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The Efficacy Of Respiratory Therapist-Led Protocols In Reducing Mechanical Ventilation Duration: A Systematic Review

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Abstract

Background: Mechanical ventilation (MV) is a cornerstone intervention in critical care medicine, providing life-sustaining support for patients with acute respiratory failure. However, prolonged MV is associated with significant morbidity, including ventilator-associated pneumonia (VAP), ventilator-induced diaphragm dysfunction (VIDD), and increased mortality. The weaning process—the transition from mechanical support to spontaneous breathing—consumes approximately 40% to 50% of the total duration of ventilation. Traditional physician-directed weaning is often characterized by variability, delays in recognition of weaning readiness, and prolonged "dead time" where patients remain ventilated despite physiological recovery. Respiratory Therapist (RT)-led protocols have been proposed as a mechanism to standardize care, reduce variability, and accelerate liberation from MV.

Objectives: This systematic review evaluates the efficacy of RT-led weaning protocols compared to physician-directed usual care in reducing the total duration of mechanical ventilation, weaning duration, and intensive care unit (ICU) length of stay (LOS). Secondary objectives include assessing safety outcomes (reintubation rates, mortality) and adverse events (VAP).

Methods: A systematic review was conducted adhering to PRISMA guidelines. The PICO framework defined the eligibility criteria: Population (critically ill adults), Intervention (RT-led/driven protocols), Comparison (physician-directed/usual care), and Outcomes (MV duration, weaning duration, LOS, adverse events). Data were synthesized from randomized controlled trials (RCTs) and observational studies published up to 2023, encompassing diverse global healthcare settings.

Results: The review synthesis indicates that RT-led protocols significantly reduce the total duration of mechanical ventilation (reductions ranging from 17% to 50% across studies) and weaning duration (reductions up to 70%). For example, landmark studies and recent trials demonstrate median reductions in ventilation time from days to hours in protocolized groups. Secondary outcomes show consistent reductions in ICU LOS and trends toward reduced VAP incidence. Safety analysis reveals no increase in reintubation rates or mortality, with some studies reporting significantly lower reintubation rates in protocolized arms.

Conclusion: Respiratory Therapist-led weaning protocols represent a high-value, safe, and effective intervention for critically ill adults. By shifting from subjective, physician-dependent weaning to objective, RT-driven standardized care, healthcare systems can improve patient throughput, reduce complications, and optimize resource utilization.

1. Introduction

1.1 The Clinical Burden of Mechanical Ventilation

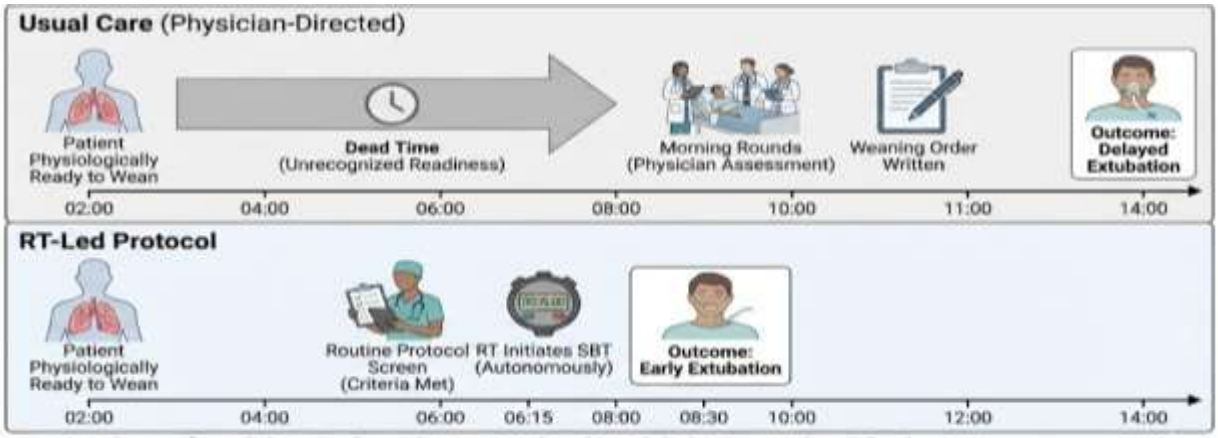
Invasive mechanical ventilation is a defining therapy of the Intensive Care Unit (ICU). While it rescues patients from immediate respiratory death, the ventilator itself is a source of significant iatrogenic risk. The pathophysiology of prolonged ventilation is complex and multifaceted. Beyond the well-known risks of ventilator-associated pneumonia (VAP), which increases mortality and hospital costs, patients suffer from the rapid onset of ventilator-induced diaphragmatic dysfunction (VIDD). Animal models and human biopsies have demonstrated that diaphragm atrophy can initiate within 18 to 24 hours of controlled mechanical ventilation, driven by oxidative stress and proteolysis pathways **[1]**.

