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The Comprehensive Systematic Review of Impact of Early Mobilization on Long-term Outcomes in ICU Patients

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ABSTRACT

Introduction: Early mobilization in intensive care unit (ICU) patients has been proposed to mitigate the deleterious effects of critical illness, yet its impact on long-term outcomes remains uncertain. This systematic review comprehensively evaluates the effects of early mobilization on long-term functional, cognitive, quality of life, and healthcare utilization outcomes in adult ICU patients.

Methods: A systematic review was conducted following PRISMA guidelines. We included randomized controlled trials, controlled clinical trials, cohort studies, case-control studies, systematic reviews, and meta-analyses involving adult ICU patients (≥18 years) who received early mobilization (initiated within 72 hours of ICU admission or mechanical ventilation) compared to standard care or delayed mobilization. Long-term outcomes were defined as

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those measured at least 30 days post-ICU or hospital discharge. Data were extracted on patient characteristics, mobilization protocols, long-term outcomes, safety, and study quality.

Results: Sixty-eight studies were included, comprising over 30,000 patients. Early mobilization consistently improved short-term functional outcomes, including muscle strength (mean difference 4.47-8.62 points on MRC scale), reduced ICU-acquired weakness (OR 2.04-2.7 for independent functional status), and increased likelihood of walking independently at discharge (OR 2.13) (Patel et al., 2023; Tipping et al., 2017; Hu et al., 2019). However, large randomized controlled trials found no significant improvement in long-term mortality (Hodgson et al., 2022) or quality of life at 6-12 months (Higgins et al., 2025). Notably, one trial demonstrated reduced cognitive impairment at 1 year (24% vs 43%, p=0.0043) (Patel et al., 2023). Subgroup analyses revealed potential harm in diabetic patients receiving high-intensity mobilization (adjusted OR 3.47 for 180-day mortality) (Serpa Neto et al., 2024). Adverse event rates were low (<3%), though the TEAM trial reported more events in the intervention group (9.2% vs 4.1%, p=0.005) (Hodgson et al., 2022).

Discussion: The evidence presents a complex picture where early mobilization yields clear short-term functional benefits that do not consistently translate into improved long-term survival or quality of life. Heterogeneity in protocols, patient populations, and outcome measures limits definitive conclusions.

Conclusion: Early mobilization safely improves in-hospital functional outcomes and reduces healthcare utilization. However, long-term benefits beyond hospital discharge remain unproven, and high-intensity protocols may harm specific subgroups.

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Individualized, progressive mobilization strategies are recommended.

Keywords: Early mobilization, intensive care unit, critical illness, long-term outcomes, functional status, ICU-acquired weakness, mechanical ventilation, quality of life

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INTRODUCTION

Background

Critical illness requiring intensive care unit (ICU) admission and mechanical ventilation is associated with profound and persistent physical, cognitive, and psychological sequelae, collectively termed post-intensive care syndrome (PICS). Patients commonly experience significant muscle wasting, weakness, and functional decline, which can persist for months to years following hospital discharge (Kress, 2009). The concept of early mobilization—initiating structured physical activity soon after ICU admission—emerged as a potential strategy to mitigate these complications by counteracting the deleterious effects of prolonged immobility and sedation (Morris et al., 2008; Schweickert et al., 2009).

The pathophysiological rationale for early mobilization is compelling. Immobility in critically ill patients accelerates muscle protein breakdown, leading to ICU-acquired weakness (ICU-AW) affecting up to 40-50% of mechanically ventilated patients (Patel et al., 2014). This weakness is associated with prolonged mechanical ventilation, extended ICU and hospital lengths of stay, increased mortality, and long-term functional disability (Hermans et al., 2014). Early mobilization theoretically preserves muscle mass and function, prevents joint contractures, improves respiratory mechanics, and may modulate the systemic inflammatory response (Winkelman et al., 2018).

The definition of "early" mobilization has varied across studies, typically ranging from within 24 hours to within 72 hours or the first week of ICU admission (Matsuoka et al., 2023; Daum et al., 2023). Interventions have progressed from passive range of motion in sedated patients to active exercises, sitting, standing, and ambulation, delivered by physiotherapists, nurses, or multidisciplinary teams (Schaller et al., 2016; Hodgson et al., 2016).

Research Gap

Despite extensive investigation over the past two decades, significant uncertainty remains regarding the true long-term benefits of early mobilization. While numerous studies have

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demonstrated improvements in short-term outcomes such as muscle strength at ICU discharge and reduced ventilation days (Tipping et al., 2017; Zang et al., 2020), the translation of these early gains into meaningful long-term improvements in quality of life, functional independence, and survival remains contested. Several large, high-quality randomized controlled trials have failed to show significant benefits in long-term outcomes (Hodgson et al., 2022; Moss et al., 2016), contradicting earlier positive findings from smaller studies and meta-analyses.

Furthermore, recent evidence has raised concerns about potential harm from high-intensity mobilization protocols, particularly in specific patient subgroups such as those with diabetes (Serpa Neto et al., 2024). The optimal timing, intensity, frequency, and duration of mobilization interventions remain poorly defined (Paton et al., 2024; Menges et al., 2021). Existing systematic reviews have reached conflicting conclusions, limited by heterogeneity in included studies, variable quality of primary research, and inconsistent outcome definitions and follow-up periods (Castro-Ávila et al., 2015; Calvo-Ayala et al., 2013).

Critically, few reviews have specifically focused on long-term outcomes defined as ≥30 days post-discharge, which is essential for understanding the true impact of early mobilization on patient-centered outcomes and healthcare resource utilization beyond the acute hospitalization period (Murooka et al., 2023; Paton et al., 2021).

Novelty of This Review

This comprehensive systematic review addresses these gaps by specifically focusing on long-term outcomes (≥30 days post-discharge) in adult ICU patients receiving early mobilization. Unlike previous reviews that have primarily concentrated on short-term endpoints, we synthesize evidence across multiple long-term domains: functional status, muscle strength, quality of life, cognitive function, psychological outcomes, mortality, and healthcare utilization. We incorporate the most recent large-scale randomized controlled trials, including the TEAM trial (Hodgson et al., 2022) and its secondary analyses (Serpa Neto et al., 2024; Higgins et al., 2025), as well as emerging evidence from COVID-19 populations (Markus et al., 2025; Saravankumar et al., 2024).

Furthermore, we critically examine subgroup effects and effect modifiers, including patient characteristics (illness severity, diagnosis, comorbidities), intervention characteristics (timing,

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intensity, frequency), and contextual factors (ICU type, care setting). This approach enables a nuanced understanding of which patients may benefit most from early mobilization and under what circumstances, moving beyond the simplistic question of whether early mobilization is effective to the more clinically relevant question of how to optimize its application for individual patients.

Research Objectives

The primary objective of this systematic review is to evaluate the impact of early mobilization on long-term outcomes (≥30 days post-ICU or hospital discharge) in adult ICU patients. Secondary objectives include: (1) to characterize early mobilization protocols and their association with outcomes; (2) to identify patient populations most likely to benefit or experience harm; (3) to assess the safety profile of early mobilization; and (4) to evaluate the quality of evidence and identify methodological limitations in the existing literature.

Hypotheses

We hypothesized that early mobilization would be associated with improved long-term functional outcomes and quality of life, reduced mortality, and decreased healthcare utilization compared to standard care. However, we anticipated that these effects might be modified by patient characteristics and intervention intensity, with potential heterogeneity across studies.

Research Benefits

This review provides clinicians, policymakers, and researchers with a comprehensive synthesis of current evidence to inform clinical practice guidelines, optimize resource allocation for ICU rehabilitation programs, and identify priorities for future research. By clarifying the long-term impact of early mobilization, we aim to support evidence-based decision-making that balances potential benefits against risks while promoting patient-centered recovery from critical illness.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This

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approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the impact of early mobilization on long-term outcomes in ICU patients.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Adult ICU Population**: Does the study include adult ICU patients (≥18 years old)?
- **Early Mobilization Definition**: Does the intervention involve early mobilization defined as structured physical activity initiated within 72 hours of ICU admission or mechanical ventilation?
- **Comparison Group**: Does the study include a comparison group (such as standard care, delayed mobilization, or no early mobilization)?
- **Long-term Outcomes**: Are outcomes measured at least 30 days post-ICU discharge or hospital discharge?
- **Study Design**: Is the study design a randomized controlled trial, controlled clinical trial, cohort study, case-control study, systematic review, or meta-analysis?
- **Isolatable Intervention**: Can early mobilization be distinguished as the primary intervention (i.e., is it NOT part of a multi-component intervention where mobilization effects cannot be isolated)?
- **Active Mobilization**: Does the intervention include active mobilization components (i.e., is it NOT limited to only passive range of motion or positioning)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

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Search Strategy

The keywords used for this research based PICO :

Element	P (Population)	I (Intervention/Exposure)	C (Comparison/Context)	O (Outcome)
Keyword 1	Intensive Care Unit Patients	Early Mobilization	Usual Care	Long-term Outcomes
Keyword 2	Critically ill patients	Early rehabilitation	Standard care	Functional status
Keyword 3	Adult ICU patients	Early activity	Conventional physiotherapy	Quality of life
Keyword 4	Mechanically ventilated patients	Physical therapy	Delayed mobilization	Mortality

The Boolean MeSH keywords inputted on databases for this research are: *("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*

Data extraction

- **Mobilization Protocol**:

  Extract comprehensive details about the early mobilization intervention in ICU patients, including:

  - Definition of 'early' (timing of initiation relative to ICU admission/mechanical ventilation)

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- Type of mobilization activities (passive ROM, active exercises, sitting, standing, walking, etc.)
- Frequency and duration of sessions
- Who delivered the intervention (physiotherapist, nurse, multidisciplinary team)
- Progression criteria and protocols
- Any comparison to control/standard care

- **ICU Patient Population**:

  Extract characteristics of the ICU patient population studied, including:

  - Primary diagnoses or reasons for ICU admission
  - Mechanical ventilation status and duration
  - Illness severity scores (APACHE, SOFA, etc.)
  - Age, gender, and other relevant demographics
  - Exclusion criteria that might limit generalizability
  - Baseline functional status or mobility level
  - Setting details (medical ICU, surgical ICU, mixed, etc.)

