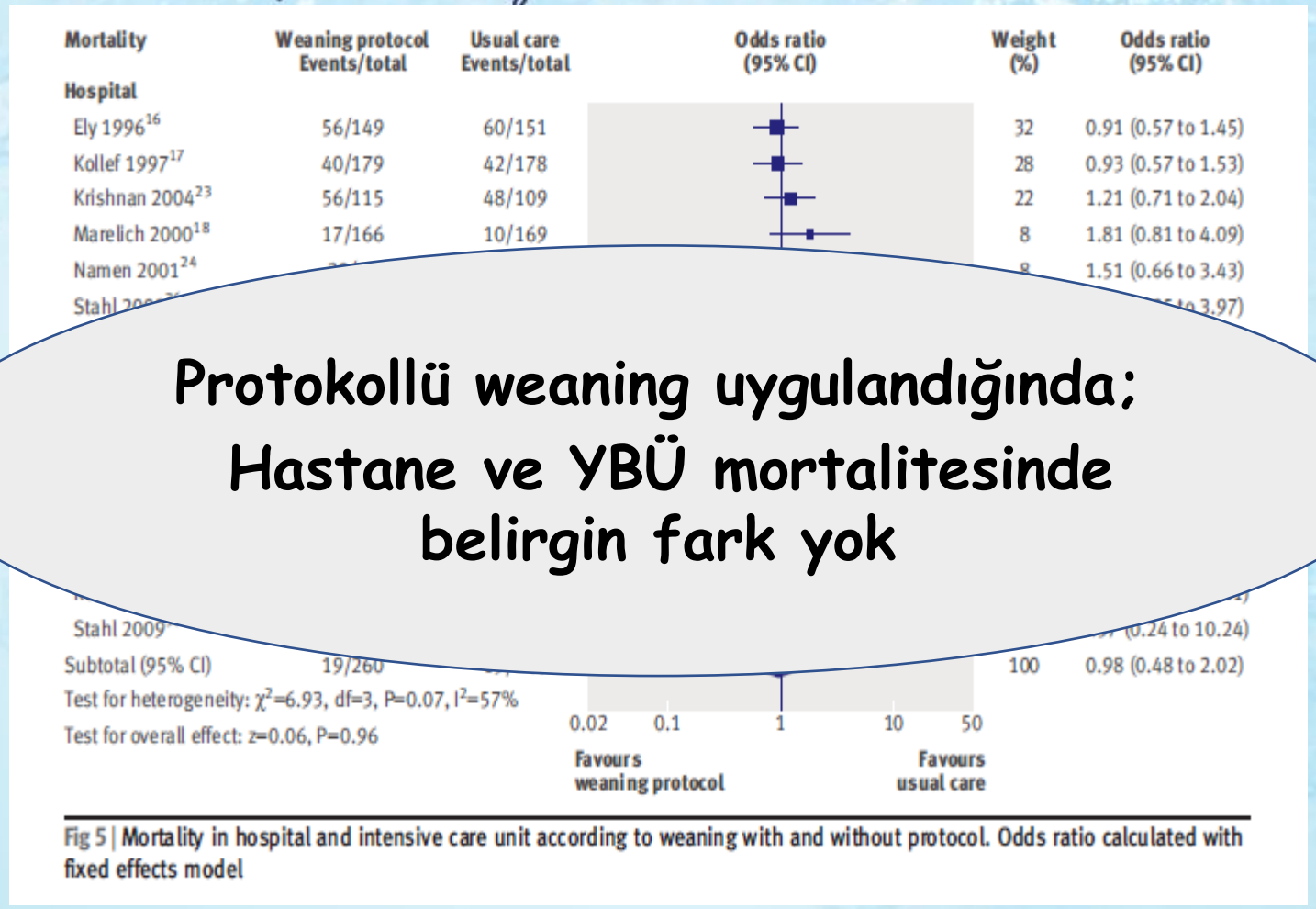


Fig 5 | Mortality in hospital and intensive care unit according to weaning with and without protocol. Odds ratio calculated with fixed effects model