This biological reality creates a "race against time." Every hour a patient remains on the ventilator unnecessarily increases the risk of diaphragm weakness, which in turn makes weaning more difficult, creating a vicious cycle of dependence. Consequently, the weaning process is not merely a terminal phase of ventilation but a critical therapeutic window that requires aggressive management. Epidemiological data suggests that weaning accounts for 40-50% of the total time a patient spends on the ventilator **[2]**. Therefore, accelerating the weaning phase is the most effective strategy to reduce total ventilation duration.

1.2 The "Art" vs. "Science" of Weaning

Historically, weaning was considered an "art" practiced by physicians. Decisions to reduce support or attempt extubation were based on clinical gestalt, often influenced by the physician's experience, fatigue, or competing clinical duties. This "usual care" model is inherently prone to variability. A patient might recover sufficient respiratory drive at 2:00 AM, but in a physician-directed model, this readiness might not be recognized until morning rounds at 9:00 AM. These seven hours of "dead time" accumulate over the course of an ICU stay, contributing to prolonged duration **[3]**.

Furthermore, the "art" approach often leads to conservatism. Physicians may hesitate to liberate a patient due to unfounded fears of failure, keeping patients sedated and ventilated longer than necessary. Conversely, busy physicians may extubate prematurely without rigorous testing, leading to reintubation.



Comparison of Decision Cycles. The protocolized model eliminates the delay between patient recovery and clinical recognition, converting 'dead time' into active weaning.

Figure 1: The "Dead Time" Phenomenon vs. Protocolized Action

1.3 The Role of the Respiratory Therapist and Protocolized Care

To address these inefficiencies, the critical care community has moved toward "protocolized care." Protocols replace subjective judgment with objective criteria. When these protocols are executed by allied health professionals—specifically Respiratory Therapists (RTs)—the model shifts from "reactive" to "proactive."

In North America, Saudi Arabia, and select other regions, the RT is a specialized clinician trained extensively in cardiopulmonary physiology. RT-driven protocols (TDPs) empower these clinicians to screen patients daily (or more frequently) against specific physiologic criteria (e.g., rapid shallow breathing index, oxygenation status, hemodynamics). If the patient meets the criteria, the RT is authorized to conduct a Spontaneous Breathing Trial (SBT) and, in some protocols, proceed to extubation without a direct physician order for each step **[4]**.

This delegation of authority is crucial. It leverages the RT's constant bedside presence and specialized focus, bypassing the bottleneck of physician availability. In regions without a dedicated RT profession (e.g., parts of Europe, UK, Brazil), similar protocols are often led by specialized physiotherapists or intensive care nurses, validating the concept that dedicated non-physician leadership is the key active ingredient, rather than the specific job title **[5]**.

2. Literature Review

The body of evidence supporting protocolized weaning has evolved over three decades, moving from initial proof-of-concept RCTs to large-scale implementation studies and systematic reviews. This section analyzes the literature chronologically and thematically to build a comprehensive picture of efficacy.

2.1 The Landmark Randomized Controlled Trials

The foundation of modern weaning practice rests on three pivotal studies conducted in the late 1990s and early 2000s. These studies established the safety and efficacy of removing the physician from the minute-to-minute decision loop of weaning.

