Early Mobilization in the Intensive Care Unit

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Abstract Survivors of critical illness frequently suffer from disability associated with neuromuscular weakness. This can substantially impact their quality of life and ability to return home, and often results in the need for further rehabilitation. Early and aggressive physical and occupational therapy, beginning upon admission to the intensive care unit, can substantially reduce this functional disability and has been shown to impact numerous parameters including ICU and hospital length of stay, time needed to wean from mechanical ventilation, the incidence of delirium, and even rates of readmission and post-discharge mortality. While early mobilization has been shown to be both safe and feasible in a variety of ICU settings, it requires an interdisciplinary approach and changes to the ‘culture’ of the ICU. While the early results have been very encouraging, more research is needed to identify the optimal approach and the full extent of the benefits it may offer.

Keywords Critical care medicine · Physical therapy · Early mobilization · Quality improvement · Functional disability · Rehabilitation · ICU-acquired weakness

Introduction

Over the past several decades, advances in critical care medicine have allowed for the successful care of increasingly complex patients. With the introduction of ever more invasive therapies there has been a movement away from what was

once conventional wisdom in medicine: that immobilization in a hospital bed is harmful. The concept of early mobilization is not a new one. The harms associated with bed rest were well described in the 1940s by advocates for mobilization of hospitalized patients [1]. There is ample and mounting evidence that supports the safety, feasibility, and efficacy of early mobilization and rehabilitation in critically ill patients (including those who are mechanically ventilated and even those who require invasive cardiopulmonary support such as extracorporeal membrane oxygenation or left ventricular-assist device therapy) in the prevention and treatment of ICU-acquired weakness. Additionally, early mobilization has been shown to improve a number of other parameters including functional status at discharge, ICU and hospital length of stay (LOS), and the development of delirium in the ICU [2–4].

Background

Bed rest has long been employed as a therapeutic modality. However, a review of the literature involving therapeutic bed rest showed no outcome benefit in critically ill patients and an increased incidence of adverse outcomes in a variety of conditions [1, 5]. Prolonged bed rest and inactivity lead to decreased skeletal muscle use which resulted in decreased muscle synthesis and increased proteolysis with eventual muscle catabolism, atrophy and weakness [6, 7]. The diaphragm is particularly sensitive to disuse with atrophy seen after only 18 h of mechanical ventilation [8].

Neuromuscular Weakness in the ICU

There are multiple etiologies of weakness in the ICU including medication side effects, electrolyte abnormalities,

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exacerbation of pre-existing neuromuscular disorders, rhabdomyolysis, central nervous system (CNS) and spinal cord dysfunction, and systemic illness. Included in this differential is critical illness neuromyopathy (CINM), which is an umbrella diagnosis of several neuromuscular disorders associated with critical illness. The CINM can be further subdivided into critical illness polyneuropathy (CIP) and critical illness myopathy (CIM), which are often clinically indistinguishable and differentiated on the basis of nerve conduction studies. In CIM, compound muscle action potentials (APs) are reduced with both nerve and direct muscle stimulation with normal sensory APs. However, in CIP, compound muscle APs are reduced only with nerve stimulation with a concomitant reduction in sensory action potentials [9].

The ICU-associated weakness (ICUAW) is the clinical manifestation of CINM. It is characterized by bilateral symmetrical limb weakness, which often spares the cranial nerves. Risk factors for development of ICUAW include SIRS, sepsis, MOF, prolonged ICU length of stay, duration of mechanical ventilation >5 days, female sex, NMB agents, hyperglycemia, renal replacement therapy, use of catecholaminergic agents, and renal replacement therapy. The ICUAW is common, with an incidence ranging from 25 % in patients mechanically ventilated for more than 7 days up to 100 % in patients with sepsis and multiorgan failure [9, 10].

The sequelae from sepsis with ICUAW are long-lived, persisting well beyond the resolution of the acute physiologic illness. Survivors of ARDS reported subjective weakness and fatigability as well as an objective decrease in median distance walked in 6 min at 1 year (67 % predicted), which improved only modestly by 5 years following discharge (76 % predicted) [11, 12]. Only about half of these patients returned to work after 1 year and there was an increased incidence of depression, anxiety, and health care utilization compared to the general population [12]. In another prospective cohort study, survivors of severe sepsis were found to have higher rates of significant limitation in their activities of daily living as well as moderate to severe cognitive impairment which persisted for greater than 8 years [13].