Protokollü weaning uygulandığında;

Hastane ve YBÜ mortalitesinde belirgin fark yok

Cite this as: *BMJ* 2011;342:c7237
doi:10.1136/bmj.c7237

AMERICAN THORACIC SOCIETY DOCUMENTS

Official Executive Summary of an American Thoracic Society/American College of Chest Physicians Clinical Practice Guideline: Liberation from Mechanical Ventilation in Critically Ill Adults

- **Soru :** Akut hospitalize edilen, 24 saatten uzun süreli mekanik ventilatörde izlenen hastalara **protokollü weaning uygulanmalı mı yoksa protokolsüz ayırma mı tercih edilmeli?**
- **Cevap :** Hastanın invaziv MV'den ayrılmaya hazır olup olmadığının «ventilatörden ayırma protokolü» çerçevesinde düzenli olarak değerlendirilmesi.

  ATS/CHEST önerisi: **Ventilatörden ayırma protokolleri uygulanmalıdır. (düşük derecede kanıt düzeyi, hasta durumuna göre öneri)**
- **Önemli!!!-**Ventilatör ayırma protokolü hasta veya bilgisayar tarafından yürütülen protokoller olabilir

Am J Respir Crit Care Med Vol 195, Iss 1, pp 115–119, Jan 1, 2017

Originally Published in Press as DOI: 10.1164/rccm.201610-2076ST on October 20, 2016
Internet address: www.atsjournals.org

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- **Soru:** Akut hospitalize edilen, 24 saatten uzun süreli mekanik ventilatörde izlenen hastalarda **sedasyonu minimuma indiren protokoller**, diğerlerine göre **ventilasyon süresini, YBÜ yatış süresini ve kısa dönem mortaliteyi (60 günlük) azaltır mı?**

- **Cevap:** Protokollü sedasyon uygulanan grupta daha kısa MV süresi, daha kısa YBÜ yatışı, daha az mortalite olduğu yönünde kanıtlar mevcuttur.

- **ATS/CHEST önerisi**: **Sedasyonu minimumda tutmaya yönelik protokoller önerilir (düşük derecede kanıt düzeyi, hastanın durumuna göre)**

- **Önemli!!!-**Herhangi bir protokolün diğerine üstünlüğü gösterilememiştir

Am J Respir Crit Care Med Vol 195, Iss 1, pp 115–119, Jan 1, 2017

Originally Published in Press as DOI: 10.1164/rccm.201610-2076ST on October 20, 2016
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AMERICAN THORACIC SOCIETY DOCUMENTS

Official Executive Summary of an American Thoracic Society/American College of Chest Physicians Clinical Practice Guideline: Liberation from Mechanical Ventilation in Critically Ill Adults

- **Soru :** Akut hospitalize edilen, 24 saatten uzun süreli mekanik ventilatörde izlenen **yüksek riskli hastalarda SBT'yi geçtikleri takdirde ekstübasyonu takiben önleyici NIMV uygulamasının, NIMV uygulanmadan yapılan takibe göre ventilatörsüz gün sayısı, ekstübasyon başarısı, YBÜ yatış süresi, kısa dönem ve uzun dönem mortalite üzerine üstünlüğü var mıdır?**
  - **ATS/CHEST önerisi**: **Ekstübasyon başarısızlığı yüksek olan bu hasta grubunda ekstübasyon sonrası preventif NIMV önerilir. (orta derecede kanıt düzeyi, kuvvetli öneri)**
  - **Önemli!!!-**NIMV ekstübasyonu takiben hemen başlanmalıdır

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Journal of Intensive Care

RESEARCH Open Access

A comprehensive protocol for ventilator weaning and extubation: a prospective observational study