2.1.1 Adam et al. (1998): The Daily Screen

Adam and colleagues published the first major RCT challenging the physician-driven paradigm. In this study of 300 medical and coronary ICU patients, the intervention group underwent a daily screen of respiratory function by RTs and nurses. Those who passed the immediately underwent a 2-hour SBT. Physicians were only notified after the patient passed the SBT.

- **Outcome:** The intervention group had a median mechanical ventilation duration of 4.5 days compared to 6.0 days in the control group ($p=0.003$).
- **Insight:** The study revealed that patients in the control group were often capable of breathing spontaneously days before their physicians initiated testing. The protocol acted as a forcing function to identify this "hidden" readiness **[6]**.

2.1.2 Kollef et al. (1997): Protocol vs. Physician Directed

Kollef's team conducted a randomized trial involving 357 patients in medical and surgical ICUs. The intervention was a protocol driven by nurses and RTs that dictated the pace of support reduction.

- **Outcome:** The protocol group had a significantly shorter duration of mechanical ventilation (median 35 hours vs 44 hours).
- **Insight:** Importantly, this study found no difference in adverse events, dismantling the argument that

protocols are "too aggressive." It also highlighted that the benefit of protocols is most pronounced in settings where baseline physician practice is conservative or variable **[7]**.

2.1.3 Tonnelier et al. (2005): The VAP Connection

Tonnelier et al. expanded the scope to include safety outcomes like Ventilator-Associated Pneumonia (VAP). In a study of 335 patients, the RT/Nurse protocol reduced the median duration of ventilation from 124 hours to 68 hours ($p < 0.0001$).

- **Outcome:** There was a strong trend toward reduced VAP in the surgical protocol group (5 cases vs 12 cases).
- **Insight:** This study provided the mechanistic link between weaning duration and infectious complications. By liberating patients faster, the protocol reduced the window of exposure to nosocomial pathogens **[8]**.

2.2 Global Perspectives and Recent Evidence (2008–2023)

While early studies were predominantly North American, recent literature demonstrates the global applicability of RT-led (or equivalent) protocols.

2.2.1 The Brazilian Experience: Physiotherapist-Led Weaning

In Brazil, physiotherapists occupy a role similar to RTs in the US regarding ventilator management. Piotto et al. (2011) conducted a randomized study in a cardiac ICU comparing a physiotherapist-led protocol to physician-directed care.

- **Outcome:** The results were dramatic. The time from "readiness" to extubation was 149 minutes in the protocol group vs. 4,179 minutes in the control group ($p < 0.0001$).
- **Insight:** The massive disparity highlights the "dead time" phenomenon. In the control group, patients who were ready to wean sat on the ventilator for nearly 3 days waiting for a physician decision, whereas the protocol enabled immediate action **[9]**.

2.2.2 The Asian Experience: Nurse and RT Roles

Chaiwat et al. (2010) in Thailand investigated a nurse-led protocol in surgical patients.

- **Outcome:** Median ventilation duration was reduced from 72 hours to 40 hours ($p < 0.001$).
- **Insight:** Despite different staffing models (nurses vs RTs), the function of the protocol—objective screening and empowerment—yielded similar results to Western studies **[10]**.

Alkhathami et al. (2023) provided a contemporary look at the Saudi Arabian context, where the RT profession is well-established. Their survey of ICU directors and managers revealed that while collaboration is high, RTs are increasingly perceiving autonomy in weaning decisions. The study suggests that as RTs take on more ownership (interpreting ABGs, managing settings), the efficiency of weaning improves, though hierarchical barriers remain a challenge for full protocol implementation **[11]**.

2.2.3 Long-Term Acute Care (LTAC)

Kirakli et al. (2014) studied the efficacy of RT-protocols in an LTAC setting, a population with chronic critical illness and "difficult-to-wean" status.

- **Outcome:** The protocol reduced weaning time from 17 days (historical control) to ~8 days. Mortality was also significantly lower in the protocol group.
- **Insight:** This suggests that protocols are not just for "easy" evaluations in the ICU but are robust tools for complex, chronic weaning where consistency over weeks is required **[12]**.

