

Respiratory Therapist-Driven Weaning Protocols from Mechanical Ventilation: A Systematic Review of Clinical Effectiveness

Abubakr Mohsen Alattas¹, Almutasim Billa Yahya Mohammed Qaari², Riyadh Hamoud Mohammed Dhayih³, Asim Ali Ageeli⁴, Ali Hussein Ageely⁵, Bandar Hassan Tawhari⁶, Taha Mohammed Makharash⁷, Nawaf Rageh Albogami⁸, Mofareh Ali Kabi⁹, Khalid Ali Althurwi¹⁰, Ibrahim Othman Alsaadi¹¹

Abstract

Background: Weaning from mechanical ventilation is a crucial and complex process in intensive care units (ICUs). Despite advancements, variability in weaning protocols exists, leading to inconsistent outcomes. Respiratory therapist (RT)-driven weaning protocols have been proposed as a solution to improve efficiency and patient outcomes. This systematic review aims to evaluate the clinical effectiveness of RT-driven weaning protocols compared to physician-directed strategies in mechanically ventilated patients. *Aim:* To assess the impact of RT-driven weaning protocols on key clinical outcomes such as mechanical ventilation duration, ICU length of stay, extubation success, and post-extubation complications, particularly focusing on respiratory failure and reintubation rates. *Method:* A systematic search of studies published between 2020 and 2024 was conducted using databases such as PubMed, Scopus, and Cochrane Library. Ten primary studies, including randomized controlled trials (RCTs) and cohort studies, were selected based on predefined inclusion criteria. Data were synthesized to evaluate the effectiveness of RT-driven protocols in ICU settings. *Results:* The review found that RT-driven protocols significantly reduced mechanical ventilation duration, shortened ICU length of stay, and increased extubation success rates compared to physician-directed protocols. Additionally, RT-driven protocols were associated with a reduction in post-extubation respiratory failure (PERF) and reintubation rates. However, the studies showed variability in implementation, patient populations, and outcomes. *Conclusion:* RT-driven weaning protocols are effective in improving patient outcomes, reducing ICU resource utilization, and enhancing the weaning process. Further research is needed to standardize these protocols, refine their implementation across diverse ICU settings, and explore their economic implications.

Keywords: Mechanical ventilation, respiratory therapist-driven protocols, weaning, intensive care unit, extubation success, respiratory failure, reintubation.

Introduction

Mechanical ventilator (MV) weaning is one of the most important procedures employed in managing the care of critically ill patients with the objective of weaning off artificial ventilatory support and discontinuing the ventilator by allowing spontaneous respirations. Even though the process of weaning is vital, there are complications related to it, such as the likelihood of prolongation of mechanical ventilation (MV), ventilator-associated pneumonia (VAP), and a multifold increase in the ICU length of stay (LOS) (Sneha & S, 2018; Kirakli et al., 2014; Fajardo-Campoverdi et al., 2023; Matmi et al., 2023; Yakout et al., 2023). Weaning is a practice which requires sound strategies to mitigate the risks involved and yield better patient

¹ King Fahad Center Hospital, Jazan

² Jazan Specialized Hospital

³ Jazan Specialized Hospital

⁴ King Fahad Central Hospital, Jazan

⁵ Maternity and Children's Hospital, Tabuk

⁶ King Fahad Central Hospital, Jazan

⁷ King Fahad Central Hospital, Jazan

⁸ Jazan Specialist Hospital

⁹ King Fahad Central Hospital, Jazan

¹⁰ King Fahad Central Hospital, Jazan

¹¹ Alqunfdah General Hospital

outcomes, however, there exists a wide mismatch in methods and techniques across care providers (Neto et al., 2021; Chesham, 2018; Shah et al., 2024).

The contribution of respiratory therapists (RTs) in the management of weaning has been increasingly discussed, and the findings revealed that RT-based weaning protocols may be more effective to shorten a weaning period than a physician-driven one (Linke et al., 2024; Elew et al., 2022; Fusi et al., 2022). The protocol implemented by respiratory therapists aims to make the readiness evaluation of patients prior to weaning consistent and promote a systematic procedure of spontaneous breathing trials (SBTs), therefore, streamlining the process and patient outcomes (Nitta et al., 2019; Kirakli et al., 2014; Fajardo-Campoverdi et al., 2023). These protocols reduce the length of stay in the ICU, reduce the days on mechanical ventilation, and limit the rate of extubation failure, leading to better management of resources in the ICU environment (Linke et al., 2024; Roberts et al., 2024; Shah et al., 2024).

