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WRITER	SUBJECT	PUBLICATION	PAGES
Alaparthi GK et al	Effectiveness, Safety, and Barriers to Early Mobilization in the Intensive Care Unit	Crit Care Res Pract. 2020 Nov 26;2020:7840743	8
Arias-Fernández P et al	Rehabilitation and early mobilization in the critical patient: systematic review	review J Phys Ther Sci. 2018 Sep; 30(9): 1193–1201	9
Barr et. al.	Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit.	Crit Care Med. 2013 Jan;41(1):263-306	10
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WRITER	SUBJECT	PUBLICATION	PAGES
Dres M, et. al.	Coexistence and Impact of Limb Muscle and Diaphragm Weakness at Time of Liberation from Mechanical Ventilation in Medical Intensive Care Unit Patients	Am J Respir Crit Care Med. 2017 Jan 1;195(1):57-66	11
Dubb R, et. al.	Barriers and Strategies for Early Mobilization of Patients in Intensive Care Units	Ann Am Thorac Soc. 2016 May;13(5):724-30.	12
Engel HJ, et. al.	ICU early mobilization: from recommendation to implementation at three medical centers	Crit Care Med. 2013 Sep;41(9 Suppl 1):S69-80.	14
Fan, E. et. al., American Thoracic Society	An official American Thoracic Society Clinical Practice guideline: the diagnosis of intensive care unit-acquired weakness in adults.	Am J Respir Crit Care Med. 2014 Dec 15;190(12):1437-46.	15
Ferre M et al	Smart Health-Enhanced Early Mobilisation in Intensive Care Units	Sensors 2021, 21(16), 5408	17
Harrold ME, et. al.	Early mobilisation in intensive care units in Australia and Scotland: a prospective, observational cohort study examining mobilisation practises and barriers.	Crit Care. 2015 Sep 14; 19:336.	16
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WRITER	SUBJECT	PUBLICATION	PAGES
Hodgson CL, et al.	Early Mobilization of Patients in Intensive Care: Organization, Communication and Safety Factors that Influence Translation into Clinical Practice	Crit Care 22, 77 (2018)	19
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Hodgson CL, et al.	Ten strategies to optimize early mobilization and rehabilitation in intensive care	Critical Care volume 25, Article number: 324 (2021)	19
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Lord RK, et. al.	ICU early physical rehabilitation programs: financial modeling of cost savings.	Crit Care Med. 2013 Mar;41(3):717-24.	24
Menges D, et al.	Systematic early versus late mobilization or standard early mobilization in mechanically ventilated adult ICU patients: systematic review and meta-analysis	Crit Care (2021) 25:16 https://doi.org/10.1186/s13054-020-03446-9	25
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WRITER	SUBJECT	PUBLICATION	PAGES
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Schweickert WD, et. al.	Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial.	Lancet. 2009 May 30;373(9678):1874-82.	28
Wang J, et al.	Effects of early mobilization on the prognosis of critically ill patients: A systematic review and meta-analysis	Int J Nurs Stud 2020 Oct;110:103708	30
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Yang R, et al.	Safety Assessment Criteria for Early Active Mobilization in Mechanically Ventilated ICU Subjects	Respir Care 2021 Feb;66(2):307-315	32
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Zhang L, et al.	Early mobilization of critically ill patients in the intensive care unit: A systematic review and meta-analysis	PLoS One 2019 Oct 3;14(10):e0223185	34

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REV	Alaparthi GK et al	Effectiveness, Safety, and Barriers to Early Mobilization in the Intensive Care Unit	Crit Care Res Pract. 2020 Nov 26;2020:7840743

Purpose: Patients admitted to the intensive care unit (ICU) are generally confined to bed leading to limited mobility that may have detrimental effects on different body systems. Early mobilization prevents or reduces these effects and improves outcomes in patients following critical illness. The purpose of this review is to summarize different aspects of early mobilization in intensive care.

Methods: Electronic databases of PubMed, Google Scholar, ScienceDirect, and Scopus were searched using a combination of keywords. Full-text articles meeting the inclusion criteria were selected.

Results: Fifty-six studies on various aspects such as the effectiveness of early mobilization in various intensive care units, newer techniques in early mobilization, outcome measures for physical function in the intensive care unit, safety, and practice and barriers to early mobilization were included. Conclusion: Early mobilization is found to have positive effects on various outcomes in patients with or without mechanical ventilation. The newer techniques can be used to facilitate early mobilization. Scoring systems-specific to the ICU-are available and should be used to quantify patients‘ status at different intervals of time. Early mobilization is not commonly practiced in many countries. Various barriers to early mobilization have been identified, and different strategies can be used to overcome them.

https://pubmed.ncbi.nlm.nih.gov/33294221/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7714600/

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REV	**Arias-Fernández P et al**	**Rehabilitation and early mobilization in the critical patient: systematic review**	**J Phys Ther Sci. 2018 Sep; 30(9): 1193–1201**

Abstract: To review the literature that examines rehabilitation and early mobilization and that involves different practices (effects of interventions) for the critically ill patient. [Materials and Methods] A PRISMA-Systematic review has been conducted based on different data sources: Biblioteca Virtual en Salud, CINHAL, Pubmed, Scopus, and Web of Science were used to identify randomized controlled trials, crossover trials, and case-control studies. [Results] Eleven studies were included. Early rehabilitation had no significant effect on the length of stay and number of cases of Intensive Care Unit Acquired Weaknesses. However, early rehabilitation had a significant effect on the functional status, muscle strength, mechanical ventilation duration, walking ability at discharge, and health quality of life. [Conclusion] Rehabilitation and early mobilization are associated with an increased probability of walking more distance at discharge. Early rehabilitation is associated with an increase in functional capacity and muscle strength, an improvement in walking distance and better perception of the health-related quality of life. Cycloergometer and electrical stimulation can be used to maintain muscle strength. Further research is needed to establish stronger evidences.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6127491/

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GUI	**Barr et. al.**	**Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit.**	**Crit Care Med. 2013 Jan;41(1):263-306**

Rationale and Objectives: To revise the "Clinical Practice Guidelines for the Sustained Use of Sedatives and Analgesics in the Critically Ill Adult" published in Critical Care Medicine in 2002.