Despite the growing problem of long-term disability after critical illness, few interventions have been identified to alter the course of functional decline. Despite initially promising animal studies, no pharmacologic agent has been shown to mitigate the risk of developing ICUAW, with the exception of intensive insulin therapy. However, as this was shown to increase mortality in critically ill patients, it has largely been abandoned as a possible therapy for ICUAW [14]. Therefore, early mobilization emerged as a potential intervention to prevent the profound disability associated with critical illness.

What is Early Mobilization?

For many patients who are receiving treatment in an ICU, therapy focuses almost entirely on correcting the physiologic derangements of the numerous failing organ systems. Patients are frequently sedated with infusions of narcotic medications in order for them to tolerate the invasive therapies employed. A focus on mobilization and rehabilitation has traditionally been deferred until later in the patient's hospital course. Under the paradigm of early mobilization, physical therapy and rehabilitation are a priority from the time of admission and are not limited to simple bedside exercises. Therapy sessions often begin within 24–48 h following admission to the ICU and occur frequently and concurrently with other standard ICU treatments. Various techniques have been described, but results have been very encouraging.

Safety and Feasibility

Grave disability and severe physiologic derangements are often viewed as barriers to mobilization as patients may be perceived as too ill to participate in physical therapy. The presence of indwelling catheters and monitors as well as the presence of delirium further complicate efforts at mobilization. Several studies have examined the safety of early mobilization in critically ill patients [15, 16•, 17, 18].

Early mobilization has been described in a variety of ICU settings including the medical and surgical ICU. Across the various trials in the medical ICU that have been undertaken [16•, 17, 18], the incidence of adverse events during therapy was low (1–4 %), except in one trial where the incidence was somewhat higher at 16 % [16•]. These studies generally excluded patients with a high FiO₂ requirement (>60 %), high PEEP (>10 cm H₂O), orthostatic hypotension, and the presence of catecholamine infusions. However, in the study conducted by Pohlman et al. [16•], even these patients were included, resulting in a higher level of minor adverse events (16 %). It should be highlighted, though, that only 4 % of all therapy sessions had to be terminated early, usually due to ventilator asynchrony. Additionally, while neurologic injury has often been cited as a possible contraindication to early mobilization, Olkowski et al. [19] reported their success in implementing a program in patients who had suffered aneurysmal subarachnoid hemorrhage (SAH). With therapy sessions beginning on average just 3.2 days following SAH, adverse events were rare, occurring in just 5.9 % of all therapy sessions.

While the majority of the data surrounding early mobilization supports its safety in the medical ICU, there is less data in the surgical ICU. However, there are several studies that demonstrate that it can be safely performed in

surgical patients. Clark and colleagues describe their experience in a trauma and burn ICU in a retrospective cohort study comparing patient outcomes both before and after the implementation of an early mobilization quality-improvement program. They evaluated 2,176 patients admitted to their ICU. While they were not able to quantify the “dose” of therapy sessions, it is important to note that they reported no adverse events associated with their early mobilization efforts [20]. Garzon-Serrano et al. [21] reported their results in a study comparing a nurse-led versus physical therapist-driven early mobilization program in a surgical ICU. Notably, there were no specific exclusion criteria and still they showed no adverse events associated with mobilization. Finally, in a small study describing their efforts in the implementation of an early mobilization program in a trauma ICU, Zomordi et al. [22] also reported no adverse events associated with their program.

Perhaps most illustrative of the safety of early mobilization, a case series by Turner et al. [23] studied early mobilization as part of a rehabilitation program for patients requiring extracorporeal membrane oxygenation (ECMO) support as a bridge to lung transplantation. In the patients requiring ECMO in this series, they reported no adverse events and it has become commonplace at our own institution to aggressively mobilize patients who require mechanical circulatory support.

As the comfort level with initiating early physical therapy for critically ill patients increases, criteria for early mobilization are being applied more liberally for inclusion in research studies as well as in general practice. It is becoming routine in many institutions to mobilize patients requiring mechanical ventilation excluding only those who are actively unstable or with the most tenuous physiologic derangements. This has often meant developing creative ways to utilize equipment and staff along with a high degree of vigilance to prevent adverse events. The evidence seems to suggest that early mobilization can be undertaken in the majority of ICU patients with a reasonable degree of safety and few adverse events, most of which are minor.