- **Long-term Outcomes**:

  Extract all long-term outcomes measured in relation to early mobilization in ICU patients, including:

  - Specific outcomes assessed (functional status, muscle strength, quality of life, mortality, return to work, etc.)
  - Measurement tools and scales used (Barthel Index, SF-36, MRC scale, etc.)
  - Follow-up time points (hospital discharge, 3 months, 6 months, 1 year, etc.)
  - Definition of 'long-term' used in the study
  - Any composite or primary endpoints specified

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- **Impact Results**:

  Extract the effects of early mobilization on long-term outcomes in ICU patients, including:

  - Direction of effect (beneficial, harmful, no difference) for each long-term outcome
  - Effect sizes with confidence intervals where reported
  - Statistical significance (p-values)
  - Clinical significance or meaningful differences noted by authors
  - Subgroup analyses or moderating factors affecting long-term outcomes
  - Any dose-response relationships identified

- **Safety Profile**:

  Extract safety and feasibility data for early mobilization in ICU patients, including:

  - Adverse events during mobilization sessions
  - Serious adverse events or complications
  - Session discontinuation rates and reasons
  - Contraindications or safety criteria used
  - Feasibility issues or barriers to implementation
  - Protocol adherence rates

- **Study Design**:

  Extract study design characteristics that affect the strength of evidence for early mobilization's impact on long-term outcomes in ICU patients, including:

  - Study type (RCT, quasi-RCT, cohort, etc.)
  - Sample size and power calculations
  - Randomization and blinding methods
  - Control group characteristics

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- Loss to follow-up rates for long-term outcomes
- Risk of bias considerations noted

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	*("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*	23
Semantic Scholar	*("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*	253
Springer	*("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*	527
Google Scholar	*("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*	1,370
Wiley Online Library	*("Intensive Care Unit Patients" OR "Critically ill patients" OR "Adult ICU patients" OR "Mechanically ventilated patients") AND ("Early Mobilization" OR "Early rehabilitation" OR "Early activity" OR "Physical therapy") AND ("Usual Care" OR "Standard care" OR "Conventional physiotherapy" OR "Delayed mobilization") AND ("Long-term Outcomes" OR "Functional status" OR "Quality of life" OR "Mortality")*	452

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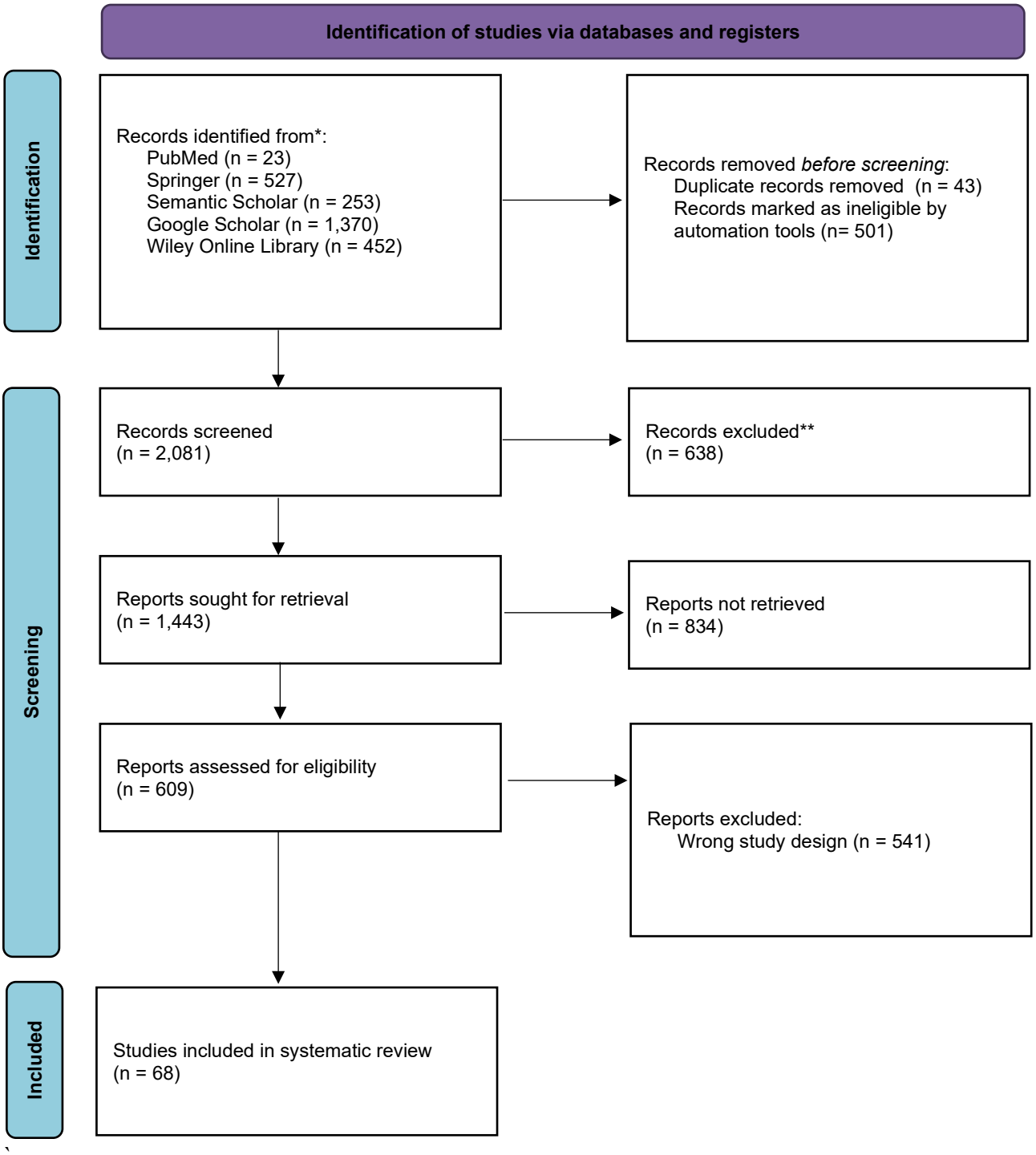


Figure 1. Article search flowchart

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RESULTS

Study Characteristics

The included studies evaluating early mobilization in ICU patients encompassed a variety of designs, settings, and methodologies. Sample sizes in primary studies varied widely, from a pilot RCT with 50 patients to a large-scale RCT with 750 participants.

Methodological quality aspects showed considerable variation. Randomization methods included computer-generated permuted balanced blocks and stratified block randomization. Blinding was often challenging, with most studies unable to blind participants or personnel, though assessor blinding was frequently implemented. Control group interventions typically consisted of "usual care" or "standard care," which often lacked clear definition and varied across centers, a potential source of heterogeneity. Several systematic reviews noted the methodological limitations of the primary studies, including a high risk of performance bias, heterogeneity in interventions and outcomes, and low overall quality. Loss to follow-up for long-term outcomes was a significant issue in some trials, with rates as high as 37% at 3 months, potentially affecting the validity of long-term findings. The ICU settings were diverse, including medical, surgical, neurological, and mixed ICUs, situated in multiple countries across North America, Europe, Australia, and Asia, which enhances the generalizability of some findings but also introduces variability.

Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
C. Hodgson et al. (2022)	750	Not mentioned	Not mentioned	Not mentioned	180 days	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
B. Patel et al. (2023)	200	Medical-surgical ICU	Computer-generated permuted balanced block	Assessors masked	1 year	Increased adverse events in intervention group
S. Schaller et al. (2016)	200	Surgical ICU	Stratified block randomization	Assessor-blinded	3 months	High loss to follow-up; clinicians not masked
Alisa M. Higgins et al. (2025)	733	49 ICUs in 6 countries	Not mentioned	Not mentioned	6 months	Increased adverse events in intervention group
Chuanlin Zhang et al. (2024)	132	Not specified	Randomized assignment	Not mentioned	3 months	Not mentioned
C. Hodgson et al. (2016)	50	5 ICUs in Australia and New Zealand	Random assignment	Not mentioned	6 months	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
S. Watanabe et al. (2022)	177	Mixed ICU	Not applicable	Not applicable	90 days	Small sample size, unmeasured confounders
David S. Wang et al. (2023)	750	49 sites in 6 countries	Randomized	Not specified	180 days	Potential bias from lack of blinding
Amr M Elsayed et al. (2020)	70	Not mentioned	Randomized	Single-blinded	28 days	Not mentioned
Tasuku Hanajima et al. (2025)	268	20 ICUs in Japan	Not randomized	Not mentioned	90 days	Not mentioned
Ary Serpa Neto et al. (2024)	741	Not mentioned	Not mentioned	Not mentioned	180 days	Not mentioned
Naishadh Brahmbhatt et al. (2010)	104	2 university hospitals	Randomized	Therapists blinded	28 days	Open label design

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Claire J. Tipping et al. (2017)	1753	Not mentioned	Not applicable	Not applicable	180 days	Studies of varying quality
Zhiqiang Li et al. (2013)	Not mentioned	ICU setting	Not applicable	Not applicable	1 year	Great heterogeneity, limited methodologic quality
W. Schweickert et al. (2009)	104	2 university hospitals	Computer-generated permuted block	Therapists blinded	28 days	Not mentioned
Katherine Doiron et al. (2013)	690	General, medical, or surgical ICU	Not applicable	Not applicable	Hospital discharge	High risk of performance bias, high dropout rates
T. Girard et al. (2023)	Not mentioned	USA	Randomized	Not mentioned	At least 1 year	Increased adverse events in intervention group

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Syed A Khan et al. (2025)	2385	Not mentioned	Not applicable	Not applicable	Not mentioned	Not mentioned
Yan Hu et al. (2019)	1347	Not mentioned	Not applicable	Not applicable	6 months	Publication bias analyzed
Lijie Wang et al. (2023)	1756	Adult ICU	Not applicable	Not applicable	180 days	Cochrane risk of bias tool used
Y. Okada et al. (2019)	1322	Surgical and general ICUs	Not applicable	Not applicable	6 months	High risk for performance and detection bias
Kate E Klein et al. (2018)	1117	Neurological ICU	Not randomized	Not mentioned	12 months	Not mentioned
Ayaka Matsuoka et al. (2023)	11 RCTs	Not specified	Not applicable	Not applicable	~6 months	Serious risks in selection and missing data

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
J. Saravankumar et al. (2024)	100	Not specified	Randomized	Not mentioned	ICU discharge	Not mentioned
Liping Yang et al. (2021)	1323	Not mentioned	Not applicable	Not applicable	12 months	Publication bias suggested
J. Saravankumar et al. (2024a)	200	Not explicitly mentioned	Randomized assignment	Not mentioned	Discharge	Not mentioned
Maximilian Markus et al. (2025)	6243	ICUs in 35 countries	Not applicable	Not applicable	60 days	Not mentioned
Lucas Huebner et al. (2024)	29	Surgical ICU	Not randomized	Not blinded	3 months	Single-center, small sample, retrospective control

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Maria Aparecida Stroppa de Paula et al. (2023)	85	Not mentioned	Randomized	Not mentioned	30 days post-hospital discharge	Not mentioned
H. Al-Dorzi et al. (2023)	1708	Mixed ICU	Randomized in original trial	Not explicitly described	90 days	Post hoc design
R. S. Queiroz et al. (2020)	118	Medical and surgical ICU	Randomized	Double-blind	28 days	Low risk anticipated
A. Takaoka et al. (2020)	926	Not mentioned	Not applicable	Not applicable	6 months	GRADE assessment used
Matthew J. Meyer et al. (2013)	200	Surgical ICU	Stratified randomization	Assessors blinded	3 months	Inability to blind primary outcome assessors