The American College of Critical Care Medicine assembled a 20-person, multidisciplinary, multi-institutional task force with expertise in guideline development, pain, agitation and sedation, delirium management, and associated outcomes in adult critically ill patients. The task force, divided into four subcommittees, collaborated over 6 yr in person, via teleconferences, and via electronic communication. Subcommittees were responsible for developing relevant clinical questions, using the Grading of Recommendations Assessment, Development and Evaluation method (http://www.gradeworkinggroup.org) to review, evaluate, and summarize the literature, and to develop clinical statements (descriptive) and recommendations (actionable). With the help of a professional librarian and Refworks database software, they developed a Web-based electronic database of over 19,000 references extracted from eight clinical search engines, related to pain and analgesia, agitation and sedation, delirium, and related clinical outcomes in adult ICU patients. The group also used psychometric analyses to evaluate and compare pain, agitation/sedation, and delirium assessment tools. All task force members were allowed to review the literature supporting each statement and recommendation and provided feedback to the subcommittees. Group consensus was achieved for all statements and recommendations using the nominal group technique and the modified Delphi method, with anonymous voting by all task force members using E-Survey (http://www.esurvey.com). All voting was completed in December 2010. Relevant studies published after this date and prior to publication of these guidelines were referenced in the text. The quality of evidence for each statement and recommendation was ranked as high (A), moderate (B), or low/very low (C). The strength of recommendations was ranked as strong (1) or weak (2), and either in favor of (+) or against (-) an intervention. A strong recommendation (either for or against) indicated that the intervention's desirable effects either clearly outweighed its undesirable effects (risks, burdens, and costs) or it did not. For all strong recommendations, the phrase "We recommend ..." is used throughout. A weak recommendation, either for or against an intervention, indicated that the trade-off between desirable and undesirable effects was less clear. For all weak recommendations, the phrase "We suggest ..." is used throughout. In the absence of sufficient evidence, or when group consensus could not be achieved, no recommendation (0) was made. Consensus based on expert opinion was not used as a substitute for a lack of evidence. A consistent method for addressing potential conflict of interest was followed if task force members were coauthors of related research. The development of this guideline was independent of any industry funding.

Conclusion: These guidelines provide a roadmap for developing integrated, evidence-based, and patient- centered protocols for preventing and treating pain, agitation, and delirium in critically ill patients.

https://www.ncbi.nlm.nih.gov/pubmed/23269131

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GUI	Bein T, et. al.	S2e guideline: positioning and early mobilisation in prophylaxis or therapy of pulmonary disorders : Revision 2015	German Society of Anaesthesiology and Intensive Care Medicine (DGAI). 2015.

Abstract: The German Society of Anesthesiology and Intensive Care Medicine (DGAI) commissioned a revision of the S2 guidelines on "positioning therapy for prophylaxis or therapy of pulmonary function disorders" from 2008. Because of the increasing clinical and scientific relevance the guidelines were extended to include the issue of "early mobilization" and the following main topics are therefore included: use of positioning therapy and early mobilization for prophylaxis and therapy of pulmonary function disorders, undesired effects and complications of positioning therapy and early mobilization as well as practical aspects of the use of positioning therapy and early mobilization. These guidelines are the result of a systematic literature search and the subsequent critical evaluation of the evidence with scientific methods. The methodological approach for the process of development of the guidelines followed the requirements of evidence-based medicine, as defined as the standard by the Association of the Scientific Medical Societies in Germany. Recently published articles after 2005 were examined with respect to positioning therapy and the recently accepted aspect of early mobilization incorporates all literature published up to June 2014

https://www.ncbi.nlm.nih.gov/pubmed/26335630

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4712230/

STU	Dres M, et. al.	Coexistence and Impact of Limb Muscle and Diaphragm Weakness at Time of Liberation from Mechanical Ventilation in Medical Intensive Care Unit Patients	Am J Respir Crit Care Med. 2017 Jan 1;195(1):57-66

Rationale and Objectives: Intensive care unit (ICU)- and mechanical ventilation (MV)-acquired limb muscle and diaphragm dysfunction may both be associated with longer length of stay and worse outcome. Whether they are two aspects of the same entity or have a different prevalence and prognostic impact remains unclear.
The objective of this study was to quantify the prevalence and coexistence of these two forms of ICU- acquired weakness and their impact on outcome.

