

Managing the Patient on Mechanical Ventilation in ICU: Early Mobility and Walking Program

Christiane Perme, PT, CCS and Rohini Krishnan Chandrashekar, PT, MS, CCS

ABSTRACT

Early mobilization of critically ill patients on mechanical ventilation is an advanced physical therapy practice. It requires knowledge and specialized skills in specific areas such as cardiovascular and pulmonary anatomy and pathophysiology, mechanical ventilation and assessment of the oxygen delivery system through hemodynamic monitoring. Comprehensive knowledge and skills in these areas will impact the clinical decision-making process and treatment prescription for such complex patients. The implementation of an early physical therapy program for selected patients on mechanical ventilation with a focus on early mobility and walking is essential to minimize functional decline. The use of an interdisciplinary approach is imperative for successful outcomes. Physical therapists are an integral member of the interdisciplinary team caring for a patient in the Intensive Care Unit (ICU) and are uniquely qualified to design and implement treatment plans towards improvement of function. Physical therapists need to be competent, confident, and use strong clinical thinking skills when confronted with the challenges of patient care in the ICU. This article includes the rationale for an early mobility and walking program, the knowledge required for safe and effective treatment, and the approaches to treatment that will optimize the function of these patients

Introduction

Physical therapy is provided with the aim of improving functional performance, preventing the effects of musculoskeletal deconditioning and achieving an optimal quality of life for an individual with movement dysfunction.¹ Implementation of a physical therapy program in patients with functional decline is widely accepted. Yet, patients on mechanical ventilation in the intensive care unit (ICU) are underserved by physical therapists. The ICU setting

itself promotes limited mobility due to the intimidating and overwhelming presence of multiple lines and attachments. The problem is compounded when the patient requires ventilatory support. Intubation and mechanical ventilation are usually perceived as barriers to body positioning and mobilization. Furthermore, patients who require mechanical ventilation often present with multiple comorbidities, which could prevent them from weaning off the ventilator.

This complex environment, where patients in the ICU require prolonged mechanical ventilation, presents unique challenges to physical therapists. No consensus among experts has been developed for what defines prolonged mechanical ventilation, hence, the range reported in the literature ranges from as few as 2 days up to 30 days or more.² Increased length of stay (LOS) in an ICU adds to a high cost of care, high morbidity and mortality³ and a decreased quality of life.⁴ All of these negative outcomes are major contributing factors to poor functional status since these patients suffer a great loss of physiologic function. The implementation of an early physical therapy program for selected patients on mechanical ventilation with a focus on early mobility and walking in the ICU setting is essential to minimize functional decline.

Although early mobilization is strongly recommended,^{5,6,7} no clear, established evidence exists that it assists in the outcomes desired, e.g., reducing hospital stay, improving morbidity and mortality, and improving quality of life for the patient and the family.⁸ Physical therapists are integral members of the interdisciplinary team caring for a patient in the ICU. Physical therapists are uniquely qualified to design and implement treatment plans when outcomes are directed towards improvement of function. Nevertheless, national and worldwide standards have yet to be established for the delivery of physical therapy services to patients in ICU.⁸ This

article will focus on the clinical aspects of early mobility and walking of mechanically ventilated patients following the theoretical and physiologic rationale described in the article by Elizabeth Dean.

Knowledge required to work with patients on mechanical ventilation in the ICU

Early mobilization of critically ill patients on mechanical ventilation is an advanced physical therapy practice. It requires education and specialized skills in specific areas that impact the clinical, decision-making process as well as the treatment prescription for such complex patients. Developing this expertise will allow the therapist to communicate confidently with physicians, nurses, respiratory therapists, and any other clinicians. To provide appropriate and safe practice, physical therapists working in ICU are expected to have a strong knowledge base of the following:

- Cardiovascular and pulmonary anatomy and physiology
- Pathophysiology of cardiovascular and pulmonary disorders and the effect on oxygen transport and delivery
- Cardiovascular and pulmonary assessment
- Knowledge and ability to identify abnormal cardiac rhythms
- Monitoring and life support systems routinely used in ICU
- Mechanical ventilation (Terminology is given in Box 1)
- Thorough understanding of artificial airways
- Respiratory care and supplemental oxygen delivery equipment
- Medications commonly used in ICU and their implications for physical therapy practice
- Knowledge and interpretation of laboratory values
- The role of each ICU interdisciplinary team member
- Familiarity with emergency procedures and policies in the ICU where you practice