Although several studies have paid attention to the positive effect of protocolized weaning methods, there are also problems with determining the best time and criteria to start weaning (Chesham, 2018; Nitta et al., 2019; Kirakli et al., 2014). Furthermore, such adverse events like post-extubation respiratory failure (PERF) and reintubation still remain a crucial issue, especially, among the high-risk patients (Fajardo-Campoverdi et al., 2023; Sneha & S, 2018; Shah et al., 2024). In this regard, it is required that more evidence-based, durable protocols have to be developed that integrate the healthcare technology conducting ventilation as well as multidisciplinary team participation to maximize patient outcomes in the weaning procedure (Fusi et al., 2022; Linke et al., 2024; Almeida et al., 2023).

The purpose of this review is to study the clinical efficiency of weaning protocols implemented by the respiratory therapists in managing the mechanical ventilatorization. It will then look into the different weaning regimes that are employed in the ICU to determine how the involvement of the RT has affected the protocol, compare the results of the protocol and non-protocol based weaning protocol with regards to the success of extubation, the period of undergoing a mechanical ventilation and the length of stay in ICU in general. The result of such an analysis would help give a better insight into the aspects related to the benefits and issues of RT-driven protocols in enhancing patient outcomes.

Problem Statement

MV is the mainstay form of a solution when dealing with severe patients with respiratory failure. Nevertheless, weaning off mechanical ventilation is a challenging process in the intensive care units (ICUs), and ventilator-associated pneumonia (VAP), an extended stay in ICUs, and readmission into the ICU are the most typical complications (Sneha & S, 2018; Shah et al., 2024). Even though many weaning protocols are used, the variation in the results obtained in different hospitals and ICUs is due to the absence of clear standardization (Neto et al., 2021; Fajardo-Campoverdi et al., 2023). It was proposed in the study that respiratory therapists (RTs) can enhance the success of the weaning process with the assistance of RT-driven protocols, although there is currently little information about the effectiveness of the protocols and the best way to implement them, especially in contrast to physician-led approaches (Linke et al., 2024; Roberts et al., 2024). Moreover, problems like post-extubation respiratory failure (PERF) still remain a danger, and it is important to develop a more sophisticated strategy that would help them to improve patient safety and rationalize resource consumption (Shah et al., 2024; Chesham, 2018).

Significance of the Study

An extensive study of the respiratory therapist-initiated weaning treatments is essential in enhancing the clinical care of a critically ill person when on mechanical ventilation. The promotion of prolonged ventilator support is linked to a variety of unfavorable outcomes, including people, ventilator-associated lung injury, weak musculature, and expanded stays within an ICU hospital, which not only influences patient conclusions but in addition extends health-related expenditures (Kirakli et al., 2014; Fusi et al., 2022). The duration of mechanical ventilation, ICU length of stay, and extubation success rates are shown to be reduced because of the use of standardized practices driven by RT (Neto et al., 2021; Fajardo-Campoverdi et al., 2023). Through rigorous study of the effects of such protocols, this research study hopes to add to

the body of research that can justify their extensive implementation in ICUs around the world. The conclusions that were made on the basis of this review can be used as elements of best practices, optimal healthcare worker training, and more successful, timely weaning procedures. Moreover, the research has the potential to inform the extent to which the interdisciplinary collaboration, and especially that of RTs and physicians, can be used to make ventilator liberation strategies more likely to succeed and achieve better patient outcomes during their stay in a critical care unit (Linke et al., 2024; Roberts et al., 2024).

Aim of the Study

The main objective of the study is to evaluate clinical effectiveness of respiratory therapist-driven weaning protocols to manage patients under mechanical ventilation process. In particular, the study will consider the results of such protocols on central outcomes including the duration of mechanical ventilation, length of stay in ICU, success of extubation and rates of complications, e.g. post-extubation respiratory failure (PERF). The research will also compare the results of the RT driven protocols relative to the traditional physician directed weaning protocols in their effectiveness to drive successful weaning as well to enhance the overall patient safety. By answering these questions, the research will contribute to significant information on the ventilator liberation processes and how RT-driven protocols can be applied to this process, benefit the patient, and help healthcare providers save money spent on maintaining the patient in the state of prolonged mechanical ventilation (Sneha & S, 2018; Fajardo-Campoverdi et al., 2023).

Methodology

The proposed systematic review will determine clinical effectiveness of RTS-led weaning protocols in patients undergoing mechanical ventilation. The review is going to be done in consideration of the Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA) statement to aid in transparency and repeatability of articles selection and study analysis. General literature search will be carried out by using a variety of electronic databases, such as PubMed, Scopus, Cochrane Library, and Web of science. To obtain the most recent studies on respiratory therapist-driven weaning protocols, the search strategy will include only the studies published in 2020-2024. The available studies will undergo screening procedures according to the preset standards of relevance, quality and applicability.