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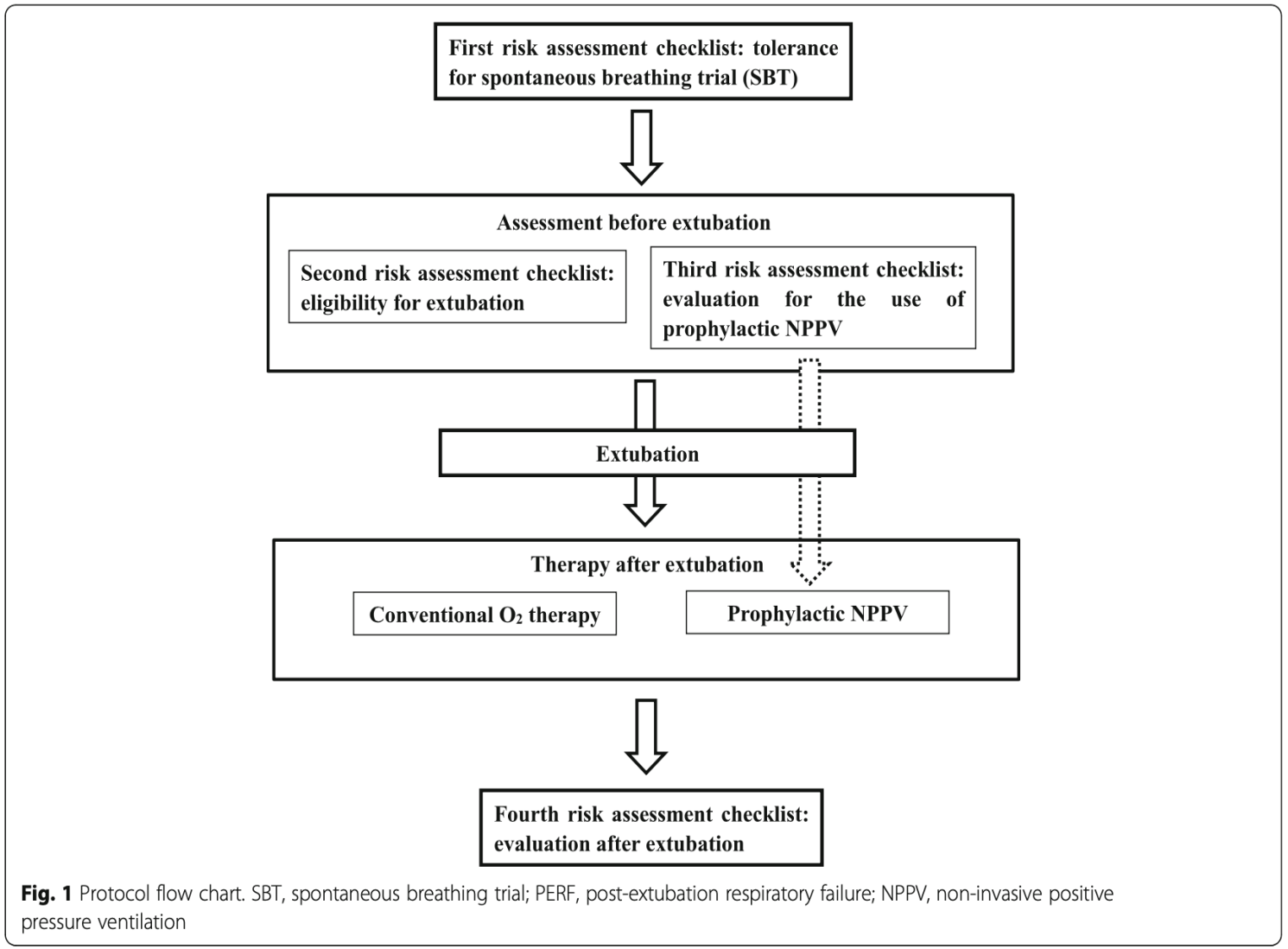

Fig. 1 Protocol flow chart. SBT, spontaneous breathing trial; PERF, post-extubation respiratory failure; NPPV, non-invasive positive pressure ventilation

First risk assessment checklist: tolerance for spontaneous breathing trial (SBT)

Spontaneous breathing for 30 minutes through ventilator with "flow trigger" mode rate set to 0, PSV set to 0, PEEP 5 cm H_2O or a T-tube.