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Sabrina Eggmann et al. (2016)	115	Interdisciplinary ICU	Concealed allocation	Assessor-blinded	6 months	Heterogeneity of population
Debora Rosa et al. (2023)	10 articles	Not mentioned	Not applicable	Not applicable	Not mentioned	Not mentioned
Kui Zang et al. (2020)	1941	Not mentioned	Not applicable	Not applicable	Hospital discharge	Not mentioned
Jiani Wang et al. (2020)	39 articles	Not mentioned	Not applicable	Not applicable	6 months	Quality and risk of bias evaluated
A. Castro-Ávila et al. (2015)	774	Medical, surgical, multidisciplinary, respiratory ICUs	Not applicable	Not applicable	12 months	Limited by heterogeneity, inadequate concealment

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Peter E. Morris et al. (2008)	330	Medical ICU	Block allocation design	Not blinded	Hospital discharge	Lack of blinding, not individually randomized
B. Patel et al. (2014)	104	Medical ICU	Randomized	Therapists blinded	Hospital discharge	Secondary analysis limitations
D. Fraser et al. (2015)	132	Mixed ICU	Randomized	Not blinded	30 days	Retrospective design
D. S. Schujmann et al. (2019)	99	Not specified	Randomized	Blind evaluation	Not mentioned	Not mentioned
T. Hoffmann et al. (2009)	104	Medical ICUs	Computer-generated permuted block	Single-blinded (assessors)	28 days	Lack of blinding for patients/providers
Enrique Calvo-Ayala et al. (2013)	14 studies	Various	Not applicable	Not applicable	≥ 6 months	Heterogeneity, lack of blinding, high dropout

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Nils Daum et al. (2023)	1923	Not mentioned	Not applicable	Not applicable	Not mentioned	Assessed using RoB2
M. Paton et al. (2024)	7004	Not mentioned	Not applicable	Not applicable	Not mentioned	Cochrane risk-of-bias tool used
K. Carayannopoulos et al. (2025)	8462	ICU	Not applicable	Not applicable	Not mentioned	GRADE approach used
Yukie Murooka et al. (2023)	6679	Not mentioned	Not applicable	Not applicable	3 years	Propensity score matching used
S. Watanabe et al. (2022a)	192	Mixed ICU	Not randomized	Not mentioned	3 months	Lack of randomization, significant loss to follow-up
Luo Ruo Yu et al. (2023)	Not mentioned	ICU	Not applicable	Not applicable	Not mentioned	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Bin Chen et al., 2021	652	Cardiac surgery ICU	Not applicable	Not applicable	Not mentioned	Adjusted for heterogeneity
D. Campos et al. (2022)	139	ICU in Brazil	Randomized	Not mentioned	Not mentioned	Not mentioned
S. Schaller et al. (2019)	200	Not mentioned	Randomized, stratified by GCS	Outcome-assessor blinded	Hospital discharge	Not mentioned
J. Maheswaran et al. (2020)	Various	General or mixed ICU	Not specified	Not specified	Up to 1 year	Excludes certain ICU settings
C. Winkelman et al. (2018)	54	4 adult ICUs in 2 academic centers	Sealed envelope randomization	Blinded assessment of outcomes	ICU LOS	Lack of control group; loss to follow-up

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
T. M. P. C. Biazon et al. (2024)	1047	Brazil	Not mentioned	Not mentioned	Not mentioned	Not mentioned
F. Rottmann et al. (2023)	343	Single center	Not mentioned	Not mentioned	30 days	Not mentioned
Hsiao-Ching Yen et al. (2024)	65	Trauma ICU	Block randomization	Single-blind	3 months	Single center, modest sample size
Saisai Li et al. (2025)	3076	Not mentioned	Not applicable	Not applicable	Not mentioned	Not mentioned
Lai Wang et al. (2023)	1835	Not mentioned	Not applicable	Not applicable	6 months	Publication bias analyzed
Sofia Sancisi et al. (2022)	16 studies	ICU	Not applicable	Not applicable	6 months	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
F. Thiolliére et al. (2021)	276	Multiple French ICUs	Not randomized	Not mentioned	6 months	Significant loss to follow-up
J. Kress et al. (2009)	330	University medical ICU	Not randomized	Not mentioned	Hospital discharge	Observational design
P. Waldauf et al. (2020)	3548	Not mentioned	Not applicable	Not applicable	Not mentioned	Potential for incomplete implementation
Keibun Liu et al. (2022)	296	Mixed ICU	Not applicable	Not applicable	Hospital discharge	Retrospective, single-center design
R. Kwakman et al. (22)	40	Single center	Not mentioned	Not mentioned	Hospital discharge	Small sample size

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Wendie Zhou et al. (2022)	150	Dual-center (surgical, medical, emergency, cardiac, general ICUs)	Blinded external randomization	Data analyst and recruiters blinded	ICU discharge	No follow-up after ICU discharge
D. Mcwilliams et al. (2018)	103	Large UK ICU	1:1 stratified randomization	Not mentioned	Not mentioned	Not mentioned
Ryota Fuke et al. (2018)	6 RCTs	Not specified	Not applicable	Not applicable	6 months	High or unclear risk of performance and attrition bias
M. Paton et al. (2021)	186	2 tertiary hospital ICUs in Australia	Not applicable	Not mentioned	6 months	Not mentioned
Heidi J. Engel et al. (2013)	473	Medical-surgical ICU	Not applicable	Not applicable	Discharge	Retrospective data, lack of 7-day coverage

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Thatiana Barboza Carnevalli Bueno et al. (2025)	74	Brazil	Randomized	Blinded	6 months	Not mentioned
Jing-qi Zhou et al. (2022)	320	ICU	Not applicable	Not mentioned	Not mentioned	Not mentioned
C. Creutzfeldt et al. (2015)	Not mentioned	Neurological ICU	Not randomized	Not mentioned	12 months	Non-randomized design
N. Alugubelli et al. (2017)	200	Surgical ICUs	Randomized	Not mentioned	3 months	High loss to follow-up (38%)
Fabiano Oliveira da Rocha et al. (2024)	Not mentioned	ICU	Not applicable	Not applicable	Discharge	Not mentioned
Aishwarya Rai et al. (2025)	30	Not specified	Not applicable	Not mentioned	30 days	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Philipp Kloss et al. (2023)	4190	General ICU	Not applicable	Not applicable	Not available	Lack of long-term follow-up
Y. Mitobe et al. (2016)	63	ICU	Not randomized	Not applicable	ICU discharge	Selection and survivor bias
Jun Zhang et al. (2019)	917	Not mentioned	Not applicable	Not applicable	Not mentioned	Cochrane bias risk assessment used
J. I. Alvarado Sánchez et al. (2025)	74	Single center	Stratified randomization	Independent evaluator blinded	90 days	Not applicable
D. Menges et al. (2021)	1304	Mixed diagnoses	Randomized	Not specified	6 months	High risk of bias in most studies
H. Wozniak et al. (2024)	Not mentioned	ICU	Not applicable	Not applicable	Not mentioned	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
M. Munkwitz et al. (2010)	731	Medical ICUs	Not applicable	Not applicable	Hospital discharge	Significant heterogeneity
P. Morris et al. (2011)	280	ICU	Not applicable	Not mentioned	12 months	8% lost to follow-up
Inês Bento et al. (2025)	Not applicable	ICU	Not applicable	Not applicable	Discharge	Cochrane RoB 2 tool and GRADE system to be used
I. P. Cruz et al. (2021)	Not mentioned	Adult ICU	Not applicable	Not applicable	Not mentioned	Not mentioned
L. Salisbury et al. (2013)	790	Not mentioned	Not applicable	Not applicable	"months or years"	Methodological quality of most trials was low
K. Rosenberg et al. (2023)	Not mentioned	ICU	Not mentioned	Not mentioned	Not mentioned	Not mentioned

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Study	Sample Size	ICU Type/Setting	Randomization Method	Blinding Status	Follow-up Duration	Overall Risk of Bias Assessment
Amanda de Paula Silva et al. (2024)	5 articles	Adult ICUs	Not applicable	Not applicable	Not mentioned	Not mentioned

Patient Population Characteristics

The patient populations across the included studies were predominantly adult, critically ill patients requiring mechanical ventilation. Ages typically ranged from the mid-50s to early 70s. Primary reasons for ICU admission were diverse and included sepsis, pneumonia, trauma, COVID-19 related illness, post-surgical care, and acute respiratory failure. Illness severity was commonly measured using scores such as APACHE II and SOFA, with moderate to high scores reported in many studies.

A common inclusion criterion was baseline functional independence prior to hospitalization, often defined by a Barthel Index score of 70 or higher. This criterion may limit the generalizability of findings to patients with pre-existing functional limitations. Exclusion criteria frequently included pre-existing neuromuscular diseases, severe cognitive impairment, rapidly fatal conditions, unstable fractures, and certain neurological injuries. The mechanical ventilation status was a key characteristic, with many studies enrolling patients within 48 to 96 hours of intubation and expecting ventilation to continue for at least another 24 to 72 hours. The duration of mechanical ventilation was a frequently reported outcome, with early mobilization groups often showing a reduction in ventilation days.