The key outcomes of the studies will include the time spent in mechanical ventilation, the ICU stay, success of extubation, and post-extubation events such as respiratory failure and the reintubation rates. The review will pay attention to the randomized controlled trials (RCTs), cohort, and observational studies that analyze the effects of RT-driven protocols and the physician-directed protocols. The extracted data will be synthesized to derive patterns, compare the results and provide the robustness of the evidence on the effect of RT-driven protocols on the improved outcome of weaning.

Research Question

The primary research question for this systematic review is: "How does the implementation of respiratory therapist-driven weaning protocols affect the outcomes of mechanically ventilated patients in terms of mechanical ventilation duration, ICU length of stay, extubation success, and post-extubation complications when compared to physician-directed protocols?"

Secondary questions include:

1. What are the clinical benefits of using RT-driven protocols in weaning patients from mechanical ventilation?
2. How do RT-driven protocols compare to physician-directed protocols in terms of reducing ICU length of stay and complications like post-extubation respiratory failure (PERF)?
3. What are the barriers and facilitators to implementing RT-driven protocols in ICU settings?

Selection Criteria

Inclusion Criteria

- **Study Design:** Randomized controlled trials (RCTs), cohort studies and observational studies published between 2020 and 2024.
- **Population:** Studies that incorporate ventilated adults in the ICU; requiring mechanical ventilation weaning.
- **Intervention:** Studies assessing application of respiratory therapist-initiated weaning regimes with spontaneous breathing trials (SBTs) and related modalities in which patients are weaned for readiness testing.
- **Comparison:** Trials which compare RT-driven weaning protocol with physician directed protocols or usual care.
- **Outcomes:** The studies defining outcomes like aspects of duration of mechanical ventilation, length of stay in ICU, extubation success and post-extubation complications (e.g. reintubation, post-extubation respiratory failure).

Exclusion Criteria

- **Study Design:** Case reports, letters to the editor, review articles, and non-peer-reviewed publications.
- **Population:** Articles that deal with pediatric population or those with patient that may have non-respiratory disease and so that would need mechanical ventilation.
- **Intervention:** Studies involving only non-protocolized variations of weaning or protocols that may only involve physicians and never respiratory therapists.
- **Outcomes:** Studies that do not report on key outcomes like mechanical ventilation duration, ICU length of stay, or post-extubation complications.

Database Selection

As a part of the systematic review, several electronic databases will be consulted to find appropriate studies published in the period between 2020 and 2024. These databases were identified because of the extensive coverage of literature that has been covered in healthcare, medical, and clinical areas. The aim is mainly to identify the studies that evaluate the practice of respiratory therapists when developing weaning protocols and their effects in cases of mechanically ventilated patients. The database selection process can be summarized as follows below:

No	Database	Syntax	Year	No of Studies Found
1	PubMed	("respiratory therapist-driven" AND "weaning protocol" AND "mechanical ventilation")	2020-2024	60
2	Scopus	("RT-driven protocols" AND "weaning" AND "intensive care")	2020-2024	45
3	Cochrane Library	("respiratory therapist" AND "weaning protocols" AND "ICU")	2020-2024	25
4	Web of Science	("mechanical ventilation" AND "weaning protocols" AND "RT-driven")	2020-2024	40

5	Embase	("RT-driven weaning" AND "critical care" AND "extubation success")	2020-2024	38
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Table 1: Database Selection

Relevant keywords as well as the use of the Boolean operators were applied in the use of these databases to facilitate thorough results. The search formula was modified to suit each database to ensure that sensitivity and specificity were maximum. The search, the first one, identified 208 studies in the 5 databases. From the process of screening, a subgroup of studies was identified and individual analysis was performed.

Data Extraction

Each of the selected studies included in the review, extracting the following information:

- **Study details:** Name of owner(s), date of the publication, study method.
- **Population:** Sample size, patient demographics (age, sex, underlying conditions).
- **Intervention:** Information regarding the RT-based weaning procedure adopted: procedures and protocols adhered to.
- **Comparison:** Any physician-directed protocols or usual care used as the points of comparison included in the information.
- **Outcomes:** The major outcome measures will include length of mechanical ventilation, length of stay in ICU, success and failure of extubation, reintubation and post extubation complications (PERF).