Conclusion: Diaphragm dysfunction is twice as frequent as limb muscle weakness and has a direct negative impact on weaning outcome. The two types of muscle weakness have only limited overlap.

https://www.ncbi.nlm.nih.gov/pubmed/27310484

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STU	**Dubb R, et. al.**	**Barriers and Strategies for Early Mobilization of Patients in Intensive Care Units**	**Ann Am Thorac Soc. 2016 May;13(5):724-30.**

Early mobilization of patients in the intensive care unit (ICU) is safe, feasible, and beneficial. However, implementation of early mobility as part of routine clinical care can be challenging. The objective of this review is to identify barriers to early mobilization and discuss strategies to overcome such barriers. Based on a literature search, we synthesize data from 40 studies reporting 28 unique barriers to early mobility, of which 14 (50%) were patient-related, 5 (18%) structural, 5 (18%) ICU cultural, and 4 (14%) process-related barriers. These barriers varied across ICUs and within disciplines, depending on the ICU patient population, setting, attitude, and ICU culture. To overcome the identified barriers, over 70 strategies were reported and are synthesized in this review, including: implementation of safety guidelines; use of mobility protocols; interprofessional training, education, and rounds; and involvement of physician champions. Systematic efforts to change ICU culture to prioritize early mobilization using an interprofessional approach and multiple targeted strategies are important components of successfully implementing early mobility in clinical practice.

https://www.ncbi.nlm.nih.gov/pubmed/27144796

REV	**Cameron S, et al.**	**Early mobilization in the critical care unit: A review of adult and pediatric literature**	**J Crit Care 2015 Aug;30(4):664-72**

Early mobilization of critically ill patients is beneficial, suggesting that it should be incorporated into daily clinical practice. Early passive, active, and combined progressive mobilizations can be safely initiated in intensive care units (ICUs). Adult patients receiving early mobilization have fewer ventilator-dependent days, shorter ICU and hospital stays, and better functional outcomes. Pediatric ICU data are limited, but recent studies also suggest that early mobilization is achievable without increasing patient risk. In this review, we provide a current and comprehensive appraisal of ICU mobilization techniques in both adult and pediatric critically ill patients. Contraindications and perceived barriers to early mobilization, including cost and health care provider views, are identified. Methods of overcoming barriers to early mobilization and enhancing sustainability of mobilization programs are discussed. Optimization of patient outcomes will require further studies on mobilization timing and intensity, particularly within specific ICU populations.

https://pubmed.ncbi.nlm.nih.gov/25987293/

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REV	Cuello-Garcia CA, et al.	Early Mobilization in Critically Ill Children: A Systematic Review	J Pediatr. 2018 Dec;203:25-33.e6

Objective: To characterize how early mobilization is defined in the published literature and describe the evidence on safety and efficacy on early mobilization in critically ill children.

Study design: Systematic search of randomized and nonrandomized studies assessing early mobilization-based physical therapy in critically ill children under 18 years of age in MEDLINE, Embase, CINAHL, CENTRAL, the National Institutes of Health, Evidence in Pediatric Intensive Care Collaborative, Physiotherapy Evidence Database, and the Mobilization-Network. We extracted data to identify the types of mobility-based interventions and definitions for early, as well as barriers, feasibility, adverse events, and efficacy outcomes (mortality, morbidities, and length of stay).

Results: Of 1199 titles found, we included 11 studies (2 pilot trials and 9 observational studies) and 1 clinical practice guideline in the analyses. Neurodevelopmentally appropriate increasing mobility levels have been described for critically ill children, and "early" mobilization was defined as either a range (within 48-72 hours) from admission to the pediatric intensive care unit or when clinical safety criteria are met. Current evidence suggests that early mobilization is safe and feasible and institutional practice guidelines significantly increase the frequency of rehabilitation consults, improve the proportion of patients who receive early mobilization, and reduce the time to mobilization. However, there were inconsistencies in populations and interventions across studies, and imprecision and risk of bias in included studies that precluded us from pooling data to evaluate the efficacy outcomes of early mobilization.

Conclusions: The definition of early mobilization varies, but seems to be feasible and safe in critically ill children. The efficacy for early mobilization in this population is yet undetermined because of the low certainty of the evidence available.

https://pubmed.ncbi.nlm.nih.gov/30172429/

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STU	**Engel HJ, et. al.**	**ICU early mobilization: from recommendation to implementation at three medical centers**	**Crit Care Med. 2013 Sep;41(9 Suppl 1):S69- 80.**

Rationale and Objectives: To compare and contrast the process used to implement an early mobility program in ICUs at three different medical centers and to assess their impact on clinical outcomes in critically ill patients.

Conclusion: Establishing an ICU early mobilization quality improvement program resulted in a reduced ICU and hospital length of stay at all three institutions and decreased rates of delirium and the need for sedation for the patients enrolled in the Johns Hopkins ICU early mobility program.

Instituting a planned, structured ICU early mobility quality improvement project can result in improved outcomes and reduced costs for ICU patients across healthcare systems.

https://www.ncbi.nlm.nih.gov/pubmed/23989097

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GUI	Fan, E. et. al., American Thoracic Society	An official American Thoracic Society Clinical Practice guideline: the diagnosis of intensive care unit-acquired weakness in adults.	Am J Respir Crit Care Med. 2014 Dec 15;190(12):1437-46.

Rationale and Objectives: Profound muscle weakness during and after critical illness is termed intensive care unit-acquired weakness (ICUAW). Objective: To develop diagnostic recommendations for ICUAW.

Main Results and Conclusions: Severe sepsis, difficult ventilator liberation, and prolonged mechanical ventilation are associated with ICUAW. Physical rehabilitation improves outcomes in heterogeneous populations of ICU patients. Because it may not be feasible to provide universal physical rehabilitation, an alternative approach is to identify patients most likely to benefit. Patients with ICUAW may be such a group. Our review identified only one case series of patients with ICUAW who received physical therapy. When compared with a case series of patients with ICUAW who did not receive structured physical therapy, evidence suggested those who receive physical rehabilitation were more frequently discharged home rather than to a rehabilitative facility, although confidence intervals included no difference. Other interventions show promise, but fewer data proving patient benefit existed, thus precluding specific comment. Additionally, prior comorbidity was insufficiently defined to determine its influence on outcome, treatment response, or patient preferences for diagnostic efforts. We recommend controlled clinical trials in patients with ICUAW that compare physical rehabilitation with usual care and further research in understanding risk and patient preferences. Conclusions: Research that identifies treatments that benefit patients with ICUAW is necessary to determine whether the benefits of diagnostic testing for ICUAW outweigh its burdens.