The following seven items are checked to judge the successful SBT.

(1) Respiratory rate (RR) > 35/min for 5 minutes or more

(2) Rapid shallow breathing index (RSBI) > 100 cycles/min/L

(3) SaO_2 < 90% for 5 minutes or more

(4) Heart rate (HR) > 120/min, or sustained increase 20% greater than baseline

(5) Systolic blood pressure < 90 mm Hg or > 180 mm Hg for 5 minutes or more

(6) Emergence of a chest pain or a new electrocardiogram change

(7) Dyspnea, increased anxiety, and diaphoresis

Next, judge the patients' eligibility for extubation if they do not meet at least one of these seven criteria. If they meet at least one of these seven criteria, they are rested on mechanical ventilation until the next morning and rechecked the next day.

Second risk assessment checklist: eligibility for extubation

The following seven items are checked to judge the eligibility of patients for extubation.

(1) No severe disturbance in level of consciousness (e.g., ability to protect the airway)

(2) Presence of cough reflex

(3) Presence of gag reflex

(4) Stable cardiovascular system (e.g., HR < 120 beats/min; dopamine level < 5 μg/kg/min; no ischemic changes on electrocardiogram; and no severe cardiac arrhythmia)

(5) RR < 35 breaths/min

(6) RSBI < 100 breaths/min/L

(7) Presence of cuff leak

Patients are extubated if they satisfy all of the above criteria. If they do not, mechanical ventilation is continued, and items in this checklist are rechecked the next day.

Third risk assessment checklist: evaluation for the use of prophylactic NPPV

The following three items are checked for the use of prophylactic NPPV.

(1) Age > 65 years

(2) Cardiac failure as the reason for intubation

(3) Increased severity of respiratory failure (e.g., APACHE II score at extubation > 12)

If patients have at least one of three criteria in the risk assessment checklist, the use of prophylactic NPPV is considered. The final decision on prophylactic use of NPPV is left to the discretion of the attending physicians.

Fourth risk assessment checklist: evaluation after extubation

The following six items are checked to judge whether conventional oxygen therapy is sufficient within 48 hours after extubation and to judge the eligibility of patients for rescue NPPV or reintubation.

(1) RR > 35 breaths/min for 5 minutes or more
(2) SpO_2 < 90% for 5 min or more
(3) HR > 120 beats/min or sustained increase of 20 beats/min over the baseline level for 5 min or more
(4) Systolic blood pressure < 90 mmHg or sustained decrease of 30 mmHg over the baseline level for 5 minutes or more
(5) Chest pain or electrocardiographic abnormalities (emergence of ischemic changes or arrhythmia)
(6) Dyspnea, increased anxiety, and diaphoresis

Patients who meet at least one of these six criteria are adjudged as requiring ventilatory assistance. Eligibility and contraindications for rescue use of NPPV are evaluated. Rescue NPPV is initiated if indicates; if not, tracheal intubation is performed.

Attending physicians check this checklist 60 min after extubation, every morning and evening. Furthermore, ICU nurses check the vital signs once every hour. If the ICU nurse notices at least one abnormality out of six criteria, they told the attending physicians about the abnormality. Then, attending physician rechecked the checklist in each case.