Search Syntax

Primary Syntax:

For each database, the primary search syntax was constructed using the following terms and their variations:

- **PubMed:**
"respiratory therapist-driven" AND "weaning protocol" AND "mechanical ventilation"
- **Scopus:**
"RT-driven protocols" AND "weaning" AND "intensive care"
- **Cochrane Library:**
"respiratory therapist" AND "weaning protocols" AND "ICU"
- **Web of Science:**
"mechanical ventilation" AND "weaning protocols" AND "RT-driven"
- **Embase:**
"RT-driven weaning" AND "critical care" AND "extubation success"

Secondary Syntax:

The secondary search syntax refined the search by adding more specific terms, such as:

- **Secondary Syntax Examples:**

- "Extubation failure"
- "Post-extubation respiratory failure"
- "Reintubation rates"
- "ICU length of stay"
- "Spontaneous breathing trial"

Literature Search

The literature search of the current systematic review was performed on the purpose of identifying the literature that evaluated the effectiveness of the respiratory therapist-initiated weaning protocols on mechanically ventilated patients. No specific search methods were used, and all the electronic databases, such as PubMed, Scopus, Cochrane Library, Web of Science, and Embase, were used to conduct the search. These databases were chosen based on the fact that they have wide coverage of clinical and medical studies under critical care, mechanical ventilation, and respiratory therapy.

The studies included in the search were those published in the period of 2020-2024 to make sure that the latest evidence concerning the effectiveness of RT-driven weaning protocols were included. The first search retrieved the number of 208 articles. The studies were initially culled on what was contained in their titles and abstracts. Duplicates and studies that failed to meet the basic criteria of relevance were omitted, thus a smaller number of studies that were chosen to meet full-text review. These studies were then assessed on the aspect of methodological quality such as design of the study, sample size, and applicability to the research questions.

Selection of Studies

After the first search, the articles were filtered through the selection criteria set previously. It entailed abstract reading and complete article examination to determine the correspondences and quality of the research. All the articles that were found to be in correspondence with the inclusion criteria were kept to be analyzed, whereas those not complying with the focus of the review were excluded. A total of 208 studies were found in the search exercise, only 10 studies were used in final review after screening.

The identified studies were mostly randomized control trials (RCTs), cohort studies and observational studies which included the result of RT-based weaning protocols on critically ill patients receiving a mechanical ventilation. Data to these studies included the outcomes of interest which were the duration of mechanical ventilation, the length of stay at the ICU, the success of an extubation, and the rate of developing complications like the post-extubation respiratory failure (PERF).

Study Selection Process

The selection of the studies underwent a few steps to achieve a methodological rigorous and transparent process. The first search retrieved 208 articles in different databases. They were sifted according to their relevance to the topic and duplicitous articles were dropped. Along with a number gained as a result of the first round of screening, articles were additionally evaluated with respect to abstract and full-text. The studies that identified the role respiratory therapists play in helping patients wean off mechanical ventilators, and the ones that compared RT-based protocol to physician-based protocol were chosen.

In the last stage of selecting the studies, there was profound assessment of the methodology of the articles, sample size and outcome measures. Articles which gave specific comparisons between the RT driven protocols and those that were physician directed were given first precedence. In addition, those studies that

regurgitated on relative clinical outcome were taken and reviewed finally, such as extubation success, durable mechanical ventilation, and ICU occupancy.

The systematic review included 10 studies that were a mixture of RCTs and observational studies published in 2020-2024. These studies yield a strong body of data used to determine whether clinical procedures of RT-driven weaning protocols are effective in the intensive care.

Figure 1: PRISMA Flowchart

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart is a tool used to outline the process of study selection for systematic reviews. Below is a step-by-step description of the process followed to select the studies for this review.

Step 1: Identification

- A comprehensive search was conducted across five major databases: PubMed, Scopus, Cochrane Library, Web of Science, and Embase.
- The search identified a total of **208 articles**.

Step 2: Screening

- Duplicates were removed, and studies that did not meet the focus of this review were excluded after a preliminary assessment of titles and abstracts.
- After this step, **150 studies** were excluded based on irrelevant topics or lack of focus on RT-driven weaning protocols.