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
C. Hodgson et al. (2022)	750	Not mentioned	Not mentioned	Not specified	100%	Not mentioned	Not mentioned	Not mentioned
B. Patel et al. (2023)	200	Not mentioned	57%	Not specified	100%	Not mentioned	Not mentioned	Functionally independent
S. Schaller et al. (2016)	200	Not mentioned	Not mentioned	Surgical patients	100%	Not mentioned	APACHE II used for stratification	Barthel Index ≥70
Alisa M. Higgins et al. (2025)	733	Not mentioned	Not mentioned	Not specified	100%	Not mentioned	Not mentioned	Not mentioned

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
Chuanlin Zhang et al. (2024)	132	Not mentioned	Not mentioned	Not specified	100%	Not mentioned	Not mentioned	Assessed by Barthel Index, Perme score, IMS
C. Hodgson et al. (2016)	50	61	60%	Not specified	100%	Not mentioned	Not mentioned	Not mentioned
S. Watanabe et al. (2022)	177	Not mentioned	Not mentioned	Not specified	Not mentioned	Not mentioned	APACHE II, SOFA recorded	Gait independence assessed

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
David S. Wang et al. (2023)	750	Not mentioned	Not mentioned	Sepsis (66%), Trauma (15%), COVID-19 (≤10%)	100%	Up to 28 days	Not mentioned	Assessed by ICU Mobility Scale
Amr M Elsayed et al. (2020)	70	Not mentioned	Both sexes	Pneumonia	100%	Reduced in intervention group	SOFA score used	Not mentioned
Tasuku Hanajima et al. (2025)	268	72-73	Not mentioned	Septic shock	Not mentioned	Not mentioned	APACHE II: 26-28	Not mentioned

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
Ary Serpa Neto et al. (2024)	741	Not mentioned	Not mentioned	21.4% with diabetes	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Naishadh Brahmbhatt et al. (2010)	104	Not mentioned	Not mentioned	Not specified	100%	More ventilator-free days in intervention group	Median APACHE II: 19.5	Functionally independent
S. Schaller et al. (2019)	200	Not mentioned	Not mentioned	Not specified	Not mentioned	Not mentioned	GCS used	Not mentioned

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
J. Saravankumar et al. (2024)	100	Not mentioned	Not mentioned	Severe COVID-19	Not mentioned	More ventilator-free days in intervention group	Not mentioned	Not mentioned
J. Saravankumar et al. (2024a)	200	Not mentioned	Not mentioned	Post-COVID ARDS	100%	10.1 days vs 13.7 days	Not mentioned	Assessed by IMS, FSS ICU
Maximilian Markus et al. (2025)	6243	Not mentioned	Not mentioned	SARS-CoV-2 infection	Yes, but % not specified	Not mentioned	Not mentioned	Not mentioned

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
Peter E. Morris et al. (2008)	330	~55	>50%	Acute respiratory failure	100%	Not mentioned	APACHE II: 21.6-23.5	ADL scores similar between groups
B. Patel et al. (2014)	104	Older in ICU-AW group	Not mentioned	Not specified	100%	Not mentioned	APACHE II scores used	Not mentioned
Lucas Huebner et al. (2024)	29	58-61	50-77%	Lung transplantation	100%	78h vs 126h	SAPS II: 46	FSS-ICU: 35
Hsiao-Ching Yen et al. (2024)	65	~52	~66%	Traumatic Brain Injury	100%	5.2 days vs 11.9 days	ISS ≥ 16	Assessed by Perme ICU Mobility score

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Study	Sample Size	Mean/ Median Age	Percent Male	Primary Diagnoses	Percent Mechanically Ventilated	Mean Ventilation Days	Severity Scores (APACHE/SOFA)	Baseline Functional Status
F. Thiollière et al. (2021)	276	>70	~50%	Medical, planned/ emergent surgery	~45%	Not mentioned	SAPS II: 47-48	Median ADL score: 6.0
Keibun Liu et al. (2022)	296	Not mentioned	65-74%	Sepsis	61% vs 70%	Not mentioned	APACHE II: 22-24; SOFA: 7-9	Lower ambulatory dependence in EM group

Table includes a representative subset of studies for illustrative purposes. For a comprehensive list, refer to the Study Characteristics table.

Early Mobilization Interventions

The definition of "early" mobilization varied across studies but generally referred to initiating interventions within the first few days of ICU admission or mechanical ventilation. Common definitions included within 24 hours, 48 hours, 72 hours, 96 hours, or within the first week.

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Interventions were typically progressive and goal-directed, delivered by physiotherapists, nurses, or multidisciplinary teams. Mobilization activities spanned a wide spectrum, including passive range of motion for sedated patients, active in-bed exercises, sitting on the edge of the bed, transferring to a chair, standing, and ambulation. Some studies also incorporated technologies like cycle ergometers or robotic-assisted devices. Session frequency was most often daily, with durations ranging from 20 to 60 minutes.

Progression of activities was guided by protocols based on patient stability, such as the Surgical ICU Optimal Mobilisation Score (SOMS) or achievement of specific functional milestones. Control groups typically received "usual care," which could range from no structured mobilization to some level of physical therapy ordered at the discretion of the primary team, making direct comparisons between studies complex. Some studies compared different intensities or frequencies of mobilization rather than mobilization versus no mobilization.

Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
C. Hodgson et al. (2022)	Not defined	Daily physiotherapy	Daily, mean 20.8 min	Physiotherapists	Not mentioned	Usual care mobilization
B. Patel et al. (2023)	Within 96h of MV	Not specified	Not specified	Not specified	Not specified	Usual care

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
S. Schaller et al. (2016)	≤1 day post-enrollment	Passive ROM, sitting, standing, ambulation	Daily goals set	Physical therapist, nurse, or doctor	SOMS algorithm, safety criteria	Individual centers' practice guidelines
C. Hodgson et al. (2016)	Not defined	Highest level of activity possible per ICU mobility scale	Not mentioned	Not mentioned	Not mentioned	Standard care
S. Watanabe et al. (2022)	Within 5 days of ICU admission	Passive ROM, active exercises, sitting, standing, walking	Not mentioned	Clinicians, physiotherapists, doctors	Physiological parameters (RASS, SpO2)	Late mobilization (>5 days)

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
David S. Wang et al. (2023)	During MV	Highest level of activity possible	Daily, 21 min vs 9 min	Physical therapists	Mobilize until fatigue; step-down approach	Usual care (considered 'early mobilization' by many)
Amr M Elsayed et al. (2020)	After 24h of intubation	Stepwise progressive mobilization	Not mentioned	Not mentioned	Not mentioned	No mobilization protocol
Tasuku Hanajima et al. (2025)	Within 48h of ICU admission	Sitting on edge of bed, standing	Not mentioned	Not mentioned	Not mentioned	No early rehabilitation group
Naishadh Brahmbhatt et al. (2010)	During daily sedation interruption	Physical and occupational therapy	Regular sessions	Therapists	Goal-oriented progression	Therapy as ordered by primary team

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
W. Schweickert et al. (2009)	Earliest days of critical illness	Physical and occupational therapy	Not specified	Not specified	Not specified	Therapy as ordered by primary team
Katherine Doiron et al. (2013)	During or after MV in ICU	ROM, bed mobility, transfers, ambulation	Not mentioned	Not mentioned	Not mentioned	Poorly described usual care
Syed A Khan et al. (2025)	Within 72h of ICU admission	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Usual care
Lijie Wang et al. (2023)	Within 3 days of ICU admission	Head up, sitting, standing, walking	1-3 times daily, 20-60 min	Not specified	Not detailed	Late mobilization and standard EM groups
Y. Okada et al. (2019)	Within 1 week of ICU admission	Physical and/or occupational therapy	Not mentioned	Physiotherapists or multidisciplinary team	Not detailed	Usual care or later mobilization

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
Ayaka Matsuoka et al. (2023)	Within 72h of ICU admission	Physical rehabilitation	Daily in most studies	Not specified	Not detailed	Usual care
J. Saravanakumar et al. (2024)	Within 48-72h of ICU admission	Not specified	Not mentioned	Not specified	Stepwise progression (4 levels)	Not detailed
Liping Yang et al. (2021)	Not mentioned	Passive/active mobilization, sitting, standing, chair transfer, walking	Not mentioned	Not mentioned	Not mentioned	Routine care
J. Saravanakumar et al. (2024a)	Within 48h of ICU admission	Structured physical therapy	Not mentioned	Not specified	Not mentioned	Standard care

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
Maximilian Markus et al. (2025)	Within 72h of ICU admission	Not specified	Not specified	Not specified	Not specified	No early mobilization group
Lucas Huebner et al. (2024)	Within first week of ICU admission	Robotic-assisted verticalization and stepping	Twice daily, 20 min	ICU team	Progression based on patient comfort	Conventional mobilization by PTs and nurses
H. Al-Dorzi et al. (2023)	First 3 ICU days	Passive ROM, active sitting, active standing	Median 5 days/week	Physiotherapist	Not mentioned	Not applicable (comparison by mobility level achieved)

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Study	Definition of Early/Timing	Mobilization Activities	Session Frequency/ Duration	Intervention Deliverer	Progression Criteria	Control Group Description
R. S. Queiroz et al. (2020)	Not specified	Progressive functional movements (rolling, sitting, standing, walking)	Once daily, 5x/week	Trained physiotherapists	Minimal assistance, Borg scale ≤6	Usual care by hospital physiotherapists

Table includes a representative subset of studies for illustrative purposes.

Functional and Physical Outcomes

The impact of early mobilization on long-term functional and physical outcomes is a central theme in the literature, with many studies reporting beneficial effects. Key outcomes assessed include functional status, muscle strength, and mobility levels, often measured at ICU discharge, hospital discharge, and several months post-discharge.

Several studies and meta-analyses found that early mobilization significantly improved muscle strength, as measured by the Medical Research Council (MRC) sum score. For instance, one meta-analysis reported a mean difference of 8.62 points on the MRC scale favoring the intervention, while another found a weighted mean difference of 4.47. A consistent finding was a reduction in the incidence of ICU-acquired weakness (ICU-AW) in mobilized groups. The odds of developing ICU-AW were significantly lower in patients receiving early mobilization combined with early nutrition and in those receiving early physical and occupational therapy.

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Functional status, often evaluated using the Barthel Index or Functional Independence Measure (FIM), also showed improvements. Patients in intervention groups were more likely to return to independent functional status at hospital discharge, with one trial reporting a 24% absolute improvement. Mobility outcomes, such as the ability to walk without assistance at discharge, were also positively affected, with one meta-analysis finding that mobilized patients were more than twice as likely to achieve this milestone. Studies using tools like the Physical Function ICU Test (PFIT) or ICU Mobility Scale (IMS) reported higher scores for intervention groups at discharge. However, not all studies found significant benefits; some reported no difference in certain functional measures or muscle strength outcomes, such as handgrip strength. One large RCT found no difference in activities of daily living at 180 days.

Dose-response relationships were also explored. One study suggested that achieving higher levels of mobilization (e.g., standing or walking), rather than simply increasing the number of sessions, was independently associated with improved health status and mobility at 6 months. Another found that twice-daily sessions were associated with better muscle strength compared to once-daily sessions.