VENTILATOR TERMINOLOGY

A/C: ASSIST CONTROL

- Non weaning mode
- Rate and tidal volume are set to deliver a minimum minute ventilation
- Patient can generate as many breaths as needed by triggering the ventilator
- On each spontaneous respiratory effort generated by the patient, the machine delivers the preset tidal volume
- Patients usually tolerate increased demands during physical therapy if medically stable

SIMV: SYNCHRONIZED INTERMITTENT MANDATORY VENTILATION

- Weaning mode
- Rate and tidal volume are set to deliver a minimum minute ventilation
- Patient is able to breath spontaneously between ventilator breaths
- On each spontaneous breath, the patient will receive as much volume as he can generate
- Often used with in conjunction with PSV

CPAP: CONTINUOUS POSITIVE AIRWAY PRESSURE

- Spontaneous mode of ventilation
- Weaning mode
- CPAP maintains positive pressure continuously in the airways
- Pressure support is be added to augment patient's tidal volume

PS: PRESSURE SUPPORT VENTILATION

- Applies to spontaneous breaths only
- May be applied to a patient's spontaneous breathing during SIMV or CPAP
- Once the patient triggers the ventilator, the preset positive pressure is delivered
- Volume is not pre-set, Pressure Support augments the tidal volume
- The patient controls respiratory rate and inspiratory time

NIPPV: NONINVASIVE POSITIVE PRESSURE VENTILATION

- Uses a mask instead of an artificial airway
- Used when short term ventilation is expected for COPD exacerbation, failed extubation, pneumonia, CHF, pulmonary edema

PEEP: POSITIVE END EXPIRATORY PRESSURE

- Pressure left in the ventilator circuit at the end of expiration
- PEEP increases functional residual capacity
- Increases lung volume to prevent or correct atelectasis
- Increases mean airway pressure to improve oxygenation
- Prevents airways from collapsing

FiO₂: FRACTION OF INSPIRED OXYGEN

- Supplemental oxygen delivered by the ventilator expressed as a percentage

Decision-making process

One of the most important skills of a physical therapist working in an ICU is the ability to make clinical decisions on when to initiate, delay, continue or stop activities for critically ill patients. The clinician must process large amounts of information in a short time to make the appropriate decisions.⁹ The physical therapy program should be based on patient's medical condition and goals, not on the ICU equipment and presence of mechanical ventilation. Limited knowledge and understanding of ICU equipment and mechanical ventilation will significantly limit outcomes for these patients.⁵

The decision-making process starts when the clinician arrives at the bedside and starts

gathering the relevant information. Then, it continues as a dynamic, response-driven process, in which clinical decisions are made minute-to-minute, based on a comprehensive evaluation of medical condition, symptoms, and the patient's response to activity. When implementing a response-driven process, the therapist must be aware of the parameters set by the medical team managing the patient and their current goals of care. A strong commitment to an interdisciplinary team approach is imperative to the clinical decision-making process as well as safe practice. Physical therapists do not need to be prepared to solve medical emergencies, however they must be aware of impending medical problems that could lead to an emergency.

Which patients on mechanical ventilation will benefit from an early mobility and walking program?

A physician referral is required prior to a physical therapy evaluation and/or the initiation of any treatment. Once a referral is made to physical therapy, the physical therapist is ultimately responsible for determining the appropriateness of an early mobility and walking program for each patient. For physical therapy purposes, early mobility means encouraging the patient to be active, upright and moving once physiological stabilization has occurred after ICU admission.

Some criteria to assist the clinician in this determination include:

- Neurologic: The patient must be able to respond to verbal stimulation and follow simple commands
- Circulatory: The patient must be hemodynamically stable with acceptable heart rate, rhythm, blood pressure without vasopressor drugs e.g., Dopamine, Vasopressin, Norepinephrine
- Respiratory: The patient must have an adequate ventilatory pattern with the rate and rhythm of breathing synchronized with the ventilatory support provided. The individual must also be receiving acceptable levels of supplemental oxygen, usually less than 0.6 FiO₂, unless specified by the physician.

Physical therapy evaluation

Once the patient is referred to physical therapy, a comprehensive physical therapy evaluation is performed. An example is provided in Box 2. The evaluation will help establish baseline information for the patient and establish the diagnosis, prognosis, and plan of care. Examinations may need to be adapted for the ICU. Many standard tests and measures are not possible in the ICU setting and the patient's medical condition may limit accurate examination. Based on the data gathered on the examination, patients in ICU who require mechanical ventilation are often found to have one or more of the following impairments and functional limitations:

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- Impaired ventilation
- Impaired gas exchange
- Impaired aerobic capacity
- Impaired muscle performance
- Inability to perform bed mobility and transfer activities independently
- Inability to ambulate
- Inability to perform self care or instrumental ADLs

Physical therapy goals

Setting appropriate goals for mechanically ventilated patients in the ICU can be a difficult task for physical therapists and should be based on the anticipated outcomes. These generally are the intended

results expected after the plan of care has been implemented.