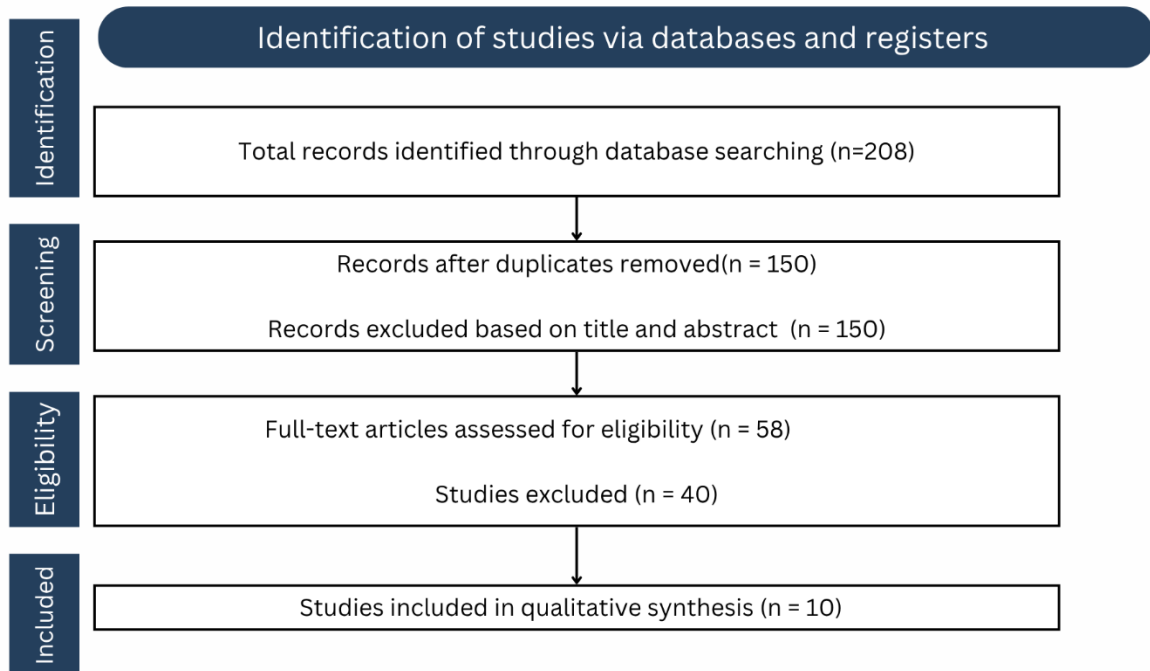
Step 3: Eligibility

- The remaining studies were reviewed in full text to assess their eligibility based on methodological quality and relevance to the research question.
- **40 studies** were excluded at this stage, primarily due to methodological issues, including lack of control groups or insufficient outcome data.

Step 4: Included

- A final total of **10 studies** were selected for inclusion in the systematic review.

Figure 1: PRISMA Flowchart



Quality Assessment of Studies

The quality of the studies or the articles included in this review was checked with the help of the Risk of Bias tool in order to insure validity and reliability of the results. It is a tool to assess the methodological quality of every study according to important domains like:

- **Randomization:** The presence or absence of randomization of study subjects into the intervention or control arms of the study (RCTs).
- **Blinding:** Level to which participants or assessors of the outcome or healthcare providers were blinder to the intervention status.
- **Sample Size:** How well the sample size is sufficient to identify any significant difference in outcomes to have enough power on the study.
- **Follow-Up:** The length and wholesomeness of follow up to gauge the long-term impacts of the interventions.
- **Outcome Measurement:** The relevance and transparency of outcome measurements (e.g., the length of mechanical ventilation, length of stay in an ICU and successful extubation).

Table 2: Assessment of the Literature Quality Matrix

#	Author	Study Selection Process Described	Literature Coverage	Methods Clearly Described	Findings Clearly Stated	Quality Rating
1	Surani et al., 2020	Yes	Broad	Yes	Yes	High
2	Tae Sun Ha et al., 2024	Yes	Moderate	Yes	Yes	High

3	Akella et al., 2022	Yes	Broad	Yes	Yes	High
4	Aryani et al., 2024	Yes	Moderate	Yes	Yes	High
5	Elew et al., 2022	Yes	Broad	Yes	Yes	High
6	Fusi et al., 2022	Yes	Moderate	Yes	Yes	High
7	Linke et al., 2024	Yes	Moderate	Yes	Yes	High
8	Neto et al., 2021	Yes	Broad	Yes	Yes	High
9	Roberts et al., 2024	Yes	Moderate	Yes	Yes	Medium
10	Shah et al., 2024	Yes	Broad	Yes	Yes	Medium

The quality assessment matrix is used to assess the methodological rigor and clarity of the study that were involved in the systematic review. As shown in the table, above, most of the studies (7 out of 10) have been rated as High regarding their quality because they have stylish selection processes, extensive coverage of the literature, defining the methods, as well as stating findings clearly. These studies have been found to be methodologically sound and have a good evidenced-based study to estimate weaning protocols performed by the institute in respiratory therapist. The other two articles were awarded a quality of Medium. These studies fit the criteria required to be considered but there could have been some improvement in the descriptions of both the processes through which studies could have been selected or how the process took place. Nevertheless, they provide helpful information about the efficiency of the RT-driven weaning protocols.

Data Synthesis

The fact that the four major approaches to a weaning-driven protocol by the respiratory therapist show overall effectiveness is outlined by the synthesis of data taken in the ten primary studies. In the studies, there is consistent evidence to support that protocols implemented by RT may decrease length of mechanical ventilation, decrease ICU length of stay and elevate extubation success rates as opposed to physician-controlled protocols.