Study	Outcome Measure	Follow-up Timepoint	Intervention Group Result	Control Group Result	Effect Size (95% CI)	p-value
B. Patel et al. (2023)	ICU-acquired weakness	1 year	0%	14%	Absolute difference -14.1% (-21.0 to -7.3)	0.0001
S. Schaller et al. (2016)	Functional mobility (mmFIM)	Hospital discharge	Median 8	Median 5	Not reported	0.0002

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Study	Outcome Measure	Follow-up Timepoint	Intervention Group Result	Control Group Result	Effect Size (95% CI)	p-value
Chuanlin Zhang et al. (2024)	Functional status (BI)	3 months	90.6 ± 18.0	77.7 ± 27.9	Not reported	0.005
Chuanlin Zhang et al. (2024)	Capacity of mobility (Perme)	3 months	17.6 ± 7.1	12.2 ± 8.5	Not reported	< 0.001
Naishadh Brahmbhatt et al. (2010)	Return to independent functional status	Hospital discharge	59%	35%	OR 2.7 (1.2-6.1)	0.02
W. Schweickert et al. (2009)	Return to independent functional status	Hospital discharge	59%	35%	OR 2.7 (1.2-6.1)	0.02
Claire J. Tipping et al. (2017)	Muscle strength (MRC Sum Score)	ICU discharge	Not reported	Not reported	MD 8.62 (1.39-15.86)	Not reported
Claire J. Tipping et al. (2017)	Walking without assistance	Hospital discharge	Not reported	Not reported	OR 2.13 (1.19-3.83)	Not reported

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Study	Outcome Measure	Follow-up Timepoint	Intervention Group Result	Control Group Result	Effect Size (95% CI)	p-value
Yan Hu et al. (2019)	Muscle strength (MRC-Score)	Hospital discharge	Not reported	Not reported	MD 4.74 (2.30-7.19)	0.0001
Yan Hu et al. (2019)	Independent walking ability	Hospital discharge	Not reported	Not reported	OR 2.04 (1.39-2.99)	0.0003
J. Saravankumar et al. (2024)	Physical Function (PFIT)	ICU discharge	25.4	18.2	Not reported	< 0.001
J. Saravankumar et al. (2024)	Muscle Strength (MRC sum score)	ICU discharge	48.6	35.4	Not reported	< 0.001
Kui Zang et al. (2020)	Muscle strength (MRC score)	Hospital discharge	Not reported	Not reported	WMD 4.47 (1.43, 7.52)	0.004

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Study	Outcome Measure	Follow-up Timepoint	Intervention Group Result	Control Group Result	Effect Size (95% CI)	p-value
Kui Zang et al. (2020)	Functional mobility (Barthel Index)	Hospital discharge	Not reported	Not reported	WMD 21.44 (10.97, 31.91)	< 0.001
Thatiana Barboza Carnevalli Bueno et al. (2025)	Functional Independence (Barthel Index)	6 months	Significantly higher	Not applicable	Not reported	< 0.05
M. Paton et al. (2021)	Mobility (EQ-5D-5L mobility domain)	6 months	Higher levels of mobilization improved scores	Not applicable	β = 0.127 (0.049-0.205)	0.001

Quality of Life and Psychosocial Outcomes

The assessment of quality of life (QoL) and psychosocial outcomes is an important component of evaluating long-term recovery after critical illness. Several studies investigated these domains using validated instruments such as the Short Form-36 (SF-36) and the EuroQol-5D (EQ-5D), with follow-up periods typically ranging from 3 to 12 months post-discharge.

The findings regarding the impact of early mobilization on QoL have been mixed. One large RCT involving 750 patients found no significant difference in QoL, cognitive function, or

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psychological function between the early mobilization and usual care groups at 180 days. Similarly, a cost-effectiveness analysis alongside the same trial found no significant difference in EQ-5D utility scores at 6 months. Several systematic reviews and meta-analyses also concluded that there was no consistent effect on QoL.

However, some studies have reported positive effects. One trial found that early mobilization led to higher physical component scores on QoL testing at 1 year, though mental component scores were similar between groups. Another study noted that achieving higher levels of mobilization, as opposed to just more frequent sessions, was independently associated with improved EQ-5D utility scores at 6 months. Furthermore, a study in a neurological ICU reported sustained reductions in psychological distress, including depression, anxiety, and hostility, at 12 months post-implementation of an early mobility program. A prospective cohort study found that early mobilization was associated with a lower incidence of psychiatric symptoms (depression, anxiety, or PTSD) at 3 months post-discharge.

Cognitive outcomes have also been examined. A significant finding from one RCT was that early mobilization reduced the rate of cognitive impairment at 1 year from 43% to 24%, suggesting it may be a key intervention for preventing long-term cognitive deficits post-ICU stay. However, other large trials and reviews have found no significant impact on cognitive function.

Study	Instrument Used	Follow-up Timepoint	Intervention Group Scores	Control Group Scores	Between-Group Difference (95% CI)	Statistical Significance
C. Hodgson et al. (2022)	Not specified	180 days	Similar to control	Similar to intervention	Not reported	No significant difference

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Study	Instrument Used	Follow-up Timepoint	Intervention Group Scores	Control Group Scores	Between-Group Difference (95% CI)	Statistical Significance
B. Patel et al. (2023)	Montreal Cognitive Assessment	1 year	24% cognitive impairment	43% cognitive impairment	Absolute difference -19.2% (-32.1 to -6.3)	p=0.0043
B. Patel et al. (2023)	QoL Physical Component	1 year	Median 52.4	Median 41.1	Not reported	p<0.0001
B. Patel et al. (2023)	QoL Mental Component	1 year	Median 55.9	Median 55.2	Not reported	p=0.98
Alisa M. Higgins et al. (2025)	EuroQoL-5D 5-level	6 months	0.532 (SE 0.021)	0.548 (SE 0.021)	Not reported	p=0.585
Syed A Khan et al. (2025)	Not specified (QOL)	Not specified	Not reported	Not reported	SMD 0.04 (-0.07-0.15)	p=0.50
Lai Wang et al. (2023)	SF-36 (PCS)	6 months	Not reported	Not reported	WMD 1.83 (-0.28-3.93)	p>0.05

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Study	Instrument Used	Follow-up Timepoint	Intervention Group Scores	Control Group Scores	Between-Group Difference (95% CI)	Statistical Significance
Lai Wang et al. (2023)	SF-36 (MCS)	6 months	Not reported	Not reported	WMD 1.72 (-0.76-4.20)	p>0.05
Kate E Klein et al. (2018)	Psychological Health Tool	12 months	Reduced distress	Higher distress (pre-intervention)	Not reported	p<0.001
S. Watanabe et al. (2022a)	HADS, IES-R	3 months	25% with psychiatric symptoms	51% with psychiatric symptoms	OR 0.27 (Adjusted)	p=0.032 (adjusted)
A. Takaoka et al. (2020)	Not specified (QoL)	6 months	Not reported	Not reported	MD 9.13 (-13.80 to 32.05)	Not mentioned
Y. Okada et al. (2019)	SF-36 (Physical Functioning)	6 months	Not reported	Not reported	MD 4.65 (-16.13 to 25.43)	Not mentioned

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Study	Instrument Used	Follow-up Timepoint	Intervention Group Scores	Control Group Scores	Between-Group Difference (95% CI)	Statistical Significance
M. Paton et al. (2021)	EQ-5D-5L Utility Score	6 months	Higher levels of mobilization improved scores	N/A (Cohort study)	β = 0.022 (0.002–0.042)	p=0.033
Thatiana Barboza Carnevalli Bueno et al. (2025)	Not specified (QoL)	6 months	Significantly improved	Not applicable	Not reported	p<0.05

Mortality and Healthcare Utilization

The impact of early mobilization on mortality and healthcare utilization outcomes, such as length of stay (LOS) and ventilator days, has been extensively studied, though results are not entirely consistent. Multiple large-scale RCTs and meta-analyses have found no significant effect of early mobilization on short-term (ICU or hospital) or long-term (90-day, 180-day, or 1-year) mortality. One of the largest trials found 180-day mortality rates of 22.5% in the intervention group versus 19.5% in the usual care group (OR 1.15, 95% CI 0.81-1.65). However, a secondary analysis of this trial revealed a significantly increased risk of 180-day mortality for patients with diabetes who received high-dose early mobilization (adjusted OR 3.47, 95% CI 1.67-7.61). Conversely, two observational studies found that early mobilization was associated with reduced mortality at 60 days in COVID-19 patients and at 90 days in a general ICU population.

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Healthcare utilization outcomes have generally shown more favorable results. Numerous studies and meta-analyses have reported that early mobilization is associated with a statistically significant reduction in ICU LOS, hospital LOS, and duration of mechanical ventilation. For instance, meta-analyses have reported reductions in ICU LOS by approximately 1-2 days and ventilation duration by 1-2 days. Patients receiving early mobilization were also more likely to be discharged home rather than to another care facility. However, some large trials did not find significant differences in these utilization outcomes.

Study	ICU Mortality	Hospital Mortality	Long-term Mortality	ICU LOS (days)	Hospital LOS (days)	Ventilator Days	Discharge Disposition
C. Hodgson et al. (2022)	Not reported	Not reported	22.5% vs 19.5% (180d)	No difference	No difference	No difference	Not reported
S. Schaller et al. (2016)	16% vs 8%	Not reported	22% vs 17% (3mo)	7 vs 10	Not reported	Not reported	Improved functional mobility at discharge
Chuanlin Zhang et al. (2024)	Lower in IG	Not reported	Not reported	No difference	No difference	No difference	Not reported

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Study	ICU Mortality	Hospital Mortality	Long-term Mortality	ICU LOS (days)	Hospital LOS (days)	Ventilator Days	Discharge Disposition
David S. Wang et al. (2023)	No difference	Not reported	No difference (180d)	No difference	No difference	No difference	Not reported
Amr M Elsayed et al. (2020)	Lower at day 7	Not reported	Lower at day 28	Reduced	Reduced	Reduced	Not reported
Tasuku Hanajima et al. (2025)	Not reported	Not reported	28% vs 23% (90d)	Not reported	Not reported	Not reported	Not reported
Ary Serpa Neto et al. (2024)	Not reported	Not reported	Higher in diabetes subgroup (180d, aOR 3.47)	Not reported	Not reported	Not reported	Not reported

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Study	ICU Mortality	Hospital Mortality	Long-term Mortality	ICU LOS (days)	Hospital LOS (days)	Ventilator Days	Discharge Disposition
W. Schweickert et al. (2009)	Not reported	Not reported	Not reported	No difference	No difference	More ventilator-free days (23.5 vs 21.1)	Not reported
Syed A Khan et al. (2025)	Not reported	Not reported	No diff (RR 1.10)	Reduced (MD -1.02)	Not reported	Reduced (MD -1.07)	Not reported
Peter E. Morris et al. (2008)	Not reported	Not reported	Not reported	5.5 vs 6.9	11.2 vs 14.5	Not reported	Not reported
Maximilian Markus et al. (2025)	Not reported	No difference	Reduced (OR 0.74, 60d)	No difference	No difference	Not reported	Lower transfer rates to other facilities (OR 0.74)

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Study	ICU Mortality	Hospital Mortality	Long-term Mortality	ICU LOS (days)	Hospital LOS (days)	Ventilator Days	Discharge Disposition
H. Al-Dorzi et al. (2023)	Not reported	Not reported	Lower (aHR 0.43-0.47, 90d)	More ICU-free days	Not reported	More ventilator-free days	Not reported
Yukie Murooka et al. (2023)	Not reported	Not reported	No difference (log-rank p=0.18)	Not reported	Shorter future hospitalization (1.9 vs 2.6 mo)	Not reported	Not reported
J. Saravankumar et al. (2024)	Not reported	Not reported	Similar rates	10.4 vs 14.2	18.5 vs 24.1	More ventilator-free days (20.3 vs 14.7)	Not reported

Safety and Feasibility

The safety and feasibility of early mobilization in critically ill patients have been consistently demonstrated across numerous studies, with most concluding that the practice is safe and associated with a low incidence of adverse events. A systematic review found the overall chance of an adverse event occurring during mobilization was less than 3%, and another meta-

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analysis found no statistically significant difference in adverse events between early mobilization and usual care groups.