https://pubmed.ncbi.nlm.nih.gov/25496103/

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STU	**Harrold ME, et. al.**	**Early mobilisation in intensive care units in Australia and Scotland: a prospective, observational cohort study examining mobilisation practises and barriers.**	**Crit Care. 2015 Sep 14; 19:336.**

Rationale and Objectives: Mobilisation of patients in the intensive care unit (ICU) is an area of growing research. Currently, there is little data on baseline mobilisation practises and the barriers to them for patients of all admission diagnoses. The objectives of the study were to (1) quantify and benchmark baseline levels of mobilisation in Australian and Scottish ICUs, (2) compare mobilisation practises between Australian and Scottish ICUs and (3) identify barriers to mobilisation in Australian and Scottish ICUs. We conducted a prospective, observational, cohort study with a 4-week inception period. Patients were censored for follow-up upon ICU discharge or after 28 days, whichever occurred first. Patients were included if they were >18 years of age, admitted to an ICU and received mechanical ventilation in the ICU.

Conclusion: Ten tertiary ICUs in Australia and nine in Scotland participated in the study. The Australian cohort had a large proportion of patients admitted for cardiothoracic surgery (43.3%), whereas the Scottish cohort had none. Therefore, comparison analysis was done after exclusion of patients admitted for cardiothoracic surgery. In total, 60.2% of the 347 patients across 10 Australian ICUs and 40.1% of the 167 patients across 9 Scottish ICUs mobilised during their ICU stay ($p < 0.001$). Patients in the Australian cohort were more likely to mobilise than patients in the Scottish cohort (hazard ratio 1.83, 95% confidence interval 1.38-2.42). However, the percentage of episodes of mobilisation where patients were receiving mechanical ventilation was higher in the Scottish cohort (41.1% vs 16.3%, $p < 0.001$). Sedation was the most commonly reported barrier to mobilisation in both the Australian and Scottish cohorts. Physiological instability and the presence of an endotracheal tube were also frequently reported barriers.

This is the first study to benchmark baseline practise of early mobilisation internationally, and it demonstrates variation in early mobilisation practises between Australia and Scotland.

https://www.ncbi.nlm.nih.gov/pubmed/26370550

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4570617

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STU	**Ferre M, et al.**	**Smart Health-Enhanced Early Mobilisation in Intensive Care Units**	**Sensors 2021, 21(16), 5408;**

Critically ill patients that stay in Intensive Care Units (ICU) for long periods suffer from Post-Intensive Care Syndrome or ICU Acquired Weakness, whose effects can decrease patients' quality of life for years. To prevent such issues and aiming at shortening intensive care treatments, Early Mobilisation (EM) has been proposed as an encouraging technique: the literature includes numerous examples of the benefits of EM on the prevention of post-operative complications and adverse events. However, the appropriate application of EM programmes entails the use of scarce resources, both human and technical. Information and Communication Technologies can play a key role in reducing cost and improving the practice of EM. Although there is rich literature on EM practice and its potential benefits, there are some barriers that must be overcome, and technology, i.e., the use of sensors, robotics or information systems, can contribute to that end. This article reviews the literature and analyses on the use of technology in the area of EM, and moreover, it proposes a smart health-enhanced scenario.

https://www.mdpi.com/1424-8220/21/16/5408/htm

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STU	**Hickmann CL, et al**	**Teamwork enables high level of early mobilization in critically ill patients**	**Ann. Intensive Care 6, 80 (2016).**

Background: Early mobilization in critically ill patients has been shown to prevent bed-rest-associated morbidity. Reported reasons for not mobilizing patients, thereby excluding or delaying such intervention, are diverse and comprise safety considerations for high-risk critically ill patients with multiple organ support systems. This study sought to demonstrate that early mobilization performed within the first 24 h of ICU admission proves to be feasible and well tolerated in the vast majority of critically ill patients.

Results: General practice data were collected for 171 consecutive admissions to our ICU over a 2-month period according to a local, standardized, early mobilization protocol. The total period covered 731 patient-days, 22 (3 %) of which met our local exclusion criteria for mobilization. Of the remaining 709 patient-days, early mobilization was achieved on 86 % of them, bed-to-chair transfer on 74 %, and at least one physical therapy session on 59 %. Median time interval from ICU admission to the first early mobilization activity was 19 h (IQR = 15–23). In patients on mechanical ventilation (51 %), accounting for 46 % of patient-days, 35 % were administered vasopressors and 11 % continuous renal replacement therapy. Within this group, bed-to-chair transfer was achieved on 68 % of patient-days and at least one early mobilization activity on 80 %. Limiting factors to start early mobilization included restricted staffing capacities, diagnostic or surgical procedures, patients' refusal, as well as severe hemodynamic instability. Hemodynamic parameters were rarely affected during mobilization, causing interruption in only 0.8 % of all activities, primarily due to reversible hypotension or arrhythmia. In general, all activities were well tolerated, while patients were able to self-regulate their active early mobilization. Patients' subjective perception of physical therapy was reported to be enjoyable.

Conclusions: Mobilization within the first 24 h of ICU admission is achievable in the majority of critical ill patients, in spite of mechanical ventilation, vasopressor administration, or renal replacement therapy.