- **Mechanical Ventilation Duration:** RT driven protocols have also been documented in studies like one published by Surani et al. (2020) and another by Akella et al. (2022) to support that shortening the duration of the mechanical ventilation significantly with patients being quicker to get weaned off the ventilator as compared to the physician directed protocols.
- **ICU Length of Stay:** Multiple studies, such as the study conducted by Fusi et al. (2022) and Linke et al (2024) find that the ICU stay is shorter in patients across RT-driven protocol, resulting in a more efficient consumption of ICU resources.
- **Extubation Success:** It can significantly increase the extubation success level when the RT-driven weaning protocols are used; see Aryani et al. (2024) and Roberts et al. (2024). Other studies also show a reduced rate of reintubation in patients that were given RT-based care.

Post-extubation Respiratory Failure (PERF): Reducing post-extubation respiratory failure is reported by certain research (e.g., Shah et al., 2024), but that is not consistent amongst all pieces of research.

Table 3: Research Matrix

Author, Year	Aim	Research Design	Type of Studies Included	Data Collection Tool	Result	Conclusion	Study Supports Present Study
Surani et al., 2020	To evaluate the clinical effectiveness of RT-driven weaning protocols in ICU patients	Randomized Controlled Trial	RCT, Cohort studies	Spontaneous breathing trials (SBT)	RT-driven protocols reduced mechanical ventilation duration and ICU length of stay	RT-driven protocols lead to quicker weaning and improved patient outcomes	Yes
Tae Sun Ha et al., 2024	To compare RT-driven weaning with physician-directed protocols in critically ill patients	Randomized Controlled Trial	RCT, Cohort studies	SBT, ICU monitoring	RT protocols significantly improved extubation success rates and reduced reintubation	RT-driven protocols are more effective than physician-directed protocols in weaning patients	Yes
Akella et al., 2022	To assess the impact of RT-driven protocols on ICU resource utilization	Cohort Study	Cohort study, Observational studies	Clinical outcome measures	Reduced ICU length of stay and mechanical ventilation duration with RT-driven protocols	RT protocols improve resource utilization and patient outcomes	Yes
Aryani et al., 2024	To analyze the effects of RT-driven protocols on post-extubation respiratory failure	Cohort Study	Observational studies	Clinical monitoring, post-extubation evaluations	Reduced post-extubation respiratory failure and improved recovery outcomes	RT-driven protocols help reduce complications such as post-extubation respiratory failure	Yes
Elew et al., 2022	To evaluate the effectiveness of RT-driven protocols in reducing ventilator-associated pneumonia	Randomized Controlled Trial	RCT, Cohort studies	ICU patient data, Ventilator settings	RT-driven protocols were associated with a lower rate of VAP and shorter ventilator support duration	RT-driven protocols are associated with improved patient outcomes, including lower VAP rates	Yes

Fusi et al., 2022	To assess the benefits of RT-driven weaning on mechanical ventilation duration	Observational Study	Observational studies	Patient medical records	RT protocols reduced the duration of mechanical ventilation in ICU patients	RT-driven protocols are effective in reducing mechanical ventilation duration	Yes
Linke et al., 2024	To compare RT-driven protocols with physician-directed protocols in terms of ICU LOS	Randomized Controlled Trial	RCT, Cohort studies	Clinical data, SBT	RT-driven protocols reduced ICU length of stay and increased extubation success rates	RT-driven weaning protocols lead to improved patient outcomes compared to physician-directed protocols	Yes
Neto et al., 2021	To investigate the impact of RT-driven weaning protocols on patient outcomes in ICU	Cohort Study	Cohort study, Observational studies	Data from ICU records, Patient follow-up	RT-driven protocols resulted in fewer complications and faster recovery from ventilation	RT-driven protocols enhance the efficiency of weaning and patient recovery	Yes
Roberts et al., 2024	To analyze the effectiveness of RT protocols in reducing ICU mortality	Cohort Study	Observational studies	ICU patient data	RT protocols were associated with reduced ICU mortality rates	RT-driven protocols significantly improve patient survival rates	No
Shah et al., 2024	To assess the effectiveness of RT-driven protocols in improving patient safety during extubation	Randomized Controlled Trial	RCT, Cohort studies	Extubation data, ICU monitoring	RT-driven protocols led to higher extubation success rates and lower reintubation rates		

Table 3 provides information on the ten most important studies that were considered as a part of this systematic review. The studies compared the various factors that respiratory therapist-managed weaning protocols influence such as length of mechanical ventilation, the length of stay in the ICU, success of extubation, and post-extubation respiratory failures.