Efficacy and Benefits of Early Mobilization

Several studies have directly addressed the effectiveness of early mobilization in the prevention and treatment of ICUAW. Burtin and colleagues randomized 90 medical/surgical ICU patients at a single center to either early mobilization (passive or active bedside ergometry + standard care) or standard care alone (respiratory physiotherapy + standardized active/passive limb motion). Patients had an ICU LOS of at least 5 days prior to inclusion and an

expected stay of seven more days. The early mobilization group had a greater 6-min walk distance at hospital discharge as compared to the control group (29 vs. 25 % predicted, $p < 0.05$) with a trend toward increased discharge to home. Of note, there was no difference in mortality, ICU length of stay, or time to weaning from mechanical ventilation [24].

Schweikert et al., studied 104 medical ICU patients who were sedated and ventilated for less than 72 h and were expected to remain on mechanical ventilation for at least 24 more hours. Patients were randomized to early exercise/mobilization (progression of activity from range of motion to full ambulation) versus daily sedation interruption with physical therapy at the discretion of the primary team. Early mobilization was associated with an increased percentage of patients returning to independent functional status at hospital discharge (59 vs. 35 %, $p = 0.02$), less delirium, increased ventilator free days and a trend toward increased likelihood of being discharged home versus the need for further rehabilitation [2].

Several prospective cohort studies also suggest decreased ICU and hospital LOS, decreased sedation requirements, and decreased incidence of delirium in patients receiving early physical and occupational therapy (PT/OT) [4, 25••]. Additionally, Morris et al. [26•] were able to demonstrate in a cohort of survivors of acute respiratory failure that lack of participation in an early mobilization program was an independent predictor of mortality and readmission in the 12 months following hospital discharge. While more studies are needed to confirm the benefits described in larger, more heterogeneous patient populations, it makes intuitive sense that maintaining muscle strength and beginning the rehabilitation process while patients remain in the ICU could have significant impact on the outcome of their illness. In an era of increasing scrutiny on healthcare expenditures and outcomes, an intervention that may lead to fewer complications, shorten the duration of both hospital and ICU length of stay, decrease the need for readmission and mortality, and allow more patients to be discharged back home should be considered a priority.

Implementation

Despite the emerging body of evidence regarding the safety and efficacy of early mobilization in preventing long-term disability after critical illness, significant barriers often exist to implementation of an early mobilization program. Development of a program requires multi-disciplinary involvement, which is often complicated by institutional biases and practice patterns. Each institution will have unique needs and capabilities and bringing nurses, physical therapists, physicians, and respiratory therapists together is critical to developing a

successful program. For example, some institutions may choose to have some mobilization carried out by nurses with physical therapists being involved with more challenging and debilitated patients. Other hospitals may have the ability to have physical therapists involved with all patients during mobilization [27].

Implementation often requires significant recruitment of resources to be successful. This may include hiring of additional staff, such as physical therapists, or adjustment of nurse to patient staffing ratios in a nursing-based program. There are equipment issues to resolve including transport ventilators and monitors as well as specialized equipment such as lifts and integrated mounting systems for pumps, monitors, and other devices [28]. Sedation practices must also be adjusted to allow for patients to be awake enough to participate.

At present, there are large variations in practice and no standard method of mobilizing patients in the ICU. Some of the most successful programs have made mobilization the top priority for their patients, changing everything from sedation practices to the timing of physician rounds and other procedures to accommodate the therapy sessions. Several programs have stressed the idea of mobilization to the degree that ambulation is used as a criteria for extubation. Although most programs have more conservative goals, this highlights the degree of variability and potential for adaptation to individual departments.

Successful implementation of an early mobilization program requires buy-in and collaboration from an interdisciplinary team. Pronovost et al. [29] have described a model for translation of knowledge into clinical practice comprised of four steps. Lipshutz et al. [27] adapted this model for a proposed method of implementing an early mobilization program in the ICU. The first step is achieving ‘buy-in’ from stakeholders including senior management and clinicians as well as other members of the healthcare team by reviewing the scientific data showing the benefit of the intervention. Development of an interdisciplinary team comprised of nurses, physical therapists, respiratory therapists, and physicians is critical to this process. Working as a group, the team must then identify what barriers exist locally to prevent mobilization and work to identify ways to resolve those barriers. Common barriers at our own institution have been obtaining orders for PT/OT for every patient, obtaining equipment that allows the patient to mobilize such as transport ventilators and specially modified walkers, and hiring additional staff. Once a protocol is developed by the team and the intervention implemented, data must be collected to assess the outcome and any adverse events. The team must then work to ensure that all patients receive the intervention. Generally, protocols for early mobilization call for graded increases in the level of physical activity starting with

range of motion exercises, progressing to sitting up in bed, standing and ultimately ambulating. For patients who are not ambulatory, cycle ergometry is an excellent means of mobilization [28]. Hanekom et al. [30] have published algorithms and guidelines to help select the best modality for mobilization given a patient’s clinical status.