Anticipated Outcomes

- Level of arousal is improved
- Optimized cardiopulmonary function
- Optimized neuromuscular function
- Loss of functional abilities is minimized
- Independence is maximized
- Weaning process is facilitated when the primary cause of weaning failure is muscle weakness
- Patient attitude towards recovery is improved

Physical therapy short- and long-term goals should be measurable and time-limited. In many cases, a patient's medical condition improves rapidly and the expected time of mechanical ventilation is short and predictable. For such patients, functional recovery is expected as the medical condition improves. Short- and long-term function-oriented goals can be set in these cases. Setting long-term goals for more complex patients requiring extended periods of ventilatory support may not be reasonable. Due to fluctuations in the patient's medical status as well as an unpredictable prognosis, the long-term goals may be deferred until the patient demonstrates an improvement in the medical condition.

Goals should always be patient-specific, based on individual capabilities and overall medical condition. Areas of focus for setting goals for impairments and functional limitations include:

- Improve muscle strength or motor control in order to promote increased function:
 - Lower extremities
 - Upper extremities
 - Head and trunk control
- Improve endurance:
 - Increase repetitions of exercises for upper and lower extremities
 - Increase time sitting unsupported at the edge of the bed
 - Increase walking distance within acceptable signs and symptoms
 - Adding aerobic activities such as bicycle and arm ergometry and stair
- Progressively improve functional mobility:
 - Bed mobility activities
 - Standing with assistive device and assistance
 - Transfer to a chair or bedside commode
 - Walking re-education with an assistive device and assistance
 - Independence with ADLs

PHYSICAL THERAPY EVALUATION

- Chart Review:* Past and present medical history
- Previous level of function:* Independence with ambulation and Activities of Daily Living (ADLs), use of assistive device/adaptative equipment/durable medical equipment (DME), activity level, exercise habits.
- Social history:* Family resources and support system, employment
- Mental status:* Level of consciousness as well as ability to follow commands, presence of sedation and rationale for its use, confusion, agitation
- Skin integrity*
- Cardiac status:* Heart rate and rhythm, blood pressure, ejection fraction, presence of invasive life support and equipment like pulmonary artery catheter, IABP, LVAD, CVVHD
- Pulmonary status:* Ventilator settings, arterial blood gas values, oxygen saturation value, X-rays results, last ventilator change, weaning process and schedule
- Neurological status:* Intracranial pressure, tone, presence of paralysis/paresis, coordination, sensation
- Musculoskeletal status:* Fractures, limitations in range of motion (ROM), presence of significant muscle weakness
- Medications:* especially those that can potentially affect functional performance: Corticosteroids, neuromuscular-blockers, narcotics, sedatives
- Relevant laboratory and diagnostic tests*
- Current functional status:* Bed mobility, transfers, and ability to walk

Physical therapy treatment

Physical therapy interventions in ICU can include positioning, postural drainage, airway clearance, breathing retraining, therapeutic exercises, inspiratory muscle

training (IMT), transfers, gait re-education and patient/family education. As discussed previously, the focus of the physical therapy treatment for mechanically-ventilated patients in ICU should be to assist the patient achieve the upright position, tolerate weight-bearing activities and progress to walking re-education as soon as possible. Physical therapy interventions must be selected prudently in a goal-oriented manner with focus on function. The prescriptive parameters for this patient population were discussed in detail in the Elizabeth Dean's accompanying article.

Gait re-education for patients requiring mechanical ventilation in ICU is the link between bed rest and the ability to bear weight, walk, and improve functional mobility. Suggestions for devices to assist in ambulation are available,^{10,11,12} but a standard of care to guide practice for such patients does not exist. Weight-bearing activities can be a great challenge for the elderly and high acuity patient population. Profound weakness, decreased endurance, and multiple medical problems significantly limit functional gains. The use of a dynamic tilt-table as an adjunct to conventional rehabilitation techniques has reported in the literature.^{12,13} It allows patients to perform closed-chain exercises in a gravity-reduced environment using their own body-weight.^{13,14} Sometimes identifying patients who will benefit from an early mobility and walking program can

delivery to support activity. Progression of a mobilization test is shown in Box 3.

Prior to mobilizing these patients, several questions must be answered to develop an appropriate treatment plan.