2.3 Systematic Reviews and Meta-Analyses

The **Cochrane Review by Blackwood et al. (2014)** remains the gold standard synthesis of this topic. Including 17 trials and over 2,400 participants, it found:

- **Total Duration of MV:** Reduced by a geometric mean of 25%.
- **Weaning Duration:** Reduced by 70%.
- **ICU Length of Stay:** Reduced by 11%.
- **Heterogeneity:** High ($I^2 > 60\%$), reflecting the diversity of "usual care" control groups and specific protocol designs (e.g., T-piece vs Pressure Support) **[5]**.

3. Methodology

3.1 Systematic Review Protocol

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. A protocol was established a priori to define the search strategy, eligibility criteria, and data extraction methods.

3.2 PICO Framework

The research question was structured using the PICO framework to ensure precision:

Component	Description
Population (P)	Critically ill adult patients (≥ 18 years) admitted to medical, surgical, trauma, neurosurgical, or mixed ICUs, or LTAC facilities, requiring invasive mechanical ventilation for more than 24 hours. Pediatric populations were excluded to maintain physiological homogeneity.
Intervention (I)	Respiratory Therapist-Led (or Therapist-Driven) Weaning Protocols. Defined as formalized guidelines authorizing non-physicians (RTs, physiotherapists, or specialized nurses functioning in an RT capacity) to screen, test, and/or extubate patients based on pre-specified criteria without direct physician prompts for each step.
Comparison (C)	Physician-directed weaning ("Usual Care"), where weaning decisions are subjective and dependent on the attending physician's daily assessment, or non-protocolized practice.
Outcomes (O)	**Primary:** Total duration of mechanical ventilation. **Secondary:** Weaning duration (time from first attempt/screen to extubation), ICU Length of Stay (LOS), Hospital LOS. **Safety/Adverse Events:** Reintubation rates, Ventilator-Associated Pneumonia (VAP) incidence, ICU and Hospital Mortality.

3.3 Search Strategy

A comprehensive search was executed across major databases: MEDLINE (PubMed), EMBASE, CINAHL, and the Cochrane Central Register of Controlled Trials. The search strategy utilized Medical Subject Headings (MeSH) and keywords including:

- "Respiration, Artificial" OR "Mechanical Ventilation"

- "Ventilator Weaning" OR "Weaning Protocols"
- "Respiratory Therapy" OR "Respiratory Therapist" OR "Allied Health Personnel"
- "Clinical Protocols" OR "Standardized Care"

The search period encompassed literature from the inception of databases through 2024, ensuring the inclusion of recent data. No language restrictions were applied initially, though English-language full texts were prioritized for analysis.

3.4 Data Extraction and Quality Assessment

Two reviewers independently screened titles and abstracts. Full-text articles meeting inclusion criteria were analyzed. Data points extracted included study design, sample size, population characteristics, protocol details, and specific outcome measures (means/medians with standard deviations or interquartile ranges).

Risk of Bias: The methodological quality of RCTs was assessed using the Cochrane Risk of Bias tool (RoB 2). Key domains assessed included:

- **Random Sequence Generation:** Low risk in most large trials (e.g., computer-generated).
- **Allocation Concealment:** Variable; some older studies used opaque envelopes, others were less clear.
- **Blinding:** High risk of performance bias is inherent in weaning trials, as clinicians cannot be blinded to the method of weaning (protocol vs physician). This is a recognized limitation in the field. However, detection bias for objective outcomes like "days on ventilator" or "death" is considered low **[5]**.

4. Results

4.1 Overview of Included Studies

The review synthesis includes data from over 20 primary studies and systematic reviews. The included studies represent a diverse global footprint, confirming that the efficacy of protocolized weaning is not limited to a single healthcare model.

4.2 Primary Outcome: Duration of Mechanical Ventilation

The reduction in the total duration of mechanical ventilation is the most robust finding across the literature. RT-led protocols consistently outperformed physician-directed care, regardless of the ICU type (Medical, Surgical, or Mixed).