However, some large RCTs have raised concerns. The TEAM trial reported a significantly higher number of adverse events in the intervention group (9.2%) compared to the usual care group (4.1%, p=0.005), including seven serious adverse events versus one in the control group. These events primarily consisted of arrhythmias, altered blood pressure, and oxygen desaturation. Another trial also reported a higher number of adverse events in the intervention group, though none were classified as serious. Reasons for discontinuing mobilization sessions, when reported, were most commonly patient instability, such as patient-ventilator asynchrony or fatigue.

Feasibility has been established in various settings, including neurological ICUs and community hospitals, with studies showing that structured, nurse-led, or multidisciplinary team-led protocols can be implemented successfully. Identified barriers to implementation include resource limitations, the need for staff training and education, and overcoming a culture of immobility in the ICU. Safety protocols and contraindications are crucial for safe implementation, with studies using specific physiological parameters (e.g., hemodynamic stability, oxygenation levels) to guide initiation and progression of mobilization.

Study	Total Mobilization Sessions	Adverse Events (n, %)	Serious Adverse Events	Session Discontinuations (n, %)	Adherence Rate	Major Barriers Identified
C. Hodgson et al. (2022)	Not reported	34 (9.2%) vs 15 (4.1%)	7 vs 1	Not reported	Not reported	Not reported
B. Patel et al. (2023)	Not reported	7 (6%) vs 0 (0%)	Not reported	Not reported	Not reported	Not reported

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Study	Total Mobilization Sessions	Adverse Events (n, %)	Serious Adverse Events	Session Discontinuations (n, %)	Adherence Rate	Major Barriers Identified
S. Schaller et al. (2016)	Not reported	25 (2.8%) vs 10 (0.8%)	None observed	Not reported	Not mentioned	Bedside clinicians not masked
W. Schweickert et al. (2009)	498 (intervention group)	Not reported	1 (desaturation)	19 (4%)	Not reported	Not reported
Katherine Doiron et al. (2013)	Not reported	Desaturation, catheter dislodgement	Not specified	19 of 498 (4%)	Not reported	Not reported
Ayaka Matsuoka et al. (2023)	Not reported	Bradycardia, decreased BP/SpO2	None reported	Not reported	Not reported	Not reported
A. Takaoka et al. (2020)	3117 (cycling sessions)	5 (0.16%)	Not reported	Not reported	Not reported	Not reported

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Study	Total Mobilization Sessions	Adverse Events (n, %)	Serious Adverse Events	Session Discontinuations (n, %)	Adherence Rate	Major Barriers Identified
Peter E. Morris et al. (2008)	Not reported	None reported	None reported	Frequent reason was patient fatigue	Not reported	Not reported
C. Winkelman et al. (2018)	Not reported	None occurred	None occurred	~20%	High adherence with trained RNs	No baseline muscle strength data
D. Fraser et al. (2015)	Not reported	No adverse events in mobility group	Not reported	Not reported	Not reported	Lack of standardized workflows, need for education
M. Paton et al. (2024)	Not reported	<3% chance	Not reported	Not reported	Not reported	Not reported

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Study	Total Mobilization Sessions	Adverse Events (n, %)	Serious Adverse Events	Session Discontinuations (n, %)	Adherence Rate	Major Barriers Identified
Syed A Khan et al. (2025)	Not reported	No significant difference (RR 1.72)	Not reported	Not reported	Not reported	Not reported

Subgroup Analyses and Effect Modifiers

Subgroup analyses across the included studies have identified several factors that may modify the effects of early mobilization on long-term outcomes. Illness severity and patient diagnosis appear to be important moderators. Patients with lower illness severity at admission (e.g., APACHE II score <20) and those with a longer expected ICU stay may derive the most benefit from rehabilitation interventions. In a trial of surgical ICU patients, early, goal-directed mobilization was found to be effective even in patients with an impaired initial state of consciousness (GCS ≤ 8), suggesting that a low GCS is not necessarily a contraindication.

Patient comorbidities also play a critical role. A secondary analysis of the TEAM trial found a significant interaction between diabetes status and the intervention's effect on mortality. While high-dose early mobilization did not improve the primary outcome of days alive and out of the hospital for patients with diabetes, it was associated with a more than threefold increase in 180-day mortality compared to usual care. This finding highlights a specific patient population for whom high-intensity mobilization may be harmful and underscores the need for careful patient selection.

The characteristics of the intervention itself, including timing and intensity, have been explored as potential effect modifiers. A dose-response relationship was suggested by findings that more intense mobilization, such as achieving a standing position, was associated with higher 30-day

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survival in patients on V-V ECMO support. Similarly, another study found that achieving higher levels of mobilization (measured by the ICU Mobility Scale) was independently associated with improved health status at 6 months, whereas simply increasing the number of mobilization sessions was not. Regarding timing, one study found that patients with sepsis might benefit most from achieving mobilization within 2-4 days of ICU admission. Conversely, a systematic review found no clear benefit from a very early start of the intervention overall. Finally, a meta-analysis subgroup analysis did not clearly identify any specific mobilization variable—including timing (≤72 h vs >72 h) or duration (≥20 min/day vs <20 min/day)—that was associated with increased harm.

Synthesis of Evidence

The evidence regarding the impact of early mobilization on long-term outcomes in ICU patients presents a complex and, at times, contradictory picture. While the intervention is generally considered safe and feasible, its effectiveness varies significantly across different outcomes, patient populations, and intervention protocols.

A strong and consistent body of evidence supports the beneficial effect of early mobilization on short-term physical and functional outcomes. Multiple systematic reviews and RCTs demonstrate improvements in muscle strength, reduced incidence of ICU-acquired weakness, enhanced functional mobility at hospital discharge, and a greater likelihood of walking independently. This is often accompanied by a reduction in healthcare utilization, including shorter durations of mechanical ventilation and reduced ICU and hospital lengths of stay. These benefits are clinically significant as they contribute to faster recovery within the hospital setting and may facilitate a discharge to home rather than to a rehabilitation facility.

However, the evidence for long-term benefits beyond hospital discharge is less consistent. For major outcomes like long-term mortality and health-related quality of life, large, high-quality RCTs and subsequent meta-analyses have frequently found no significant difference between early mobilization and usual care. This suggests that the early functional gains may not always translate into sustained improvements in overall health status or survival months later.

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The heterogeneity in findings can be partially explained by differences in patient populations and intervention intensity. The TEAM trial, which found no benefit and increased harm from a "high-dose" mobilization protocol, suggests a potential ceiling effect or even harm with overly aggressive interventions, particularly in certain subgroups like patients with diabetes. This contrasts with studies using more moderate, progressive protocols that reported benefits. This implies that "more" is not always "better," and the key may lie in tailoring the intensity and type of mobilization to the individual patient's clinical status and comorbidities. The finding that early mobilization can significantly reduce long-term cognitive impairment in one study is a promising area that warrants further investigation, as it could represent a major advance in mitigating post-intensive care syndrome.

In clinical practice, the synthesized evidence supports the implementation of early, progressive mobilization for most ICU patients to improve in-hospital functional outcomes and reduce healthcare utilization. Yet, it also calls for caution and a patient-centered approach, avoiding a one-size-fits-all, high-intensity strategy. The potential for increased adverse events and mortality in specific subgroups, like patients with diabetes, highlights a critical area for future research to define optimal protocols and patient selection criteria.

DISCUSSION

This comprehensive systematic review synthesizes evidence from 68 studies examining the impact of early mobilization on long-term outcomes in adult ICU patients. The findings reveal a complex and nuanced picture, characterized by consistent short-term functional benefits that do not reliably translate into improved long-term survival or quality of life, alongside emerging concerns about potential harm from high-intensity protocols in specific patient subgroups.

Short-term Functional Benefits: A Consistent Finding

Our review confirms robust evidence supporting early mobilization's beneficial effects on short-term physical and functional outcomes measured at ICU or hospital discharge. Multiple high-quality studies demonstrated significant improvements in muscle strength, with meta-analyses

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reporting mean differences of 4.47 to 8.62 points on the Medical Research Council (MRC) sum score favoring intervention groups (Tipping et al., 2017; Hu et al., 2019; Zang et al., 2020). The clinical significance of this improvement is underscored by a corresponding reduction in ICU-acquired weakness (ICU-AW) incidence. Patel et al. (2023) reported a striking absolute reduction of 14% in ICU-AW at one year (0% vs 14%, p=0.0001), while earlier trials demonstrated that mobilized patients were significantly more likely to return to independent functional status at hospital discharge (odds ratio 2.7) (Schweickert et al., 2009; Brahmbhatt et al., 2010).

Mobility outcomes were similarly improved. Tipping and colleagues (2017) found that patients receiving early mobilization were more than twice as likely to walk without assistance at hospital discharge (OR 2.13, 95% CI 1.19-3.83). These findings align with more recent trials in specific populations. Saravankumar et al. (2024) reported significantly higher Physical Function ICU Test (PFIT) scores (25.4 vs 18.2, $p<0.001$) and MRC sum scores (48.6 vs 35.4, $p<0.001$) at ICU discharge in patients with severe COVID-19 receiving early mobilization. Similarly, Chuanlin Zhang et al. (2024) demonstrated sustained improvements in Barthel Index scores (90.6 ± 18.0 vs 77.7 ± 27.9, p=0.005) and Perme mobility scores (17.6 ± 7.1 vs 12.2 ± 8.5, $p<0.001$) at three months post-discharge.

These functional improvements were accompanied by reductions in healthcare utilization. Meta-analyses consistently reported shortened duration of mechanical ventilation (by approximately 1-2 days) and reduced ICU and hospital lengths of stay (Khan et al., 2025; Li et al., 2025; Wang et al., 2020). Saravankumar et al. (2024) found that early mobilization increased ventilator-free days by 5.6 days (20.3 vs 14.7 days) in post-COVID ARDS patients, while Morris et al. (2008) reported reductions in ICU length of stay from 6.9 to 5.5 days. These efficiency gains have important implications for healthcare resource utilization and costs, particularly given the high expense of ICU care.

The consistency of these short-term benefits across diverse patient populations—including medical, surgical, neurological, and COVID-19 patients—and across various healthcare settings in North America, Europe, Australia, and Asia (Schaller et al., 2016; Hodgson et al., 2016; Yen et al., 2024) supports the generalizability of early mobilization's immediate functional effects. The

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biological plausibility is well-established: early activity counteracts muscle protein catabolism, prevents joint contractures, improves respiratory mechanics, and may modulate the systemic inflammatory response (Winkelman et al., 2018).