- What is the level of patient participation?
- What is the severity of the patient's functional impairments?
- What are the available treatments of choice?
- What are the treatment priorities in this case? Why?
- What are the prescriptive parameters?
- What should be the treatment sequence? Why?
- What is the expected time available and course of treatment?

Good communication with the physician, nurse and respiratory therapist is essential and they must agree on the appropriate activity for each patient on a daily basis. The nurse must be available to assist with IV lines and the respiratory therapist to assist with ventilator management. An organized plan must be in place to ensure that lines and leads are connected appropriately for assessment and are managed during treatment. Alarms often go off when working with patients in an ICU on a monitor or a ventilator. They alert

sure you resolve the issue and then continue with planned treatment if appropriate. When alarms go off:

- Stop treatment momentarily
- Observe and provide support to the patient
- Determine which alarm is sounding and why
- Take appropriate steps to resolve problems causing the alarm to sound
- If you are unsure as to why, or the alarms do not stop, call the nurse or respiratory therapist immediately
- Never leave the patient

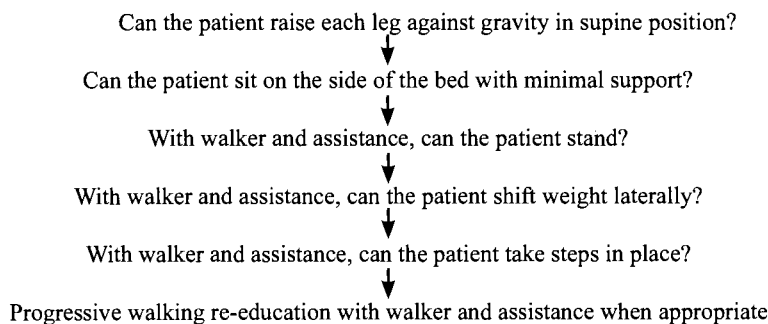
Monitoring the ICU patient on mechanical ventilation

The physical therapist must have knowledge of normal values for vital signs. The heart rate (HR), blood pressure (BP), oxygen saturation (SpO₂), and respiratory rate (RR) at rest must be noted. In the ICU, these signs are available on the telemetry monitor. The acceptable range for vital signs may differ with each patient. Determine what is acceptable for each patient prior to each therapy session once the overall medical condition is thoroughly assessed. The limits for each vital sign during activity should be discussed with and agreed upon by the interdisciplinary team. Due to the critical nature of patients' illnesses and constant changes in overall medical condition, a vigilant assessment is necessary to determine whether the patient is tolerating the planned intervention. It also allows the treatment plan to be modified as necessary to adhere to the set parameters and promote safety. Always correlate vital signs with symptoms and also be specifically aware of sudden changes in the vital signs. Appropriate ventilatory and oxygen support must be provided so that the patient can tolerate increased levels of activity.

Absolute contraindications for the early mobility and walking program

- Comatose, unresponsive patients
- Significant and symptomatic changes in resting EKG with hemodynamic compromise

MOBILIZATION TEST IN ICU



be difficult; however delaying mobility can place patients at risk for the development of preventable secondary impairments and functional limitations. Some patients may be ready to move before they appear to be or before we think they are. A mobilization test can help determine whether the patient has the motor control and adequate oxygen

clinicians that the vital signs or ventilator function are outside the parameters set by the medical team. When an alarm sounds, evaluate the patient. An alert and oriented patient is usually not in immediate danger. If a patient is responsive and participating, the therapy treatment should not be terminated just because of an alarm. Make

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- Unstable angina
- Uncontrolled heart failure
- Hemodynamic instability requiring high doses or multiple vasopressor drugs
- Suspected or known dissecting aneurysm
- Acute pulmonary emboli with unstable medical condition
- Significant oxygenation dysfunction requiring high levels of supplemental oxygen, usually more than 0.7 FiO₂, unless specified by the physician
- Cerebral edema with uncontrolled ICP
- Significant neurological and/or musculoskeletal dysfunction
- Unstable fractures

Barriers to an early mobility and walking program for mechanically ventilated patients in the ICU

To decrease the possibility of adverse effects during the course of physical therapy evaluation and treatments, the following factors must be assessed and considered prior to establishing a treatment plan:

- Confidence and level of expertise of physical therapist in the ICU environment
- Lack of patient cooperation
- ICU culture promoting bed rest
- Age and level of function prior to ICU admission
- Severity of disease and comorbidities
- Limited cardiac and pulmonary reserve
- Limited assessment of strength, mobility and ability to bear weight
- Patient's body weight
- Pain
- Sedation
- Nutritional status
- Sleep deprivation
- Interdisciplinary cooperation
- Staff availability to assist with mobility
- Number of lines, tubes monitoring and life support equipment