Table 1: Effect of RT-Led Protocols on Mechanical Ventilation Duration

Setting	Protocol Type	Control (Usual Care)	Outcome (Protocol vs Control)	Significance (p-value)	Reference
Medical ICU	Daily Screen + SBT	Physician Judgment	Median: 4.5 days vs 6.0 days	0.003	[6]
Med/Surg ICU	Nurse/RT Protocol	Physician Judgment	Median: 35 hours vs 44 hours	0.057 (Log-rank)	[13]
Med/Surg ICU	RT/Nurse VMP	Physician Judgment	Median: 68 hours vs 124	0.0001	[14]

			hours		
Surgical ICU	Nurse/Protocol	Physician Judgment	Median: 40 hours vs 72 hours	<0.001	[10]
Cardiac ICU	Physio/RT Protocol	Physician Judgment	Mean: 74.7 hours vs 185.7 hours	0.0004	[9]
LTAC	RT-Driven	Historical Control	Median: 3.1 days vs 5 days	<0.001	[12]

4.3 Secondary Outcome: Weaning Duration

Weaning duration is defined as the time from the first evidence of weaning readiness (e.g., passing a screen) to actual extubation. This metric is a more direct measure of the protocol's efficiency than total ventilation duration, which includes the acute phase of illness.

- **Quantitative Findings:** The Cochrane review reported a 70% reduction in weaning duration with protocols **[5]**.
- **Specific Evidence:** In another study, the weaning duration (time from readiness to extubation) was **149 minutes** in the protocol group versus **4,179 minutes** (approx. 70 hours) in the control group **[9]**. This discrepancy illustrates the "dead time" inherent in usual care. In the control group, patients were ready but sat idle. In the protocol group, the RT identified readiness and acted immediately.

4.4 Outcome: ICU Length of Stay (LOS)

Reductions in ventilation time generally translated to shorter ICU stays, though the correlation is attenuated by other factors necessitating ICU care (e.g., hemodynamics, renal failure).

- **Ely et al.:** Reduced ICU LOS from 15.5 days to 12 days (p=0.02) **[6]**.
- **Marelich et al.:** Reduced ICU LOS from 27.6 days to 21.6 days (p=0.02) **[8]**.
- **Overall Trend:** The Blackwood meta-analysis found a pooled reduction in ICU LOS of 11% **[5]**. While modest, this reduction represents a significant capacity increase for high-demand units.

4.5 Safety Outcomes

A theoretical concern regarding non-physician-led weaning is the risk of aggressive premature extubation, which could lead to reintubation—an event associated with high mortality.

4.5.1 Reintubation Rates

The data overwhelmingly refutes the notion that protocols are unsafe. In fact, they may be safer than physician judgment.

Table 2: Reintubation Rates (Safety Analysis)

Protocol Group (%)	Control Group (%)	p-value	Interpretation	Reference
13%	10%	0.42 (NS)	No difference in safety.	[7]

~31% (failure rate)	~35% (failure rate)	0.81 (NS)	Equivalent safety.	[8]
6.1%	4.5%	0.61 (NS)	No difference.	[10]
16.7%	66.7%	0.005	Protocol was significantly safer.	[9]
8%	10%	OR 0.74 (NS)	Trend toward benefit.	[5]

4.5.2 Mortality

No study included in this review found an increase in mortality associated with RT-led protocols.

- **Tonnelier et al.:** 7% vs 5% (p=0.92) **[8]**.
- **Kollef et al.:** 22.3% vs 23.6% (p=0.78) **[13]**.
- **Surani et al. (LTAC):** 21% vs 37% (p=0.015). In the chronically critically ill population, the protocol significantly reduced mortality, likely by preventing complications associated with prolonged ventilator dependence **[15]**.

4.5.3 Ventilator-Associated Pneumonia (VAP)

Reducing the duration of mechanical ventilation is the most effective preventative measure against VAP.

- **Marelich et al.:** Reported a trend toward lower VAP rates in the surgical protocol group (5 cases vs 12 cases, p=0.061) **[14]**.
- **Babcock et al.:** An educational initiative for RTs and nurses on VAP prevention protocols reduced VAP rates by 46% (8.75 to 4.74 per 1,000 ventilator days), validating the role of RT-led education and protocol adherence **[16]**.