Long-term Outcomes: The Attenuation Puzzle

Despite compelling short-term benefits, the translation of these early gains into sustained improvements in long-term outcomes remains uncertain. Large, high-quality randomized controlled trials and subsequent meta-analyses have frequently failed to demonstrate significant differences in long-term mortality or health-related quality of life between early mobilization and usual care groups.

The TEAM trial, the largest and most rigorous study to date involving 750 mechanically ventilated patients across 49 ICUs in six countries, found no significant difference in 180-day mortality (22.5% vs 19.5%, OR 1.15, 95% CI 0.81-1.65) or days alive and out of hospital between early mobilization and usual care groups (Hodgson et al., 2022). Quality of life, assessed using the EuroQoL-5D at six months, was also similar between groups (Higgins et al., 2025). These null findings were corroborated by Wang et al. (2023) and Serpa Neto et al. (2024) in secondary analyses of the same trial.

Systematic reviews and meta-analyses examining quality of life outcomes have reached similar conclusions. Khan et al. (2025) found no significant effect on quality of life (SMD 0.04, 95% CI -0.07-0.15, p=0.50) in their updated meta-analysis. Lai Wang et al. (2023) reported no significant differences in either physical component scores (WMD 1.83, 95% CI -0.28-3.93) or mental component scores (WMD 1.72, 95% CI -0.76-4.20) of the SF-36 at six months. Okada and colleagues (2019) similarly found no difference in SF-36 physical functioning at six months (MD 4.65, 95% CI -16.13-25.43). Takaoka et al. (2020) reported a non-significant mean difference of 9.13 points (95% CI -13.80-32.05) in quality of life measures following in-ICU cycle ergometry.

This dissociation between short-term functional gains and long-term outcomes raises important questions about the mechanisms underlying recovery from critical illness. Several explanations merit consideration. First, the severity of critical illness may overwhelm the protective effects of early mobilization, with residual organ dysfunction, ongoing inflammation, and metabolic

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derangements limiting long-term recovery regardless of early activity (Herridge et al., 2011). Second, post-discharge factors—including access to rehabilitation services, social support, nutritional status, and development of new medical complications—may be more important determinants of long-term outcomes than in-ICU interventions (Salisbury and Walsh, 2013). Third, measurement issues may contribute, as quality of life instruments may lack sensitivity to detect clinically meaningful changes in this population, or follow-up periods may be insufficient to capture late recovery (Murooka et al., 2023).

Cognitive Outcomes: A Promising Exception

A notable exception to the pattern of null long-term findings concerns cognitive outcomes. Patel and colleagues (2023) demonstrated that early mobilization significantly reduced the rate of cognitive impairment at one year from 43% to 24% (absolute difference -19.2%, 95% CI -32.1 to -6.3, p=0.0043) in mechanically ventilated patients. This represents a 44% relative reduction in cognitive impairment, a finding with profound implications given the high prevalence and devastating impact of post-ICU cognitive dysfunction.

The mechanism by which early mobilization might preserve cognitive function is biologically plausible. Physical activity increases cerebral blood flow, upregulates neurotrophic factors such as brain-derived neurotrophic factor (BDNF), reduces neuroinflammation, and may enhance neuroplasticity (Girard and Pandharipande, 2023). Additionally, early mobilization typically involves reduced sedation exposure, which independently benefits cognitive outcomes (Jackson et al., 2010). The Patel et al. (2023) finding aligns with experimental evidence and smaller clinical studies suggesting that the brain may be particularly responsive to early rehabilitation interventions.

However, not all studies have replicated this cognitive benefit. The TEAM trial found no significant difference in cognitive function at six months (Hodgson et al., 2022), and Tipping et al. (2017) noted inconsistent reporting of cognitive outcomes across included studies. The discrepancy may relate to differences in patient populations, mobilization protocols, or cognitive assessment methods. Nevertheless, the potential for early mobilization to mitigate post-ICU cognitive

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impairment represents a critical avenue for future research, particularly given the absence of effective pharmacological interventions for this condition.

Subgroup Effects and Effect Modifiers: Moving Beyond One-Size-Fits-All

The heterogeneous findings across studies can be partially explained by differences in patient populations and intervention characteristics. Subgroup analyses have identified several factors that may modify the effects of early mobilization, moving the field toward more personalized approaches.

Illness severity at admission appears to be an important moderator. Patients with lower illness severity (e.g., APACHE II score <20) and those with longer expected ICU stays may derive the most benefit from rehabilitation interventions (Menges et al., 2021). Conversely, the sickest patients may be too physiologically compromised to participate meaningfully in mobilization, or may experience competing risks that overshadow any potential benefit. Schaller and colleagues (2019) found that early, goal-directed mobilization was effective even in surgical ICU patients with impaired initial consciousness (Glasgow Coma Scale ≤8), suggesting that low GCS alone should not preclude mobilization efforts.

Patient diagnosis also influences outcomes. In sepsis patients, Liu et al. (2022) found that achieving mobilization within 2-4 days of ICU admission was associated with optimal outcomes, suggesting a critical window for intervention. For cardiac surgery patients, Bin Chen et al. (2021) reported beneficial effects of early mobilization on recovery trajectories. In traumatic brain injury, Yen et al. (2024) demonstrated that early progressive mobilization was safe and improved functional outcomes, with intervention groups showing reduced ventilator days (5.2 vs 11.9 days) and improved Perme ICU Mobility scores. For COVID-19 patients requiring prolonged mechanical ventilation, Markus et al. (2025) found that early mobilization was associated with reduced 60-day mortality (OR 0.74) and lower transfer rates to other facilities.

The most concerning subgroup finding emerged from the TEAM trial's secondary analysis examining patients with diabetes. Serpa Neto and colleagues (2024) identified a significant interaction between diabetes status and the intervention's effect on mortality (adjusted OR 3.47, 95% CI 1.67-7.61 for 180-day mortality). While high-dose early mobilization did not improve the

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primary outcome of days alive and out of hospital for diabetic patients, it was associated with a more than threefold increase in mortality compared to usual care. This finding highlights a specific patient population for whom high-intensity mobilization may be harmful and underscores the critical importance of careful patient selection and individualized prescription.

The mechanisms underlying this harm remain speculative. Diabetic patients have altered metabolic responses to stress, including impaired glucose utilization, endothelial dysfunction, and heightened inflammatory responses (Patel et al., 2014). High-intensity mobilization may provoke excessive sympathetic activation, hemodynamic instability, or metabolic derangements in this vulnerable population. Alternatively, diabetic patients may have subclinical autonomic dysfunction or cardiovascular disease that predisposes them to adverse events during physical exertion. These findings emphasize that "more" is not necessarily "better," and that optimal mobilization intensity may differ across patient subgroups.

Intervention Characteristics: Dose, Timing, and Intensity

The characteristics of the mobilization intervention itself—including timing, intensity, frequency, and duration—have been explored as potential determinants of outcomes. A dose-response relationship was suggested by Paton and colleagues (2021), who found that achieving higher levels of mobilization (measured by the ICU Mobility Scale) was independently associated with improved health status (EQ-5D-5L mobility domain, $\beta=0.127$, $p=0.001$) and utility scores ($\beta=0.022$, $p=0.033$) at six months, whereas simply increasing the number of mobilization sessions was not. Similarly, Rottmann et al. (2023) reported that achieving a standing position was associated with higher 30-day survival in patients on V-V ECMO support, suggesting that the quality or level of mobilization may be more important than quantity.

The optimal timing of mobilization initiation remains debated. Most studies have defined "early" as within 72 hours of ICU admission or mechanical ventilation (Matsuoka et al., 2023; Daum et al., 2023). Network meta-analyses by Luo et al. (2023) and Daum et al. (2023) did not clearly identify any specific mobilization timing ($\leq$72 hours vs >72 hours) associated with superior outcomes or increased harm. However, Liu et al. (2022) suggested that patients with sepsis might

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benefit most from mobilization within 2-4 days, while earlier initiation could be less effective or potentially harmful in the most acutely unstable phase.

The intensity of mobilization has emerged as a critical consideration. The TEAM trial's "high-dose" protocol—involving daily mobilization aiming for the highest level of activity possible, with a mean session duration of 20.8 minutes—was associated with increased adverse events without improving outcomes (Hodgson et al., 2022). This contrasts with studies using more moderate, progressive protocols that reported benefits without excess harm (Schaller et al., 2016; Schweickert et al., 2009). Paton and colleagues' (2024) systematic review found no clear association between specific mobilization variables (timing, duration, frequency) and adverse events or mortality, suggesting that patient selection and clinical judgment may be more important than rigid protocol specifications.

The type of mobilization activities may also matter. Interventions have ranged from passive range of motion to active exercises, sitting, standing, and ambulation, with some studies incorporating technologies like cycle ergometers (Takaoka et al., 2020) or robotic-assisted devices (Huebner et al., 2024). Huebner and colleagues (2024) found that robotic-assisted verticalization and stepping in lung transplant patients was feasible and associated with reduced ventilation duration (78h vs 126h) compared to conventional mobilization, suggesting that technology may enhance mobilization capacity in selected populations. However, Takaoka et al. (2020) found very low adverse event rates (0.16%) with cycle ergometry but no significant impact on long-term outcomes in their meta-analysis.

Safety and Feasibility: Reassuring but Not Without Risk

The safety of early mobilization in critically ill patients has been consistently demonstrated across numerous studies, with most concluding that the practice is safe and associated with a low incidence of adverse events. Paton and colleagues' (2024) systematic review found the overall chance of an adverse event occurring during mobilization was less than 3%, and Khan et al. (2025) found no statistically significant difference in adverse events between early mobilization and usual care groups (RR 1.72, 95% CI not significant). These findings align with earlier meta-analyses reporting similarly low event rates (Tipping et al., 2017; Li et al., 2013).

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However, the TEAM trial raised important safety concerns by reporting a significantly higher number of adverse events in the intervention group (9.2%) compared to usual care (4.1%, p=0.005), including seven serious adverse events versus one in the control group (Hodgson et al., 2022). These events primarily consisted of arrhythmias, altered blood pressure, and oxygen desaturation. Similarly, Patel et al. (2023) reported more adverse events in the intervention group (7 [6%] vs 0 [0%]), though none were classified as serious. These findings suggest that while early mobilization is generally safe, high-intensity protocols may increase risk, and careful patient selection and monitoring remain essential.

When reported, reasons for discontinuing mobilization sessions most commonly included patient instability, such as hemodynamic compromise, oxygen desaturation, patient-ventilator asynchrony, or fatigue (Schweickert et al., 2009; Doiron et al., 2013; Morris et al., 2008). Session discontinuation rates ranged from 4% to approximately 20% across studies (Schweickert et al., 2009; Winkelman et al., 2018), highlighting the importance of real-time clinical assessment and protocol flexibility.