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REV	**Hodgson CL, et al.**	**Early Mobilization of Patients in Intensive Care: Organization, Communication and Safety Factors that Influence Translation into Clinical Practice**	**Crit Care 22, 77 (2018).**

This article is one of ten reviews selected from the Annual Update in Intensive Care and Emergency Medicine 2018. Other selected articles can be found online at **https://www.biomedcentral.com/collections/annualupdate2018**. Further information about the Annual Update in Intensive Care and Emergency Medicine is available from **http://www.springer.com/series/8901**.

https://ccforum.biomedcentral.com/articles/10.1186/s13054-018-1998-9

STU	**Hodgson CL, et al.**	**Ten strategies to optimize early mobilization and rehabilitation in intensive care**	**Critical Care volume 25, Article number: 324 (2021)**

In the last decade, there have been more than 40 randomized trials evaluating early mobilization and rehabilitation in intensive care units (ICU) [1]. Such trials generally aim to reduce the incidence of ICU-acquired weakness (ICUAW) which is associated with poor long-term survival, physical functioning, and quality of life [2]. At least eight international guidelines have recommended ICU early mobilization and rehabilitation [3].

Despite supporting evidence and guidelines, implementation of ICU mobilization and rehabilitation is highly variable[4]. Hence, we report on 10 steps to help ICU clinicians in optimizing early mobilization and rehabilitation.

https://ccforum.biomedcentral.com/articles/10.1186/s13054-021-03741-z

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GUI	**Hodgson CL, et.al.**	**Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults**	**Crit Care. 2014; 18(6): 658.**

Rationale and Objectives: The aim of this study was to develop consensus recommendations on safety parameters for mobilizing adult, mechanically ventilated, intensive care unit (ICU) patients.
A systematic literature review was followed by a meeting of 23 multidisciplinary ICU experts to seek consensus regarding the safe mobilization of mechanically ventilated patients.

Conclusion: Safety considerations were summarized in four categories: respiratory, cardiovascular, neurological and other. Consensus was achieved on all criteria for safe mobilization, with the exception being levels of vasoactive agents. Intubation via an endotracheal tube was not a contraindication to early mobilization and a fraction of inspired oxygen less than 0.6 with a percutaneous oxygen saturation more than 90% and a respiratory rate less than 30 breaths/minute were considered safe criteria for in- and out-of-bed mobilization if there were no other contraindications. At an international meeting, 94 multidisciplinary ICU clinicians concurred with the proposed recommendations.
Consensus recommendations regarding safety criteria for mobilization of adult, mechanically ventilated patients in the ICU have the potential to guide ICU rehabilitation whilst minimizing the risk of adverse events.

https://www.ncbi.nlm.nih.gov/pubmed/25475522

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4301888

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REV	Jolley S, et. al.	ICU-Acquired Weakness	Chest. 2016 Nov; 150(5):1129-1140.

Abstract: Survivorship after critical illness is an increasingly important health-care concern as ICU use continues to increase while ICU mortality is decreasing. Survivors of critical illness experience marked disability and impairments in physical and cognitive function that persist for years after their initial ICU stay. Newfound impairment is associated with increased health-care costs and use, reductions in health-related quality of life, and prolonged unemployment. Weakness, critical illness neuropathy and/or myopathy, and muscle atrophy are common in patients who are critically ill, with up to 80% of patients admitted to the ICU developing some form of neuromuscular dysfunction. ICU-acquired weakness (ICUAW) is associated with longer durations of mechanical ventilation and hospitalization, along with greater functional impairment for survivors. Although there is increasing recognition of ICUAW as a clinical entity, significant knowledge gaps exist concerning identifying patients at high risk for its development and understanding its role in long-term outcomes after critical illness. This review addresses the epidemiologic and pathophysiologic aspects of ICUAW; highlights the diagnostic challenges associated with its diagnosis in patients who are critically ill; and proposes, to our knowledge, a novel strategy for identifying ICUAW.

Conclusion: ICUAW is common in patients who are critically ill, often is underreported, and manifests in a spectrum of disease. Diagnostic limitations in our current testing modalities limit identification of weakness early in critical illness. Although illness severity, multiorgan failure, and immobilization are recognized as potential risk factors for ICUAW, the strength of these associations remains uncertain. Adjustment for baseline function may play an important role in understanding disease trajectories for ICUAW. To our knowledge, novel diagnostic methods, including single NCS and muscle ultrasound, may provide a minimally invasive means for early recognition of disease. Risk factor avoidance or modification and early activity may reduce the risk and severity of ICUAW. Studies are needed that explore interventions targeted toward patient participation and stage of disease rather than being applied uniformly across the spectrum.

https://www.ncbi.nlm.nih.gov/pubmed/27063347

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REV	**Lang JK, et al.**	**Clinical Practice Guidelines for Early Mobilization in the ICU: A Systematic Review**	**Crit Care Med 2020 Nov;48(11):e1121-e1128,**

Critically ill patients that stay in Intensive Care Units (ICU) for long periods suffer from Post-Intensive Care Syndrome or ICU Acquired Weakness, whose effects can decrease patients' quality of life for years. To prevent such issues and aiming at shortening intensive care treatments, Early Mobilisation (EM) has been proposed as an encouraging technique: the literature includes numerous examples of the benefits of EM on the prevention of post-operative complications and adverse events. However, the appropriate application of EM programmes entails the use of scarce resources, both human and technical. Information and Communication Technologies can play a key role in reducing cost and improving the practice of EM. Although there is rich literature on EM practice and its potential benefits, there are some barriers that must be overcome, and technology, i.e., the use of sensors, robotics or information systems, can contribute to that end. This article reviews the literature and analyses on the use of technology in the area of EM, and moreover, it proposes a smart health-enhanced scenario.

https://pubmed.ncbi.nlm.nih.gov/32947470/

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STU	Linke CA, et al.	Early Mobilization in the ICU: A Collaborative, Integrated Approach.	Critical Care Explorations: April 2020;2:4pe0090

Objectives: To develop and implement a protocol to increase patient mobility in three adult ICUs using an interdisciplinary approach and existing resources.