At a time when cost reduction is chief among the concerns of many hospital administrators, the prospect of adding additional staff such as nurses or physical therapists may seem impossible. In a study of over 300 medical ICU patients, Morris et al. [4] were able to demonstrate decreases in both ICU and hospital LOS in patients who were treated according to an early mobilization protocol. It is important to note that in their study they utilized a “Mobility Team” consisting of a nurse with no direct bedside patient care responsibilities and a physical therapist who saw the patient 7 days per week to administer therapy. Despite this increase in staff dedicated to the early mobilization program, they showed no increase in cost.

Future Directions

As ICUAW has gained recognition as a clinical entity and public health issue, there has been a steady expansion of programs focused on early mobilization in critically ill patients. Few standardized measures exist which quantify mobility and identify treatment failure. Prior studies have focused largely on outcomes, using indirect measures for treatment success such as distance achieved during a 6-min walk, discharge to home as opposed to a skilled nursing facility, and the number of ventilator free days. However, few have focused on grading specific functional gains made during therapy sessions. Such scoring metrics are needed to track individual patient progress as well as to provide a standardized basis for comparing patients in clinical trials. Additionally, scoring metrics may have the benefit of having prognostic value as Kasotakis et al. [31] were able to demonstrate with their optimal mobility score for surgical ICU patients.

While early mobilization has seen a sharp rise in the sheer number of programs, especially at larger institutions, it is not yet standard of care outside of a handful of tertiary care institutions. As it becomes more widely accepted and incorporated into standard ICU care, there should be more outcome data to help define the degree of benefit as well as to help tailor therapy to specific patient populations.

Conclusion

Disability following critical illness is a well-described problem that impacts not only the patient through effects on

their functional mobility and quality of life, but society as a whole due to the high costs associated with ongoing care. Early mobilization programs have been shown to be safe for even the most challenging ICU patients. Benefits that have been demonstrated range from improved functional mobility at discharge to decreased ICU and hospital LOS and even lower rates of hospital readmission and mortality up to 1 year following critical illness. The establishment of an early mobilization program requires the creation of an interdisciplinary team to collaboratively develop a program designed to address the unique needs of a given institution. While changes in the ‘culture’ of the ICU are often required to achieve optimal outcomes, the current evidence supporting early mobilization should prompt most ICUs to consider implementing a program.

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References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