Feasibility has been established across diverse settings, including neurological ICUs (Klein et al., 2018; Yen et al., 2024), surgical ICUs (Schaller et al., 2016), community hospitals (Engel et al., 2013), and less economically developed countries (Biazon et al., 2024). Studies have shown that structured, nurse-led, or multidisciplinary team-led protocols can be implemented successfully, though barriers exist. Identified barriers include resource limitations, staffing constraints, need for staff training and education, and overcoming a culture of immobility in the ICU (Fraser et al., 2015; Engel et al., 2013). Winkelman et al. (2018) achieved high adherence with trained nurses but noted the importance of baseline muscle strength data for proper evaluation.

Safety protocols and contraindications are crucial for safe implementation. Studies typically used specific physiological parameters (e.g., hemodynamic stability, oxygenation levels, heart rate and blood pressure limits) to guide initiation and progression of mobilization (Schaller et al., 2016; Queiroz et al., 2020). The Surgical ICU Optimal Mobilisation Score (SOMS) algorithm and similar protocols provide structured approaches to progression based on patient stability and functional milestones (Meyer et al., 2013; Schaller et al., 2016).

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Clinical Implications

The synthesized evidence supports the implementation of early, progressive mobilization for most ICU patients to improve in-hospital functional outcomes and reduce healthcare utilization. The consistent benefits in muscle strength, functional status, and mobility at discharge, coupled with reductions in ventilation duration and length of stay, provide compelling justification for incorporating early mobilization into routine ICU care. These improvements are clinically meaningful, as they contribute to faster recovery within the hospital setting and may facilitate discharge to home rather than to rehabilitation facilities, with associated quality-of-life and cost implications.

However, the findings also call for caution and a patient-centered approach. The dissociation between short-term functional gains and long-term outcomes suggests that expectations for sustained benefits beyond hospital discharge should be tempered. Clinicians should communicate this uncertainty to patients and families, emphasizing that early mobilization is one component of recovery but not a guarantee of long-term improvement.

The potential for increased adverse events and mortality in specific subgroups—particularly diabetic patients receiving high-intensity mobilization—highlights the critical importance of individualized prescription. A one-size-fits-all, high-intensity strategy may be inappropriate and potentially harmful. Instead, mobilization should be tailored to each patient's clinical status, comorbidities, and tolerance, with careful monitoring for adverse events. The TEAM trial findings suggest that "more" is not necessarily "better," and that optimal mobilization intensity may differ across patients (Serpa Neto et al., 2024).

For diabetic patients, these findings raise particular concerns. Clinicians should exercise caution when prescribing high-intensity mobilization in this population, perhaps opting for more gradual progression and enhanced monitoring. Whether lower-intensity mobilization provides benefit without harm in diabetic patients remains unknown and requires further investigation.

The promising cognitive findings from Patel et al. (2023) suggest that early mobilization may have important benefits beyond physical function, potentially mitigating one of the most devastating consequences of critical illness. While not yet replicated, this finding supports ongoing

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efforts to implement early mobilization and highlights the importance of including cognitive outcomes in future trials.

From a healthcare systems perspective, the demonstrated reductions in ventilation duration and length of stay have important implications for resource utilization and costs. Even if long-term outcomes are not improved, these short-term efficiency gains may justify investment in early mobilization programs, particularly given the high cost of ICU care. The cost-effectiveness analysis alongside the TEAM trial found no significant difference in EQ-5D utility scores at 6 months (Higgins et al., 2025), suggesting that any cost savings from reduced length of stay may be offset by intervention costs or lack of long-term quality-of-life benefits.

Research Implications and Future Directions

This review identifies several critical priorities for future research. First, the concerning finding of increased mortality in diabetic patients receiving high-dose mobilization requires urgent investigation. Replication in other datasets, exploration of mechanisms, and identification of potentially modifiable risk factors are needed. Future trials should prespecify subgroup analyses by diabetes status and consider adaptive designs that can identify optimal mobilization intensity for different patient populations.

Second, the cognitive benefits observed by Patel et al. (2023) warrant confirmation in large, multicenter trials with rigorous cognitive assessment. If replicated, this finding would fundamentally change the risk-benefit calculus for early mobilization and position it as a key intervention for preventing post-intensive care syndrome. Mechanistic studies examining the effects of mobilization on neuroinflammation, neurotrophic factors, and brain structure and function would strengthen the evidence base.

Third, optimal intervention characteristics—timing, intensity, frequency, duration, and type of mobilization activities—remain poorly defined. Comparative effectiveness trials or well-designed adaptive trials comparing different mobilization protocols are needed to inform evidence-based guidelines. The dose-response findings from Paton et al. (2021) suggest that achieving higher levels of mobilization may be more important than session frequency, but this requires prospective validation.

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Fourth, longer follow-up periods are needed to fully understand the trajectory of recovery after critical illness. Most studies have followed patients for 6-12 months, but recovery may continue for years (Herridge et al., 2011). Murooka et al. (2023) found no difference in long-term prognosis at 3 years in a retrospective cohort study using propensity score matching, but prospective studies with extended follow-up are lacking.

Fifth, patient-centered outcomes beyond traditional measures deserve greater attention. Return to work, social participation, caregiver burden, and patient-reported experiences are important outcomes that have been understudied. Maheswaran et al. (2020) noted ongoing and unpublished trials in this area, which may provide additional insights.

Sixth, implementation science research is needed to identify effective strategies for translating evidence into practice across diverse healthcare settings. Fraser et al. (2015) highlighted barriers including lack of standardized workflows and need for education, while Engel et al. (2013) demonstrated successful implementation through structured programs. Understanding how to overcome barriers and sustain programs over time is essential for maximizing population-level impact.

Seventh, emerging technologies such as robotic-assisted devices (Huebner et al., 2024), cycle ergometers (Takaoka et al., 2020), and neuromuscular electrical stimulation (Campos et al., 2022; Bueno et al., 2025) may enhance mobilization capacity in selected populations. Campos et al. (2022) found that adding early neuromuscular electrical stimulation to mobilization improved functional status and decreased hospitalization days, while Bueno et al. (2025) reported long-term benefits at 6 months. These promising findings warrant further investigation in adequately powered trials.

Eighth, the optimal integration of mobilization with other ICU interventions—including sedation practices, nutrition, and delirium management—requires study. Wendie Zhou et al. (2022) found that early mobilization combined with early nutrition reduced ICU-acquired weakness, suggesting synergistic effects. Multimodal rehabilitation programs addressing multiple aspects of post-intensive care syndrome may be more effective than mobilization alone (Alvarado Sánchez et al., 2025; Bento et al., 2025).

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CONCLUSION AND RECOMMENDATIONS

Summary of Findings

This comprehensive systematic review synthesizes evidence from 68 studies examining the impact of early mobilization on long-term outcomes in adult ICU patients. The findings demonstrate that early mobilization consistently improves short-term functional outcomes, including muscle strength, reduced incidence of ICU-acquired weakness, enhanced functional mobility at hospital discharge, and greater likelihood of walking independently. These benefits are accompanied by reduced duration of mechanical ventilation and shortened ICU and hospital lengths of stay, with important implications for healthcare resource utilization.

However, these short-term functional gains do not consistently translate into improved long-term outcomes. Large, high-quality randomized controlled trials and meta-analyses have generally failed to demonstrate significant benefits of early mobilization on long-term mortality or health-related quality of life at 6-12 months post-discharge. This dissociation between short-term and long-term effects represents a central finding with important clinical and research implications.

A notable exception concerns cognitive outcomes, with one high-quality trial demonstrating that early mobilization significantly reduced cognitive impairment at one year. If replicated, this finding would position early mobilization as a key intervention for preventing one of the most devastating consequences of critical illness.

Subgroup analyses reveal important effect modifiers. Patients with lower illness severity may derive greater benefit, while high-intensity mobilization in diabetic patients may be associated with increased mortality. The characteristics of mobilization interventions—particularly achieving higher levels of activity rather than simply increasing session frequency—may be important determinants of outcomes.

Safety data are generally reassuring, with low overall rates of adverse events. However, the TEAM trial's finding of increased adverse events in the intervention group, coupled with harm in diabetic patients, underscores that early mobilization is not without risk and requires careful patient selection and monitoring.

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Clinical Recommendations

Based on the synthesized evidence, we offer the following recommendations for clinical practice:

1. Early, progressive mobilization should be implemented for most mechanically ventilated ICU patients to improve short-term functional outcomes and reduce healthcare utilization. The benefits of improved muscle strength, functional status, and mobility at discharge, coupled with reduced ventilation duration and length of stay, justify program implementation.

2. Mobilization should be individualized based on patient clinical status, comorbidities, and tolerance. A one-size-fits-all, high-intensity approach may be inappropriate and potentially harmful. Progressive protocols guided by patient stability and functional milestones, such as the SOMS algorithm, provide structured approaches to safe implementation.

3. Particular caution is warranted in diabetic patients receiving high-intensity mobilization, given the association with increased mortality in the TEAM trial. Lower-intensity protocols and enhanced monitoring may be appropriate in this population until further evidence clarifies optimal approaches.

4. Early mobilization programs should include explicit safety protocols with physiological parameters guiding initiation, progression, and termination of sessions. Staff training, multidisciplinary collaboration, and strategies to overcome implementation barriers are essential for successful program implementation.

5. Patient and family education should address realistic expectations, emphasizing that early mobilization improves in-hospital recovery but may not guarantee sustained long-term benefits. The potential cognitive benefits, while promising, require confirmation.

Research Recommendations

Priority areas for future research include:

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1. Urgent investigation of the increased mortality risk in diabetic patients receiving high-dose mobilization, including replication studies, mechanistic exploration, and identification of modifiable risk factors.
2. Confirmation of cognitive benefits in large, multicenter trials with rigorous cognitive assessment and extended follow-up.
3. Comparative effectiveness trials to define optimal mobilization timing, intensity, frequency, duration, and activity types, moving beyond the question of whether mobilization works to how it works best.
4. Longer-term follow-up studies (≥2-3 years) to fully characterize recovery trajectories and identify factors associated with sustained improvement.
5. Inclusion of patient-centered outcomes beyond traditional measures, including return to work, social participation, and caregiver burden.
6. Implementation science research to identify effective strategies for translating evidence into practice across diverse healthcare settings.
7. Investigation of emerging technologies and multimodal interventions that may enhance mobilization effects or extend benefits to broader patient populations.
8. Development and validation of risk stratification tools to identify patients most likely to benefit or experience harm from early mobilization.

In conclusion, early mobilization in ICU patients safely improves short-term functional outcomes and reduces healthcare utilization, supporting its routine implementation. However, the lack of consistent long-term benefits and the potential for harm in specific subgroups call for individualized, progressive approaches and temper expectations regarding sustained effects beyond hospital discharge. The promising cognitive findings warrant confirmation and, if replicated, would fundamentally enhance the value proposition of early mobilization in critical care. As the field

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moves forward, moving beyond the simplistic question of whether early mobilization works to the more nuanced questions of how, for whom, and at what intensity will be essential for optimizing patient outcomes and resource utilization.

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