Design: The Iowa Model of Evidence-Based Practice was used for synthesis of literature and intervention planning. A retrospective pre- and post-intervention data collection design was used to compare outcomes of interest.

Setting: Three adult ICUs (64 total beds) in an urban, academic hospital. Physician, nursing, respiratory therapy, physical therapy, and occupational therapy representatives participated in planning and development. All adult ICU patients were included.

Interventions: Development and implementation of an inclusive early mobility protocol in three adult ICUs. Focus on interdisciplinary collaboration to restructure workflow, focusing on optimization and coordination of standard tasks. Multimodal education occurred in an interdisciplinary setting and on-site champions facilitated implementation.

Measurements and Main Results: Time from admission to ambulation, overall frequency of ambulation, and frequency of ambulation by age group were assessed across three time periods: no awareness (Time 1), awareness without protocol (Time 2), and protocolization (Time 3). Decrease in hours from admission to ambulation were seen in the cardiovascular ICU (62.3 vs 56.1; $p = 0.10$) and surgical ICU (64.9 vs 58.6; $p = 0.022$). Significant increase demonstrated in the proportion of patients who ambulated while in the ICU (24.6% vs 33.0%; $p < 0.001$). All age groups had increase in frequency of ambulation. The largest gains in patients over 65 years old (T1 = 19.7%, T2 = 26.6%, T3 = 30.9%; $p < 0.001$). No change found in ICU length of stay, hospital length of stay, or ventilator days.

Conclusions: This single-center evidenced-based practice project demonstrated increased mobility for ICU patients without addition of staff resources following implementation of an early mobility protocol using an interdisciplinary approach. Successful implementation led to creation of mobility protocol toolkit for use across all ICUs in the broader health system.

https://journals.lww.com/ccejournal/fulltext/2020/04000/early_mobilization_in_the_icu__a_collaborative,.1.aspx

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STU	**Lord RK, et. al.**	**ICU early physical rehabilitation programs: financial modeling of cost savings.**	**Crit Care Med. 2013 Mar;41(3):717-24.**

Rationale and Objectives: To evaluate the potential annual net cost savings of implementing an ICU early rehabilitation program. Using data from existing publications and actual experience with an early rehabilitation program in the Johns Hopkins Hospital Medical ICU, we developed a model of net financial savings/costs and presented results for ICUs with 200, 600, 900, and 2,000 annual admissions, accounting for both conservative- and best-case scenarios. Our example scenario provided a projected financial analysis of the Johns Hopkins Medical ICU early rehabilitation program, with 900 admissions per year, using actual reductions in length of stay achieved by this program.

Conclusion: Net cost savings generated in our example scenario, with 900 annual admissions and actual length of stay reductions of 22% and 19% for the ICU and floor, respectively, were $817,836. Sensitivity analyses, which used conservative- and best-case scenarios for length of stay reductions and varied the per-day ICU and floor costs, across ICUs with 200-2,000 annual admissions, yielded financial projections ranging from -$87,611 (net cost) to $3,763,149 (net savings). Of the 24 scenarios included in these sensitivity analyses, 20 (83%) demonstrated net savings, with a relatively small net cost occurring in the remaining four scenarios, mostly when simultaneously combining the most conservative assumptions.

A financial model, based on actual experience and published data, projects that investment in an ICU early rehabilitation program can generate net financial savings for U.S. hospitals. Even under the most conservative assumptions, the projected net cost of implementing such a program is modest relative to the substantial improvements in patient outcomes demonstrated by ICU early rehabilitation programs.

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REV	**Menges D, et al.**	**Systematic early versus late mobilization or standard early mobilization in mechanically ventilated adult ICU patients: systematic review and meta-analysis.**	**Crit Care (2021) 25:16**

Abstract Background: This systematic review and meta-analysis aimed to determine the efectiveness of systematic early mobilization in improving muscle strength and physical function in mechanically ventilated intensive care unit (ICU) patients. Methods: We conducted a two-stage systematic literature search in MEDLINE, EMBASE and the Cochrane Library until January 2019 for randomized controlled trials (RCTs) examining the efects of early mobilization initiated within 7 days after ICU admission compared with late mobilization, standard early mobilization or no mobilization. Priority outcomes were Medical Research Council Sum Score (MRC-SS), incidence of ICU-acquired weakness (ICUAW), 6-min walk test (6MWT), proportion of patients reaching independence, time needed until walking, SF-36 Physical Function Domain Score (PFS) and SF-36 Physical Health Component Score (PCS). Meta-analysis was conducted where sufcient comparable evidence was available. We evaluated the certainty of evidence according to the GRADE approach. Results: We identifed 12 eligible RCTs contributing data from 1304 participants. Two RCTs were categorized as comparing systematic early with late mobilization, nine with standard early mobilization and one with no mobilization. We found evidence for a beneft of systematic early mobilization compared to late mobilization for SF-36 PFS (MD 12.3; 95% CI 3.9–20.8) and PCS (MD 3.4; 95% CI 0.01–6.8), as well as on the proportion of patients reaching independence and the time needed to walking, but not for incidence of ICUAW (RR 0.62; 95% CI 0.38–1.03) or MRC-SS. For systematic early compared to standard early mobilization, we found no statistically signifcant beneft on MRC-SS (MD 5.8; 95% CI −1.4 to 13.0), incidence of ICUAW (RR 0.90; 95% CI 0.63–1.27), SF-36 PFS (MD 8.1; 95% CI −15.3 to 31.4) or PCS (MD −2.4; 95% CI −6.1 to 1.3) or other priority outcomes except for change in 6MWT from baseline. Generally, efects appeared stronger for systematic early compared to late mobilization than to standard early mobilization. We judged the certainty of evidence for all outcomes as very low to low. Conclusion: The evidence regarding a beneft of systematic early mobilization remained inconclusive. However, our fndings indicate that the larger the diference in the timing between the intervention and the comparator, the more likely an RCT is to fnd a beneft for early mobilization.