Guidelines to terminate a physical therapy session in the ICU

- Severe chest pain associated with EKG changes
- Heart rate above predicted maximum heart rate or pre-determined limits set by the medical team
- Hypotension associated with dizziness, light headedness, and diaphoresis
- Intolerable dyspnea associated with increased use of accessory muscles, paradoxical breathing pattern, nasal flaring, and cyanosis
- Unable to maintain acceptable SpO₂ despite supplemental oxygen
- Severe pain despite analgesia
- Extreme fatigue
- The patient wishes to stop

Tips for success

You must ask yourself a few questions prior to every initial evaluation and therapy treatment session. The answers to these will guide your clinical decision making process and help provide safe practice.

- Who is my patient? Information from chart review, nurse, MD, family.
- Is my patient able to participate with therapy? Awake, able to follow commands.
- Is my patient hemodynamically stable? Look at the monitor, IV drips.
- How does my patient look? Calm, relaxed, uncomfortable, acute distress.
- What is the position and integrity of the artificial airway, lines, tubes attached to the patient?
- Is my patient on life support equipment? Ventilator, Intraaortic balloon pump (IABP), Left ventricular assistive device (LVAD), Continuous venovenous hemodialysis (CVVHD).
- Has my patient's medical condition changed drastically in the past 24 hours? Recent surgery, hypotension, reintubation...
- Do I have enough help and support from the interdisciplinary team to ensure patient safety throughout the treatment session?

Patients with endotracheal intubation or tracheostomy can be safely mobilized when appropriate measures are taken.¹⁵ Therefore, physical therapists working

with mechanically ventilated patients must have a thorough knowledge of mechanical ventilation and artificial airways. A comprehensive orientation program and competency assessment is the key for a successful physical therapy practice in the critical care environment. Limited knowledge and understanding of the ICU equipment can limit therapy outcomes for ICU patients. To be equipped to provide safe and effective care for the critically ill patients, the physical therapist must:

- Understand principles of oxygen transport and basic cardiopulmonary pathophysiology
- Understand function of the ICU equipment and implications during therapy interventions
- Understand medical interventions provided in ICU
- Work closely with all members of the ICU team
- Use strong critical thinking skills

Complications directly related to therapy interventions in the ICU are rare despite numerous lines, tubes, monitoring and life support equipment; HOWEVER, here are some words of caution:

What you don't know can hurt you and your patients...

Make sure you know what you are doing...

Only do what you know and feel comfortable doing...

Done right it is safe and effective...

Done wrong it can be fatal...

Conclusion

Physical therapists practicing in the ICU face complex challenges in caring for mechanically ventilated patients. For many physical therapists, the ICU presents as an intimidating environment; however, they must never forget their primary goal of improving function. By developing a strong knowledge base and skills required for safe practice in this clinical setting, the confidence of physical therapists will increase. The use of an interdisciplinary approach is imperative for successful outcomes. Mobilization involving

gravitational stimulus and walking of selected patients requiring mechanical ventilation in ICU is recommended but it is not always part of physical therapy intervention. Since the specific role of the physical therapist in the ICU has not been well defined, it varies considerably and the physical therapy program is implemented according to the individual's professional discretion. As observed by the authors, the concept of an early mobility and walking program for selected ICU patients has the potential to affect positive outcomes, including:

- Prevention of secondary complications of bed rest
- High level of satisfaction for nurses, patients, physicians, therapists, and family members
- Assistance with ventilator weaning process as strength, functional mobility and endurance improve
- Decreased length of hospital stay and costs

We have an urgent need for research to provide scientific evidence that an early mobility and walking program definitively improves outcomes. The physical therapy profession must establish the optimal physical therapy interventions and determine their effectiveness in the treatment of patients requiring mechanical ventilation in the ICU. This will pave the way for the involvement of physical therapy to be a universally accepted standard of practice in the management of medically complex patients.

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Christiane Perme, PT CCS is a Cardiovascular and Pulmonary Clinical Specialist and a Senior Physical Therapist at the Methodist Hospital in Houston, TX. She is also staff lecturer for Motivations, Inc. and Education Resources, Inc.

Rohini Krishnan Chandrashekar PT, MS, CCS received a Bachelors Degree in Physical Therapy from University of Bombay, India and a Masters Degree in Physical Therapy from Boston University, Boston, MA. Certified as a Cardiovascular and Pulmonary Clinical Specialist since 1996. Varied experience in ICU and outpatient settings with extensive involvement in Pulmonary Rehabilitation. Presently work at Triumph Hospital and at Bay Area Rehabilitation Inc. in Houston, TX



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