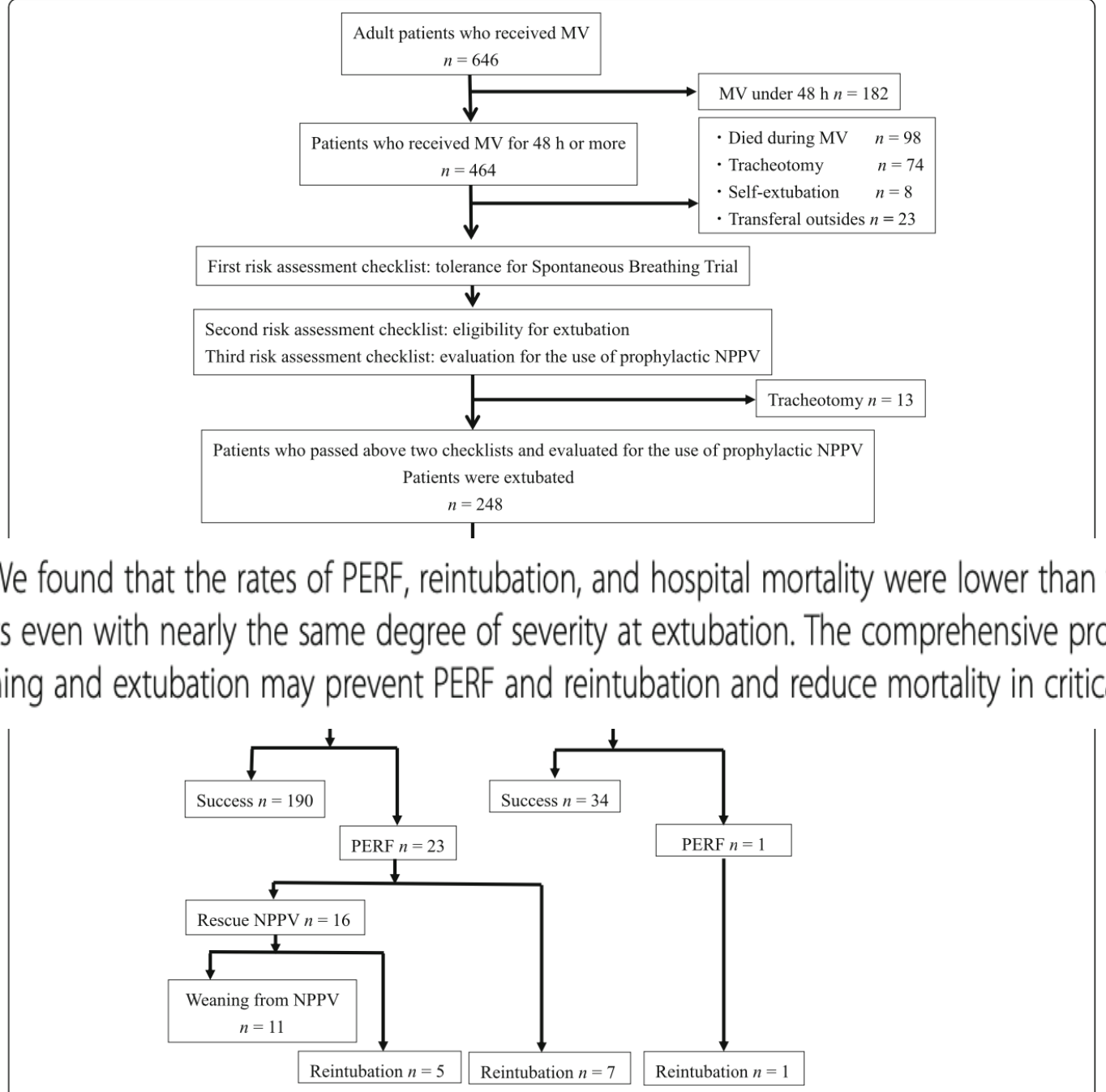

Fig. 3 Flow chart of the study patients. MV, mechanical ventilation; PERF, post-extubation respiratory failure; NPPV, non-invasive positive pressure ventilation

Conclusions: We found that the rates of PERF, reintubation, and hospital mortality were lower than those in previous reports even with nearly the same degree of severity at extubation. The comprehensive protocol for ventilator weaning and extubation may prevent PERF and reintubation and reduce mortality in critically ill patients.

Otomatize Weaning Modları

Table 1 Automated closed loop systems.