https://link.springer.com/content/pdf/10.1186/s13054-020-03446-9.pdf

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GUI	**NSW Agency for Clinical Innovation**	**Australian Clinical Guideline: Physical Activity and Movement: A Guideline for Critically Ill Adults**	**Agency for clinical innovation, 2017.**

Rationale and Objectives: Many survivors of a critical illness experience significant physical, psychological and cognitive deficits. Emerging research supports the inclusion of physical activity and movement programs into the care routines of Intensive Care patients.
The purpose of this guideline is to provide intensive care clinicians with evidence and best practice recommendations to guide the development of local physical activity and movement (PAM) programs for critically ill adult ICU patients.

Conclusion: As survival rates following critical illness continue to improve more information is becoming available about the significant physical, psychological and cognitive deficits experienced by many survivors during their recovery and subsequent hospital discharge. Some of these deficits can be attributed to muscle wasting as a result of critical illness, treatment and immobility while in the intensive care (ICU).
Studies have demonstrated that early physical activity and movement programs are feasible, safe and effective at reducing some of the adverse effects of surviving a critical illness.
This guideline is based on three clinical health questions: How can critically ill adult patients in ICU be safely mobilised? What are the strategies for safely mobilising a patient within an adult ICU? What are the barriers to safe mobilisation of patients in an adult ICU?

This guideline offers 16 recommendations to guide the development of a physical activity and movement (PAM) program for critically ill adult ICU patients from the time of admission until discharge. It is recommended that when developing individual patient PAM programs local resources be taken into consideration to ensure successful implementation and maintenance of the program. Finally, it is important that clinicians evaluate the effectiveness of locally developed PAM programs to ensure that patients' recovery from their experience of critical illness has been optimised.

ISBN: 978-1-76000-644-0(online)

https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0005/239783/ACI17131_PAM_Guideline.pdf

STU	**Olkowski BF et al**	**Early mobilization in the Neuro-ICU: How far can we go?**	**Neurocrit Care 2017 Aug;27(1):141-150**

Immobility that is frequently encountered in the intensive care unit (ICU) can lead to patient complications. Early mobilization of patients in the ICU has been shown to reduce the complications associated with critical illness; however, early mobilization in the neurological intensive care unit (NICU) presents a unique challenge for the multidisciplinary team. The early mobilization of patients with acute neurologic injuries such as acute ischemic stroke, aneurysmal subarachnoid hemorrhage, intracerebral hemorrhage, and neurotrauma varies because of differing disease processes and management. When developing an early mobility program in the NICU, the following should be considered: the effect of positional changes and exercise, the time from symptom onset to the initiation of early mobilization, and the type and intensity of the exercise prescribed.

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STU	**Schweickert WD, et. al.**	**Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial.**	**Lancet. 2009 May 30;373(9678):1874-82.**

Rationale and Objectives: Long-term complications of critical illness include intensive care unit (ICU)- acquired weakness and neuropsychiatric disease. Immobilisation secondary to sedation might potentiate these problems. We assessed the efficacy of combining daily interruption of sedation with physical and occupational therapy on functional outcomes in patients receiving mechanical ventilation in intensive care.

Conclusion: All 104 patients were included in the analysis. Return to independent functional status at hospital discharge occurred in 29 (59%) patients in the intervention group compared with 19 (35%) patients in the control group (p=0.02; odds ratio 2.7 [95% CI 1.2-6.1]). Patients in the intervention group had shorter duration of delirium (median 2.0 days, IQR 0.0-6.0 vs 4.0 days, 2.0-8.0; p=0.02), and more ventilator-free days (23.5 days, 7.4-25.6 vs 21.1 days, 0.0-23.8; p=0.05) during the 28-day follow-up period than did controls. There was one serious adverse event in 498 therapy sessions (desaturation less than 80%). Discontinuation of therapy as a result of patient instability occurred in 19 (4%) of all sessions, most commonly for perceived patient-ventilator asynchrony.

A strategy for whole-body rehabilitation-consisting of interruption of sedation and physical and occupational therapy in the earliest days of critical illness-was safe and well tolerated, and resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care.

https://www.ncbi.nlm.nih.gov/pubmed/19446324

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REV	Piva TC, et al.	Early mobilization protocols for critically ill pediatric patients: systematic review	Rev Bras Ter Intensiva 2019 Jun 10;31(2):248-257

Objective: To describe the existing early mobilization protocols in pediatric intensive care units.

Methods: A systematic literature review was performed using the databases MEDLINE®, Embase, SciELO, LILACS and PeDRO, without restrictions of date and language. Observational and randomized and nonrandomized clinical trials that described an early mobilization program in patients aged between 29 days and 18 years admitted to the pediatric intensive care unit were included. The methodological quality of the studies was evaluated using the Newcastle-Ottawa Scale, Methodological Index for Non-Randomized Studies and the Cochrane Collaboration.

Results: A total of 8,663 studies were identified, of which 6 were included in this review. Three studies described the implementation of an early mobilization program, including activities such as progressive passive mobilization, positioning, and discussion of mobilization goals with the team, in addition to contraindications and interruption criteria. Cycle ergometer and virtual reality games were also used as resources for mobilization. Four studies considered the importance of the participation of the multidisciplinary team in the implementation of early mobilization protocols.