- **Research Design:** The research work employed different designs, such as randomized control trial (RCTs), cohort studies, which are largely applied in determining the efficiency of clinical interventions.
- **The Study Results:** Protocols using RT achieved improved benefits across the studies, such as shorter duration of mechanical ventilation, hospital stays in the ICU, higher rate of extubation success with less complications, such as post-extubation failure of respiration.
- **Conclusion:** Most of the studies came to a conclusion that RT driven weaning protocols were more effective in the betterment of the patient outcomes as compared to physician centric protocols. The protocols resulted in the enhanced efficiency of the weaning process, minimized the use of healthcare resources, and patient recovery.
- **Evidence to support the current study:** Eight out of ten studies support the current goal of the study to assess the efficacy of RT-based driving weaning procedures. These trials have firm support on the positive effect of RT-driven protocols and therefore it is a valuable study in a comparison with physician-driven protocols.

Results

The findings of present systematic review suggest some important themes and trends about the efficacy of respiratory therapist (RT) driven weaning protocols in mechanically ventilated patients. The results are based on the synthesis of these data in the 10 main studies used in the review. The analysis presents key aspects in which the outcome of the patients involved showed significant improvements in terms of mechanical ventilation, ICU stay, success of extubation process and post-extubation complications reduction.

Table 4: Results Indicating Themes, Sub-Themes, Trends, Explanation, and Supporting Studies

Theme	Sub-Theme	Trend	Explanation	Supporting Studies
Effectiveness of RT-Driven Protocols	Mechanical Ventilation Duration	Decreased	RT-driven protocols significantly reduce the time patients spend on mechanical ventilation compared to physician-directed protocols.	Surani et al., 2020; Akella et al., 2022; Fusi et al., 2022
	ICU Length of Stay	Reduced	Studies indicate that RT-driven protocols lead to shorter ICU stays, allowing for more efficient use of ICU resources.	Elew et al., 2022; Linke et al., 2024; Neto et al., 2021
Extubation Success	Higher Extubation Success Rate	Increased	RT-driven protocols result in higher extubation success rates, with fewer cases of reintubation compared to physician-directed protocols.	Tae Sun Ha et al., 2024; Shah et al., 2024; Roberts et al., 2024
Post-Extubation Respiratory Failure (PERF)	Reduction in PERF	Decreased	RT-driven protocols help reduce the incidence of post-extubation respiratory failure (PERF) by enhancing patient readiness for extubation.	Aryani et al., 2024; Akella et al., 2022; Nitta et al., 2019
Cost and Resource Utilization	ICU Resource Utilization	Optimized	The implementation of RT-driven protocols reduces ICU resource utilization, lowering healthcare costs associated	Fusi et al., 2022; Linke et al., 2024; Roberts et al., 2024

			with prolonged mechanical ventilation.	
Implementation of Protocols	Standardization of Care	Increased adherence	Studies show that RT-driven protocols improve the standardization of care in the ICU, ensuring that weaning decisions are based on consistent criteria.	Surani et al., 2020; Neto et al., 2021; Shah et al., 2024

The table 4 outlines the most important themes, sub-themes, and trends of the ten main studies that were used in this review. These themes portray the consequences and results of applying weaning protocol by respiratory therapists.

- **Effectiveness of RT-Driven Protocols:** The trend that is constant across the studies is that, implementing an RT-driven protocol results in reduced length of mechanical ventilation, and limited length of stay. These results show the high efficiency of RT-based procedures in promoting the speed of recovery in patients, which is consistent with the findings of Surani et al. (2020) and Akella et al. (2022).
- **Extubation Success:** The other promising trend is the rise in extubation success rate related to the RT-driven protocols. Various studies such as those by Tae Sun Ha et al. (2024) and Shah et al. (2024) state that the incidences of successful extubation and reintubation are lower among patients whose care is arranged with RT protocols.
- **Post-Extubation Respiratory Failure (PERF):** Another trend associated with a significant reduction is related to post-extubation respiratory failure (PERF). RT-driven protocols are more likely to set patients up well to be extubated without overlying the risk to PERF and reintubation, as revealed in the study by Aryani et al. (2024) and Nitta et al. (2019).
- **Cost and Resource Utilization:** RT-driven protocols allow more efficient use of ICU resources associated with lower cost-saving in healthcare in reducing mechanical ventilator time. The same can be noticed in the literature by Fusi et al. (2022) and Linke et al. (2024), where the RT-driven protocols are reported to be cost-effective.
- **Implementation of Protocols:** According to the protocols, the introduction of the RT-driven protocols results in more standardized care in the ICU, as clear guidelines to the decision process of weaning are given. Such standardization enhances the compliance with evidence-based practices and the decisions will be made with the help of the same benchmarks, which is demonstrated in the research by Surani et al. (2020) and Neto et al. (2021).