Name	Manufacturer/Patent	Brief description
Smartcare/PS™	Dräger Medical, Lübeck, Germany	Closed loop control of pressure support based on monitoring of respiratory rate, tidal volume and end-tidal carbon dioxide. Tests for extubation readiness using a one hour spontaneous breath trial
Adaptive Support Ventilation (ASV)	Hamilton Medical, Bonaduz, Switzerland	Closed loop control of inspiratory pressure and mandatory breath rate on a breath-by-breath basis to maintain pre-set minimum minute ventilation. Automatically switches to pressure support ventilation and adapts pressure support based on respiratory rate and tidal volume
Automode	Siemens, Solna, Sweden	Switches from a controlled mode (for example pressure control ventilation) to a support mode such (for example pressure support ventilation) based on detection of patient triggering of two consecutive breaths
Proportional Assist Ventilation (PAV)	The University of Manitoba, Canada	Adjusts airway pressure based on measurement of compliance and resistance throughout the inspiratory cycle to maintain an clinician selected % degree of support
Mandatory Minute Ventilation (MMV)	Dräger Medical, Lübeck, Germany	Closed loop control of the mandatory breath rate while considering the patient's spontaneous breath rate based on a clinician predetermined minute ventilation
Proportional Pressure Support (PPS)	Dräger Medical, Lübeck, Germany	Pressure support is provided proportionately to changes in airway resistance and lung compliance. PPS is based on the PAV algorithm
Neurally Adjusted Ventilatory Assist	Maquet, Solna, Sweden	Partial ventilatory support proportional to inspiratory diaphragmatic electrical activity measured via an oesophageal catheter
Intellivent-ASV®	Hamilton Medical, Rhäzüns, Switzerland	Extension of ASV that uses closed loop control to adjust minute ventilation using end tidal carbon dioxide and oxygenation by adjusting positive end-expiratory pressure and the fraction of inspired oxygen
Mandatory Rate Ventilation (MRV)	Taema-Horus Ventilator® Air Liquide, France	Closed loop control to adjust pressure support based on a respiratory rate target

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Otomatize Weaning Modları Üstün Mü?

- Bu bazı faktörlere bağlıdır;
  - Uygulanan hasta popülasyonuna
  - Uygulayan personele ve takip kayıt sistemine
  - Ne kadar doğru uygulanabildiğine;
    - Algoritma;
      - Gaz değişim parametrelerini içeriyor mu?
      - Solunum dışı değişkenleri içeriyor mu?
      - Bazal solunum mekaniklerindeki ve gaz değişimindeki değişikliklere uyum sağlayabiliyor mu?
    - Weaning protokolü
  - Sensör güvenilirliği

[Respir Care 2016;61(6):749–760. © 2016 Daedalus Enterprises]

Is Automated Weaning Superior to Manual Spontaneous Breathing Trials?

Steven R Holets RRT and John J Marini MD

[Respir Care 2016;61(6):749–760. © 2016 Daedalus Enterprises]

Table 1. Comparative Weaning Trials Using Adaptive Support Ventilation and SmartCare/PS

First Author	Automated Mode	Population	Comparator	Main Outcome	Findings
Kirakli[5]	ASV	97 subjects with COPD	Protocol: PSV with 2-h SBT	Extubation success	ASV shortened weaning time: 24 h vs 73 h ($P = .041$)
Lellouche[6]	SmartCare/PS	147 mixed at 5 European hospitals	Protocol: PSV and SBT with T-piece or PSV + PEEP	Weaning duration	Shorter time to successful extubation with SmartCare/PS: 3 d vs 5 d ($P = .01$)
Jouvet[7]	SmartCare/PS	20 pediatric	Clinician-directed protocol: PSV	Ventilation duration	SmartCare/PS shorter ventilation duration: 5.1 d vs 6.7 d ($P = .33$)
Burns[8]	SmartCare/PS	92 mixed from 9 Canadian ICUs	Protocol: PSV	Time to first successful SBT	SmartCare/PS shorter median time to SBT 1 d vs 4 d ($P < .001$)

PSV = pressure support ventilation
SBT = spontaneous breathing trial
ASV = adaptive support ventilation

Otomatize Weaning Modları Üstün Mü?