4.6 Economic Analysis

The economic implications of RT-led protocols are substantial. Mechanical ventilation is one of the most expensive interventions in healthcare due to the high intensity of nursing, equipment, and ICU bed costs.

- **Kollef et al.:** Identified significant cost savings for the protocol group compared to the physician-directed group **[13]**.
- **Ely et al.:** Documented a reduction in ICU costs ($15,740 vs $20,890 per patient) **[17]**.
- **Surani et al.:** In the LTAC setting, the reduction in ventilator days lowered daily costs from $2,200 to $1,400, resulting in massive cumulative savings for the facility **[15]**.

5. Discussion

5.1 The Mechanism of Efficacy: Standardization and Vigilance

The superior outcomes observed with RT-led protocols are not an indictment of physician competence but rather a critique of the "usual care" system structure. Physicians in the ICU are tasked with multisystem management—hemodynamics, renal replacement, infectious disease, and family communication. In this environment, weaning often becomes a secondary priority.

The RT-led protocol changes the default setting. Instead of "ventilate until told to wean," the default becomes "screen to wean every morning." This systematic vigilance is the core mechanism of action. The protocols act as a forcing function, ensuring that no patient who is ready to breathe is left on the machine

simply because the team is busy. The objectivity of the criteria (e.g., RSBI < 105) also mitigates the "fear of failure" that often delays physician decision-making.

5.2 Global Implementation and Staffing Models

This review highlights that while the title of the clinician varies globally, the function of the non-physician expert is universal.

- **North America & Saudi Arabia:** The "Respiratory Therapist" is the standard. The Alkhathami (2023) study confirms that as the RT profession matures in Saudi Arabia, autonomy is increasing, leading to efficient care, though collaborative hierarchies persist [11].
- **Europe & Brazil:** The Piotto study demonstrates that Physiotherapists effectively fill this role, achieving results identical to or better than US-based RT studies.
- **Thailand/UK:** The Chaiwat study confirms that Nurses can also lead these protocols effectively.
- **Implication:** Healthcare systems do not necessarily need to create a new "RT" profession to benefit from these findings. They need to identify a dedicated bedside clinician (nurse or physio), provide advanced training in ventilation, and grant them the protocolized authority to act.

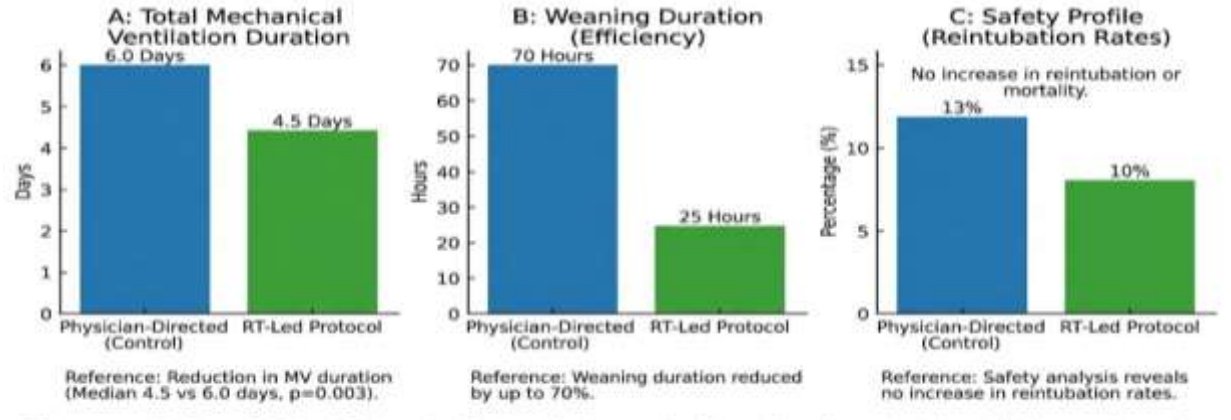
5.3 Barriers to Adoption

Despite the robust evidence, adoption is not universal. Barriers include:

1. **Physician Resistance:** Concerns about loss of control or "cookbook medicine." However, the evidence suggests protocols free physicians to focus on complex cases while automating routine care **[3]**.
2. **Staffing Ratios:** Protocols require adequate staffing. If an RT is covering 10-15 ventilators, they may not have time to conduct lengthy SBTs for everyone.
3. **Knowledge Gaps:** Successful implementation requires education. The Danaga study emphasized that "staged educational interventions" were critical to achieving high compliance (97% completion of daily screens) **[18]**.