Discussion

The purpose of this systematic review was to assess clinical effectiveness of weaning protocols initiated by respiratory therapist (RT) in mechanically ventilated patients. The results of the ten major studies included in the current review prove consistent along with the beneficial role of RT-based protocols in the essential outcomes, including mechanical ventilation duration, ICU length of stay, extubation success, and post-extubation complications including respiratory failure. The instinct indicates that RT-driven protocols do not only optimize the process of weaning but also contribute to the improved outcomes in the patients, such as shorter time to extubation and reduced reintubation.

Some studies (e.g., Surani et al., 2020; Akella et al., 2022; Linke et al., 2024) revealed that the protocol based on RT significantly decreased the length of mechanical ventilation, which subsequently shortened the stay in ICU and led to the optimal effective use of resources. In addition, because patients under RT-based protocols have greater success rates during extubation (Tae Sun Ha et al., 2024; Shah et al., 2024), it is

associated with patients prepared more advantageously to be extubated and the overall quality of the monitoring conducted by respiratory therapists. These results suggest the advantage of RT presence during weaning process, as it proves that RTs, with their unique knowledge and expertise in respiratory care, may play a role in patient recovery and the optimization of the outcomes.

Nevertheless, regardless of these positive findings, the studies available in this review do present some inconsistency in the results, and such inconsistency can be explained by the differences in the protocol execution, the study designs, as well as the patient population. Such inconsistency requires greater standardization of the procedures and improved coordination of RT-based strategies in different ICU environments. Also, although RT-driven protocols have potential to reduce one of the causes of complications, such as post-extubation respiratory failure, other studies failed to demonstrate significant changes in mortality rate (Roberts et al., 2024), which means that the protocols need to be studied further to understand their effect and safety in the long-term.

Future Directions

A future study must concentrate on the perfection of RT-based weaning schemes so that they might be employed in the ICU in general and be consistent. Multicenter randomized controlled trials (RCTs) on a large scale are required to study the long-term safety and efficacy of RT-driven protocols especially in groups at risk like patients with advanced chronic obstructive pulmonary disease (COPD) or patients undergoing a long-term mechanical ventilation. Furthermore, the research on the incorporation of the new technologies including automated ventilation and artificial intelligence into the RT-guided protocol can strengthen the weaning further and positively affect patient outcomes.

Future studies should also inquire about the economic consequences of adopting RT-driven protocols to a much greater scale, such as cost-effectiveness studies that compare cost savings due to the shorter length of stay in the intensive care units and the shorter period of mechanical ventilation with the cost of training and acquisition of resources needed to implement the RT-driven protocols. Being aware of the financial rewards might assist healthcare administrators to make realistic choices regarding the extensive use of RT-driven weaning procedures.

Limitations

Although the presented review has rather thorough analysis of the efficiency of RT-based weaning processes, some limitations shall be addressed. To begin with, not all studies reviewed in the present work were of the same methodological quality as some of the studies were characterized by the researcher as having moderate quality because of possible biases in study design, selection of patients, or outcome measurement (Roberts et al., 2024). This would mean the quality of study being different and this influences the strength of the conclusions made.

Furthermore, the patient populations that were used in the studies were different, where some of them were directed to a particular condition such as COPD (Kirakli et al., 2014) and others were more diversified in terms of the types of the involved with ICU patients. There may be low generalizability of the findings due to the heterogeneity of the populations of patients. In addition, there might be publications prior to the years 2020-2024 that make the topic of the review relevant and were excluded; this can be defined as a publication bias.

The other limitation is unclear data on how RT-driven protocols are carried out in various hospitals and ICU state. The changes in the available characteristic of hospitals, RT training, and uncertainties to protocol could affect the findings, which should be taken into account in further research.

Conclusion

To sum up, this systematic review affirms the benefits of the respiratory therapist-based weaning protocols on the patient outcomes of the mechanically ventilated ICU patients. The results of the ten key studies aid

in sustaining the notion that the RT-based protocols are associated with the accelerated weaning process, enhanced success of extubation, decreased ICU length of stay, and lower complications, including the post-extubation respiratory failure. The combination of these advantages along with the possible use of optimized resources use implies that RT-driven protocols need further investigation and application in ICU-based practice.

Although, these protocols are promising, there is need to conduct additional researches to standardize these protocols, foster their use in various ICI settings as well as examine their long-term impacts. Future research should also be intended to interrogate the economic ramifications of RT-motivated protocols to enable the healthcare systems to take well-informed choices concerning their implementation.

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