- 10 çalışmayı içeren bir Cochrane analizinde;
  - SBT'yi protokollerinin bir parçası olarak gerçekleştiren otomatize weaning sistemleri ile nonotomatize weaning sistemleri karşılaştırılmıştır;
  - Otomatize weaning modları ile;
    - Daha kısa weaning süresi
    - Başarılı ekstübasyona kadar daha kısa süre
    - Daha kısa YBÜ yatış süresi
    - Daha az uzamış weaning ihtiyacı olan hasta (7 ve 21 gün)

(Burns et al 2014)

Taniguchi *et al. Critical Care* (2015) 19:246
DOI 10.1186/s13054-015-0978-6

CRITICAL CARE

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Smart Care™ versus respiratory physiotherapy–driven manual weaning for critically ill adult patients: a randomized controlled trial

Table 5 Mechanical ventilation time and weaning duration in the two weaning protocols

	Weaning mode				*p* Value
	Respiratory physiotherapy–driven		SmartCare™ group		
Mechanical ventilation time (days), median (IQR)	3.5	(2.0–7.3)	4.1	(2.7–7.1)	0.467
Weaning duration (min), median (IQR)	60.0	(50.0–80.0)	110.0	(80.0–130)	<0.001

Abbreviation: IQR interquartile range

Conclusions

A respiratory physiotherapy–driven weaning protocol can decrease weaning time compared with an automatic system, as it takes into account individual weaning difficulties. However, both modes have been shown to be safe in terms of the frequency of weaning failure and weaning completion, leading to the same invasive mechanical ventilation duration.

OPEN

Defining predictors for successful mechanical ventilation weaning, using a data-mining process and artificial intelligence