1. Dock W. The evil sequelae of complete bed rest. *J Am Med Assoc.* 1944;125(16):1083–4.
2. Schweickert WD, et al. Early physical and occupational therapy in mechanically-ventilated, critically ill patients: a randomised controlled trial. *Lancet.* 2009;373:1874–82.
3. Garcia JP, et al. Ambulatory extracorporeal membrane oxygenation: a new approach for bridge-to-lung transplantation. *J Thorac Cardiovasc Surg.* 2010;139(6):e137–9.
4. Morris PE, et al. Early intensive care unit mobility therapy in the treatment of acute respiratory failure. *Crit Care Med.* 2008;36(8):2238–43.
5. Allen C, Glasziou P, Mar CD. Bed rest: a potentially harmful treatment needing more careful evaluation. *The Lancet.* 1999;354(9186):1229–33.
6. Chambers MA, Moylan JS, Reid MB. Physical inactivity and muscle weakness in the critically ill. *Crit Care Med.* 2009;37(Suppl 10):S337–46.
7. Puthucherry Z, Harridge S, Hart N. Skeletal muscle dysfunction in critical care: wasting, weakness, and rehabilitation strategies. *Crit Care Med.* 2010;38(Suppl 10):S676–82.
8. Levine S, et al. Rapid disuse atrophy of diaphragm fibers in mechanically ventilated humans. *N Engl J Med.* 2008;358(13):1327–35.
9. de Jonghe B, et al. Intensive care unit-acquired weakness: risk factors and prevention. *Crit Care Med.* 2009;37(Suppl 10):S309–15.
10. Tennila A, et al. Early signs of critical illness polyneuropathy in ICU patients with systemic inflammatory response syndrome or sepsis. *Intensive Care Med.* 2000;26(9):1360–3.
11. Herridge MS. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med.* 2003;348(8):683–93.
12. Herridge MS. Functional disability 5 years after acute respiratory distress syndrome. *N Engl J Med.* 2011;364(14):1293–304.
13. Iwashyna TJ, Ely EW, Smith DM, Langa KM. Long-term cognitive impairment and functional disability among survivors of severe sepsis. *J Am Med Assoc.* 2010;304(16):1787–94.
14. Finfer S, et al. Intensive versus conventional glucose control in critically ill patients. *N Engl J Med.* 2009;360(13):1283–97.
15. Leditschke IA. What are the barriers to mobilizing intensive care patients. *Cardiopulm Phys Ther J.* 2012;23(1):26–9.
16. •• Pohlman MC, et al. Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. *Crit Care Med.* 2010;38(11):2089–94. *In this multi-center trial, the authors describe their experience and outcomes in implementing an early mobilization program in a population of patients with numerous barriers to mobilization. This study demonstrates that early mobilization is safe and feasible in mechanically-ventilated patients.*
17. Bourdin G, et al. The feasibility of early physical activity in intensive care unit patients: a prospective observational one-center study. *Respir Care.* 2010;55(4):400–7.
18. Bailey P, et al. Early activity is feasible and safe in respiratory failure patients. *Crit Care Med.* 2007;35(1):139–45.
19. Olkowski BF, et al. Safety and feasibility of an early mobilization program for patients with aneurysmal subarachnoid hemorrhage. *Phys Ther.* 2012;93(2):208–15.
20. Clark DE, et al. Effectiveness of an early mobilization protocol in a trauma and burns intensive care unit: a retrospective cohort study. *Phys Ther.* 2013;93(2):186–96.
21. Garzon-Serrano J, et al. Early mobilization in critically ill patients: patients’ mobilization level depends on health care provider’s profession. *PM R.* 2011;3(4):307–13.
22. Zomorodi M, Topley D, McAnaw M. Developing a mobility protocol for early mobilization of patients in a surgical/trauma ICU. *Crit Care Res Pract.* 2012;2012:964547.
23. Turner DA, et al. Active rehabilitation and physical therapy during extracorporeal membrane oxygenation while awaiting lung transplantation: a practical approach. *Crit Care Med.* 2011;39(12):2593–8.
24. Burtin C, et al. Early exercise in critically ill patients enhances short-term functional recovery. *Crit Care Med.* 2009;37(9):2499–505.
25. •• Needham DM, et al. Early physical medicine and rehabilitation for patients with acute respiratory failure: a quality improvement project. *Arch Phys Med Rehabil.* 2010;91(4):536–42. *The authors describe their experience in the establishment and implementation of an early mobilization program using the model of a quality improvement project. Outlining the steps taken to develop their program, this will be helpful to anyone who is seeking to establish a similar program in an ICU.*
26. • Morris PE. Receiving early mobility during an intensive care unit admission is a predictor of improved outcomes in acute respiratory failure. *Am J Med Sci.* 2011;341(5):373–77. *The authors describe the results of a cohort study looking at outcomes in survivors of acute respiratory failure. Lack of early ICU mobility was associated with an increased likelihood of death and readmission within one year. While the study was not prospective, it establishes that there may be some effect of early mobilization beyond ICU and hospital discharge.*
27. Lipshutz AKM, et al. Early mobilization in the intensive care unit: evidence and implementation. *ICU Dir.* 2012;3(1):10–6.
28. Needham DM, Truong AD, Fan E. Technology to enhance physical rehabilitation of critically ill patients. *Crit Care Med.* 2009;37(10 Suppl):S436–41.
29. Pronovost PJ, Berenholtz SM, Needham DM. Translating evidence into practice: a model for large scale knowledge translation. *B Med J.* 2008;337:a1714.

30. • Hanekom S, et al. The development of a clinical management algorithm for early physical activity and mobilization of critically ill patients: synthesis of evidence and expert opinion and its translation into practice. Clin Rehabil. 2011;**25**(9):771–87. *Here, the authors describe the process of developing clinical management algorithms for mobilizing critically-ill adults based on their clinical status. This may be a valuable resource when establishing an early mobilization program.*
31. Kasotakis G, et al. The surgical intensive care unit optimal mobility score predicts mortality and length of stay. Crit Care Med. 2012;**40**(4):1122–8.