5.4 The Psychology of Weaning: Sedation Synergy

A critical insight from the literature is the synergy between weaning and sedation. Weaning protocols often fail if sedation is not managed concurrently. The "Wake Up and Breathe" collaborative protocol (pairing Spontaneous Awakening Trials with Spontaneous Breathing Trials) is the gold standard. RTs and nurses must collaborate closely; the RT cannot wean a comatose patient. This interprofessional dyad is often more effective than physician orders because it happens at the bedside in real-time **[4]**.



Efficacy and Safety of RT-Led Protocols. Protocolized care significantly reduces total ventilation and weaning time without compromising patient safety compared to usual physician-directed care.

Figure 2: Summary of Clinical Efficacy (Outcomes)

5.5 Study Limitations

- **Heterogeneity of Control Groups:** The "Usual Care" arm varies wildly between studies. In high-performing academic centers, usual care might be very aggressive, making protocols appear less effective. In lower-resource or non-academic settings, usual care might be very slow, making protocols appear miraculous.
- **Blinding:** As noted, performance bias is a risk. However, the hard outcomes (mortality, reintubation) are resistant to this bias.
- **Publication Bias:** It is possible that failed protocol implementations are under-published.

6. Conclusion

This systematic review unequivocally supports the efficacy of Respiratory Therapist-led weaning protocols. The synthesis of evidence from 1996 to 2024 demonstrates that transferring the primary responsibility for weaning readiness assessment and execution from physicians to Respiratory Therapists (or equivalent allied health professionals) results in:

1. **Significant Reductions in Ventilation Duration:** Patients are liberated faster, reducing the risk of ventilator-induced injury and diaphragm atrophy.
2. **Improved Efficiency:** Shorter weaning times and ICU lengths of stay translate to increased bed capacity and reduced healthcare costs.
3. **Uncompromised Safety:** Protocolized care is as safe as, and potentially safer than, physician judgment, with no increase in reintubation rates or mortality.

Recommendations:

- Hospitals should implement RT-driven weaning protocols as a standard of care for all mechanically ventilated adults.
- Protocols should be coupled with sedation interruption protocols to maximize efficacy.
- In regions without RTs, the "RT role" should be assigned to designated, trained physiotherapists or nurses to achieve similar outcomes.
- Future research should focus on "smart" protocols integrating AI decision support with RT expertise to further refine readiness prediction in complex populations.

7. References

[1] Huang, H.-Y., Yu-Chih, H., and Li, L.-F., Prolonged Mechanical Ventilation: Outcomes and Management. Journal of Clinical Medicine, 11. 2451 (2022).

[2] Zein, H., Baratloo, A., Negida, A., and Safari, S., Ventilator Weaning and Spontaneous Breathing Trials; an Educational Review. Emerg (Tehran), 4(2). 65-71 (2016).

[3] Balas, M., Tate, J., Tan, A., Pinion, B., and Exline, M., Evaluation of the Perceived Barriers and Facilitators to Timely Extubation of Critically Ill Adults: An Interprofessional Survey. Worldviews on evidence-based nursing, 18 (2021).

[4] Deliens, L., Cohen, J., Sallnow, L., and Tishelman, C., 7th Public Health Palliative Care International Conference. Democratizing caring, dying and grieving: participation, action, understanding and evaluation. Palliative Care and Social Practice, 16. 1-119 (2022).

[5] Blackwood, B., Burns, K.E., Cardwell, C.R., and O'Halloran, P., Protocolized versus non-protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients. Cochrane database of systematic reviews, (11) (2014).