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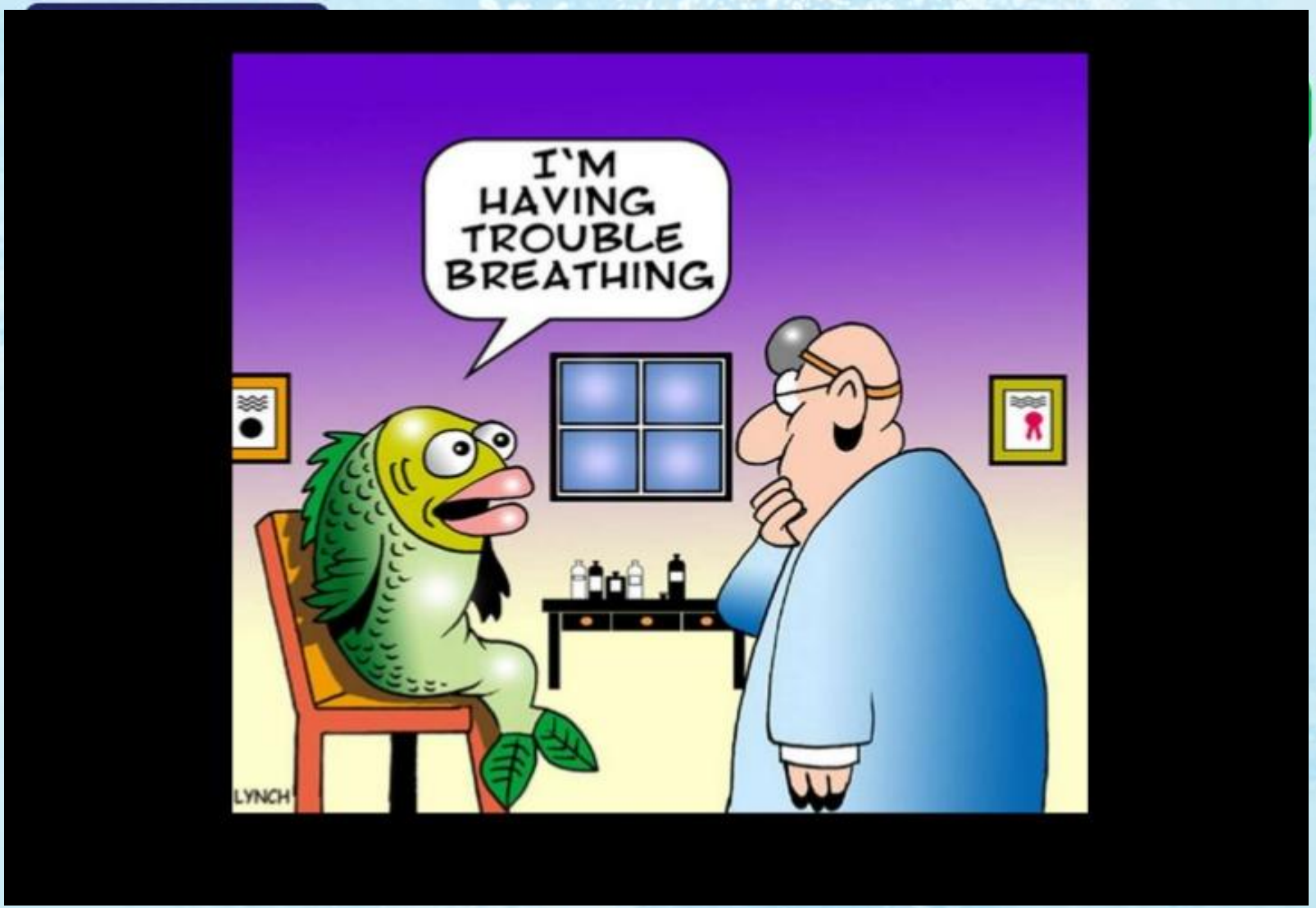
Mechanical ventilation weaning within intensive care units (ICU) is a difficult process, while crucial when considering its impact on morbidity and mortality. Failed extubation and prolonged mechanical ventilation both carry a significant risk of adverse events. We aimed to determine predictive factors of extubation success using data-mining and artificial intelligence. A prospective physiological and biomedical signal data warehousing project. A 21-beds medical Intensive Care Unit of a University Hospital. Adult patients undergoing weaning from mechanical ventilation. Hemodynamic and respiratory parameters of mechanically ventilated patients were prospectively collected and combined with clinical outcome data. One hundred and eight patients were included, for 135 spontaneous breathing trials (SBT) allowing to identify physiological parameters either measured before or during the trial and considered as predictive for extubation success. The Early-Warning Score Oxygen ($EWSO_2$) enables to discriminate patients deemed to succeed extubation, at 72-h and 7-days. Cut-off values for EWSO2 (AUC = 0.80; Se = 0.75; Sp = 0.76), mean arterial pressure and heart-rate variability parameters were determined. A predictive model for extubation success was established including body-mass index (BMI) on inclusion, occlusion pressure at 0,1 s. (P0.1) and heart-rate analysis parameters (LF/HF) both measured before SBT, and heart rate during SBT (global performance 62%; 83%). The data-mining process enabled to detect independent predictive factors for extubation success and to develop a dynamic predictive model using artificial intelligence. Such predictive tools may help clinicians to better discriminate patients deemed to succeed extubation and thus improve clinical performance.

EVE MESAJLAR…

- Yoğun bakım ünitelerinin «weaning» için protokollerinin olması, hastaların günlük değerlendirilmeleri önemli!!!
- Literatürdeki protokoller birbirine benziyor, weaning temel kurallarını içeriyor, birbirlerine üstünlükleri yok
- Yeni gelişmeler, USG ve EKO'nun weaning sürecine dahil edilmesi umut verici; ancak sonuçları topluca değerlendiren bir rehber, metaanaliz henüz yok
- Otomatize weaning modları, gelişen teknoloji ile yapay zeka uygulamaları günlük işleyişi kolaylaştıracak
  - Ama mutlaka kontrol elde tutulmalı
  - Yoğun bakım ekibi eğitimi ihmal edilmemeli
  - Her hasta bireysel değerlendirilmeli



TEŞEKKÜR EDERİM