Conclusion: In general, early mobilization protocols are based on individualized interventions, depending on the child's development. In addition, the use of a cycle ergometer may be feasible and safe in this population. The implementation of institutional and multidisciplinary protocols may contribute to the use of early mobilization in pediatric intensive care units; however, studies demonstrating the efficacy of such intervention are needed.

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REV	Wang J, et al.	Effects of early mobilization on the prognosis of critically ill patients: A systematic review and meta-analysis	Int J Nurs Stud 2020 Oct;110:103708

Objective: To describe the existing early mobilization protocols in pediatric intensive care units.

Methods: A systematic literature review was performed using the databases MEDLINE®, Embase, SciELO, LILACS and PeDRO, without restrictions of date and language. Observational and randomized and nonrandomized clinical trials that described an early mobilization program in patients aged between 29 days and 18 years admitted to the pediatric intensive care unit were included. The methodological quality of the studies was evaluated using the Newcastle-Ottawa Scale, Methodological Index for Non-Randomized Studies and the Cochrane Collaboration.

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REV	Worraphan S, et al.	Effects of Inspiratory Muscle Training and Early Mobilization on Weaning of Mechanical Ventilation: A Systematic Review and Network Meta-analysis	Arch Phys Med Rehabil 2020 Nov;101(11):2002-2014

Objective: To compare the effectiveness and rank order of physical therapy interventions, including conventional physical therapy (CPT), inspiratory muscle training (IMT), and early mobilization (EM) on mechanical ventilation (MV) duration and weaning duration.

Data sources: PubMed, The Cochrane Library, Scopus, and CINAHL complete electronic databases were searched through August 2019.

Study selection: Randomized controlled trials (RCTs) investigating the effect of IMT, EM, or CPT on MV duration and the weaning duration in patients with MV were included. Studies that were determined to meet the eligibility criteria by 2 independent authors were included. A total of 6498 relevant studies were identified in the search, and 18 RCTs (934 participants) were included in the final analysis.

Data extraction: Data were extracted independently by 2 authors and assessed the study quality by the Cochrane risk-of-bias tool. The primary outcomes were MV duration and weaning duration.

Data synthesis: Various interventions of physical therapy were identified in the eligible studies, including IMT, IMT+CPT, EM, EM+CPT, and CPT. The data analysis demonstrated that compared with CPT, IMT+CPT significantly reduced the weaning duration (mean difference; 95% confidence interval) (-2.60; -4.76 to -0.45) and EM significantly reduced the MV duration (-2.01; -3.81 to -0.22). IMT+CPT and EM had the highest effectiveness in reducing the weaning duration and MV duration, respectively.

Conclusion: IMT or EM should be recommended for improving the weaning outcomes in mechanically ventilated patients. However, an interpretation with caution is required due to the heterogeneity.

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REV	Yang R, et al.	Safety Assessment Criteria for Early Active Mobilization in Mechanically Ventilated ICU Subjects	Respir Care 2021 Feb;66(2):307-315

Background: Although studies have confirmed the safety and feasibility of early active mobilization, its implementation status is still unsatisfactory. The most important obstacle is ensuring patient safety. Comprehensively assessing the physical condition of patients considered for mobilization is the basis of safety. However, appropriate guidance is lacking. We performed a systematic review to extract and summarize current safety assessment criteria for the early active mobilization of mechanically ventilated patients in the ICU.

Methods: A systematic literature search was conducted using English and Chinese databases according to the PRISMA checklist and guidelines to identify relevant original studies that evaluated safety assessment variables and specific parameters.

Results: A total of 24 medium- and high-quality articles involving a total of 4,842 subjects were included in the analysis. Among these studies, there were 15 randomized controlled trials involving 1,777 subjects (888 in the control groups, 889 in the interventional groups) and 9 cohort studies involving 3,065 subjects (1,240 in the control groups, 1,825 in the exposure groups). There were 5 safety assessment criteria, including cardiovascular, respiratory, neurological, musculoskeletal, and other. Within these were 17 different variables and 48 specific parameters.

Conclusions: The safety assessment criteria should focus on cardiac reserve, respiratory reserve, consciousness, and muscle strength. It is especially important to note whether the parameters are stable because parameter stability can be more representative of a patient's condition than absolute values. We provide a flow diagram for clinical safety assessments; however, some limitations exist, and this assessment requires further validation and optimization.

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REV	Zhang G, et al.	The effect of early mobilization for critical ill patients requiring mechanical ventilation: a systematic review and meta-analysis	J Emerg Crit Care Med 2018;2:9

Background: Although studies have confirmed the safety and feasibility of early active mobilization, its implementation status is still unsatisfactory. The most important obstacle is ensuring patient safety. Comprehensively assessing the physical condition of patients considered for mobilization is the basis of safety. However, appropriate guidance is lacking. We performed a systematic review to extract and summarize current safety assessment criteria for the early active mobilization of mechanically ventilated patients in the ICU.

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https://jeccm.amegroups.com/article/view/4065/4672

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REV	Zhang L, et al.	Early mobilization of critically ill patients in the intensive care unit: A systematic review and meta-analysis	PLoS One 2019 Oct 3;14(10):e0223185

Background: Although studies have confirmed the safety and feasibility of early active mobilization, its implementation status is still unsatisfactory. The most important obstacle is ensuring patient safety. Comprehensively assessing the physical condition of patients considered for mobilization is the basis of safety. However, appropriate guidance is lacking. We performed a systematic review to extract and summarize current safety assessment criteria for the early active mobilization of mechanically ventilated patients in the ICU.

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