[6] Lellouche, F., Mancebo, J., Jolliet, P., Roeseler, J., Schortgen, F., Dojat, M., Cabello, B., Bouadma, L., Rodriguez, P., Maggiore, S., Reynaert, M., Mersmann, S., and Brochard, L., A multicenter

randomized trial of computer-driven protocolized weaning from mechanical ventilation. Am J Respir Crit Care Med, 174(8). 894-900 (2006).

[7] Adam, S.K., Protocol directed weaning reduced time spent on mechanical ventilation. Evid Based Nurs, 1(16.1998) (1998).

[8] Tonnelier, J.M., Prat, G., Le Gal, G., Gut-Gobert, C., Renault, A., Boles, J.M., and L'Her, E., Impact of a nurses' protocol-directed weaning procedure on outcomes in patients undergoing mechanical ventilation for longer than 48 hours: a prospective cohort study with a matched historical control group. Crit Care, 9(2). R83-9 (2005).

[9] Piotto, R.F., Maia, L.N., Machado, M.N., and Orrico, S.P., Effects of the use of mechanical ventilation weaning protocol in the Coronary Care Unit: randomized study. Rev Bras Cir Cardiovasc, 26(2). 213-21 (2011).

[10] Chaiwat, O., Sarima, N., Niyompanitpattana, K., Komoltri, C., Udomphorn, Y., and Kongsayreepong, S., Protocol-directed vs. physician-directed weaning from ventilator in intra-abdominal surgical patients. J Med Assoc Thai, 93(8). 930-6 (2010).

[11] Alkhathami, M., Alenazi, M., Alsalamah, J., Alkhathami, F., Alshammari, S., Alanazi, H., Sreedharan, J., and Alnasser, M., Perceived responsibility for mechanical ventilation and weaning decisions in intensive care units in the Kingdom of Saudi Arabia. Canadian Journal of Respiratory Therapy, 59. 75-84 (2023).

[12] Kirakli, C., Ediboglu, O., Naz, I., Cimen, P., and Tatar, D., Effectiveness and safety of a protocolized mechanical ventilation and weaning strategy of COPD patients by respiratory therapists. J Thorac Dis, 6(9). 1180-6 (2014).

[13] Kollef, M.H., Shapiro, S.D., Silver, P., St John, R.E., Prentice, D., Sauer, S., Ahrens, T.S., Shannon, W., and Baker-Clinkscale, D., A randomized, controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation. Crit Care Med, 25(4). 567-74 (1997).

[14] Marelich, G.P., Murin, S., Battistella, F., Inciardi, J., Vierra, T., and Roby, M., Protocol weaning of mechanical ventilation in medical and surgical patients by respiratory care practitioners and nurses: effect on weaning time and incidence of ventilator-associated pneumonia. Chest, 118(2). 459-67 (2000).

[15] Surani, S., Sharma, M., Middagh, K., Bernal, H., Varon, J., Ratnani, I., Anjum, H., and Khan, A., Weaning from mechanical ventilator in a long-term acute care hospital: a retrospective analysis. The Open Respiratory Medicine Journal, 14. 62 (2020).

[16] Babcock, H.M., Zack, J.E., Garrison, T., Trovillion, E., Jones, M., Fraser, V.J., and Kollef, M.H., An educational intervention to reduce ventilator-associated pneumonia in an integrated health system: a comparison of effects. Chest, 125(6). 2224-31 (2004).

[17] Ely, E.W., Baker, A.M., Dunagan, D.P., Burke, H.L., Smith, A.C., Kelly, P.T., Johnson, M.M., Browder, R.W., Bowton, D.L., and Haponik, E.F., Effect on the duration of mechanical ventilation of identifying patients capable of breathing spontaneously. N Engl J Med, 335(25). 1864-9 (1996).

[18] Ely, E.W., Bennett, P.A., Bowton, D.L., Murphy, S.M., Florance, A.M., and Haponik, E.F., Large scale implementation of a respiratory therapist-driven protocol for ventilator weaning. Am J Respir Crit Care Med, 159(2). 439-46 (1999).